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REVIEW

BIRDS, NEEDLES, AND IRON: LATE HOLOCENE PREHISTORIC ALASKAN GROOVING TECHNIQUES

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ABSTRACT

This article considers questions in prehistoric technology by examining organic artifacts from several Alaska Late Holocene sites, including Croxton Site Locality J at Tukuto Lake, western Brooks Range. Examples of bone needle "cores" and needles crafted from large bird humeri are measured and microscopically examined to distinguish possible differences in tools and reduction techniques. Tool handles used to accomplish grooving, including "engraving tool handles," as well as differences between iron and stone bits, are discussed. Archaeometric data, avian ecology, and ethnographic accounts are explored to investigate aspects of needle manufacture, the introduction of iron, and the potential relationships people had to these materials and objects.

KEYWORDS: Avifauna, needles, bone, technology, Ipiutak, engraving

INTRODUCTION

Grooving technologies, the processes by which organic materials were divided and shaped, were frequently put to use by arctic and subarctic cultures. These processes have been studied by archaeologists to some degree and continue to be of interest for understanding tool manufacture. Semenov's well-known *Prehistoric Technology* (1976 [1964]) gives excellent insights into a variety of processes in bone, antler, and ivory reduction pertinent to this paper's focus on grooving bone, especially aspects of metal versus stone bits. Bird bone is known worldwide for use in the manufacture of a variety of small implements, including needles (cf. Gál 2005, 2007), but there has been little detailed analysis of processes associated with needle production. Variations in techniques in the reduction of large bird bones for needle manufacture may be useful in considering the movement of traded material and innovation in material technology during prehistoric times in Alaska.

In addition to the analysis of bird bone cores and the nature of bird bone itself, we consider the construction of tools required to accomplish grooving, including "engraving tool handles" (*sic* Larsen and Rainey 1948) and other handles, as well as bits associated with grooving techniques. The probability of traded iron being used as bit material in the Bering Sea region by the turn of the first millennium AD has been clearly stated, for example, in Gusev et al. (1999) and illustrated in Gusev and Zhilin (2002). Observations on the use of iron have been discussed since at least Collins (1937a). Larsen and Rainey (1948), McCartney and Mack (1973), McCartney (1988), and Bowers (2009) have made direct observations and analysis of traded iron and its impact on technology. Our research tests whether the difference between organic material grooved with iron bits versus stone bits is visible microscopically, specifically in the manufacture of bird bone needles. These efforts are directed toward an underlying

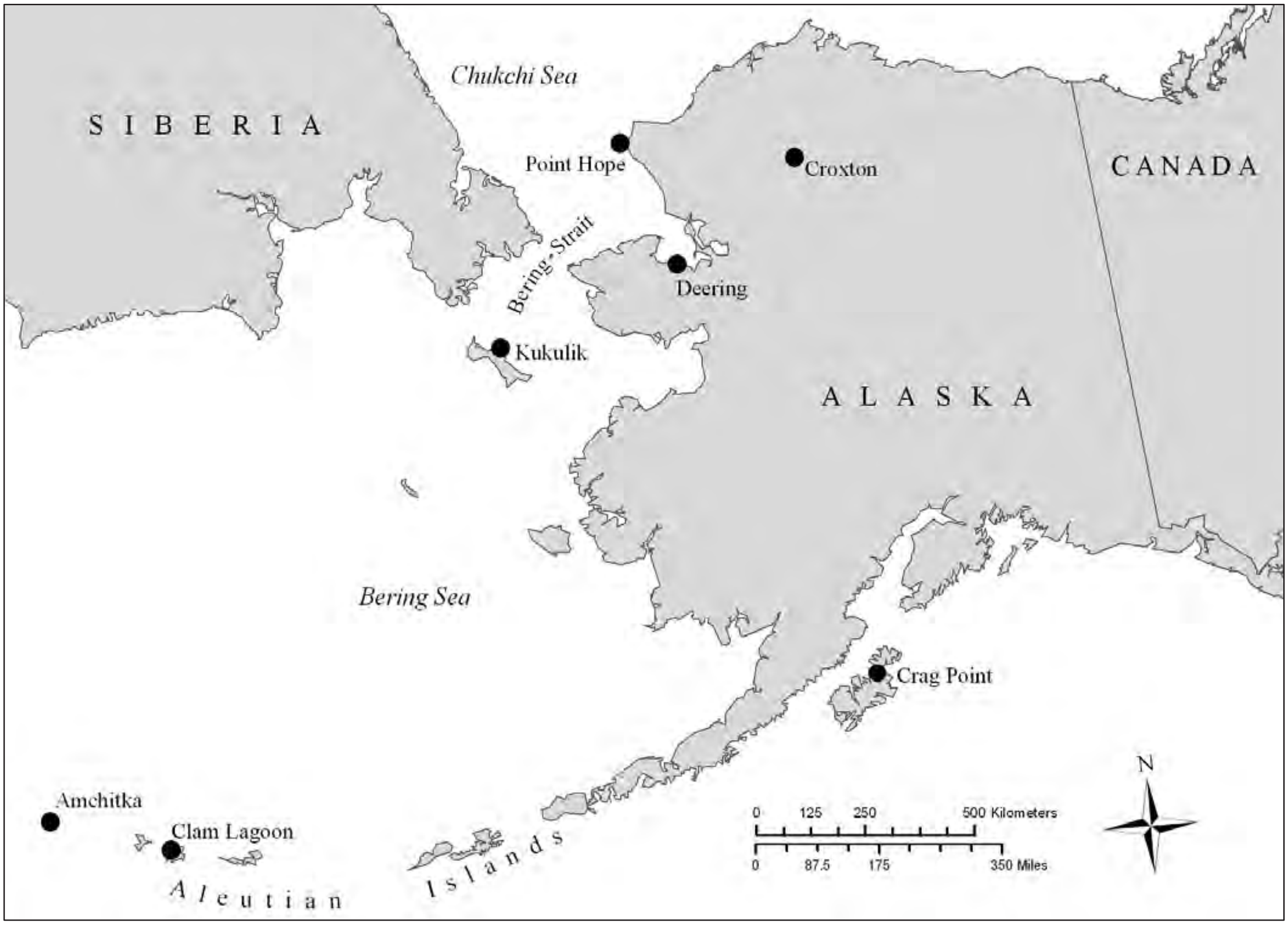

Figure 1. Locations of sites discussed in the text.

goal of understanding relationships people have to objects and how these relationships change over time as the function of objects or manufacturing technologies change.

The spatial extent of bird bone needle cores that exhibit reduction by linear grooving (and are the waste products of needle manufacture) ranges from the Rat Islands in the Aleutian chain to Point Barrow, the northernmost coast of Alaska, to Kodiak Island in the Gulf of Alaska region. In this research we consider selected sites within Alaska (Fig. 1), with artifacts accessible for direct examination, though grooved bird bone cores are present in the organic assemblages of other Alaska sites and in other arctic/subarctic areas. There are differences across Alaska in the types of grooving on bird bones as well as the species of birds used to supply the bone, but wing long bones, especially humeri, appear to be used most consistently. In an attempt to understand spatial and temporal factors in core manufacturing variability, we measured and examined microscopically the grooves, needles, and needle "blanks" (thin strips of bird bone removed or still attached to the core and not yet smoothed and shaped for use as a needle or pin) from seven Alaska archaeological sites dating from 900 BC to AD 1280.

In this study, we generated a range of questions that revolve around bird bone needle manufacture: (1) can the use of introduced material, i.e., iron, be detected by examining grooves on bird bone needle cores; (2) what was the nature of the complete tools used to create the grooves in bird bone reduction sequences; (3) what directed the apparent preference for certain bird species used for the raw material in needle manufacture; and (4) can cultural processes such as settlement strategies or transmission of tool-making techniques be further clarified by the examination of these artifacts.

To explore these questions, we microscopically examined needles and grooves on bird bone cores, considered the nature of the complete tool used to accomplish the grooving (both handle and bit), and contemplated the temporal contexts and cultural milieu in which needles were manufactured and used.

BACKGROUND

Needles have been recovered from a number of sites in the Bering Strait region, some with associated bird bone needle cores, some from sites with dates of occupation before the postulated introduction of iron, and some from after this time. Lithic bits, of course, were used to groove organic material for millennia before the introduction of iron; currently, evidence points to iron use at Alaska sites by at least AD 400 (see Discussion below). For understanding needle manufacturing processes and associated tools, and for considering material availability and the preservation of bird bone artifacts, background information on grooving tools, avifauna taphonomy, ranges of bird species, and dates of sites with needle cores are included here.

GROOVING TOOLS: SCRIBER BITS AND BEAKED BITS

We assume the human hand had similar requirements in the past as today and observed that at least two types of handles attached to bits, potentially meant for grooving, are present at sites with grooved bird bone (for an interesting early discussion of hands and tool handle sizing, see Alpenfels 1955). Commonly today, grooving by hand is accomplished by metal bitted tools with handles of wood (or synthetic material), which are generally lobed or mushroom-shaped at one end, made to provide a surface for the palm of the hand to exert force in a pushing motion (see Untracht 1968 for illustrations as well as explanation of bits, handles and methods). Alternatively, as illustrated in Semenov (1976 [1964]:156), grooving can be accomplished by holding a tool in a near-vertical fashion using a pulling motion. This type of tool has a thick handle with a short bit at the end (Fig. 2). Semenov (1976 [1964]:165) described "claw-shaped" or beaked bits and stated "the slots on Eskimo harpoons shows [*sic*] that the burins [metal bits] employed were claw-shaped with a sharpened point" in order to create the detailed and undercut grooves in toggling harpoons. What he described as handles for these iron bits have a small slot at one end to accept the bit, and recesses below the shoulders to accept lashing for holding the handle sides tightly together, keeping the bit in place. Collins (1937b) and Gusev and Zhilin (2002) describe these bits and handles as present in Siberian sites of Okvik-Old Bering Sea times through Thule. These handles, sometimes completely split into halves with the slot at right angles to the split (as shown by dashed lines on the handle in Figure 2), are found at Croxton and other

Figure 2. Left, handle with slotted end and beaked metal bit (based on Nelson 1899:Plate 36) and, right, sketch based on one type of modern graver and handle.

Ipiutak sites and many Alaska and Canadian Thule sites. E.W. Nelson (1983 [1899]:80–81) also included claw-shaped and other metal-bitted ivory and bone-working tools or "scoring or etching implements" in his inventory of tools of the Bering Strait, some of which have split and slotted handles. Lithic burins are often described with little reference to hafting, but may have been hafted with similar slotted handles.

Tools meant for more delicate work have a narrower handle large enough for a comfortable fit between the fingers. The engraving tool handles labeled as such by Larsen and Rainey (1948:plate 8, numbers 15–24) and similar to what was found at Tukuto Lake are thin, delicate implements seemingly designed for maximum visibility while working, very similar to modern scribers, scalpels, or pens with midhandle thickening for finger control (see Fig. 3). Several examples of these handles in archaeological collections are decoratively carved and have slotted perforations in the midsection of the handle.

Other researchers have referred to these handles when describing scoring, scratching, incising, graving, and etching (Collins 1937b; Dumond 2001a; Giddings and Anderson 1986; Morrison 1988; Nelson 1983 [1899]; Stanford 1976). We will refer to these tool handles henceforth as *scriber* handles, with the caveat that any number of materials may have been used in the slots at their tips,

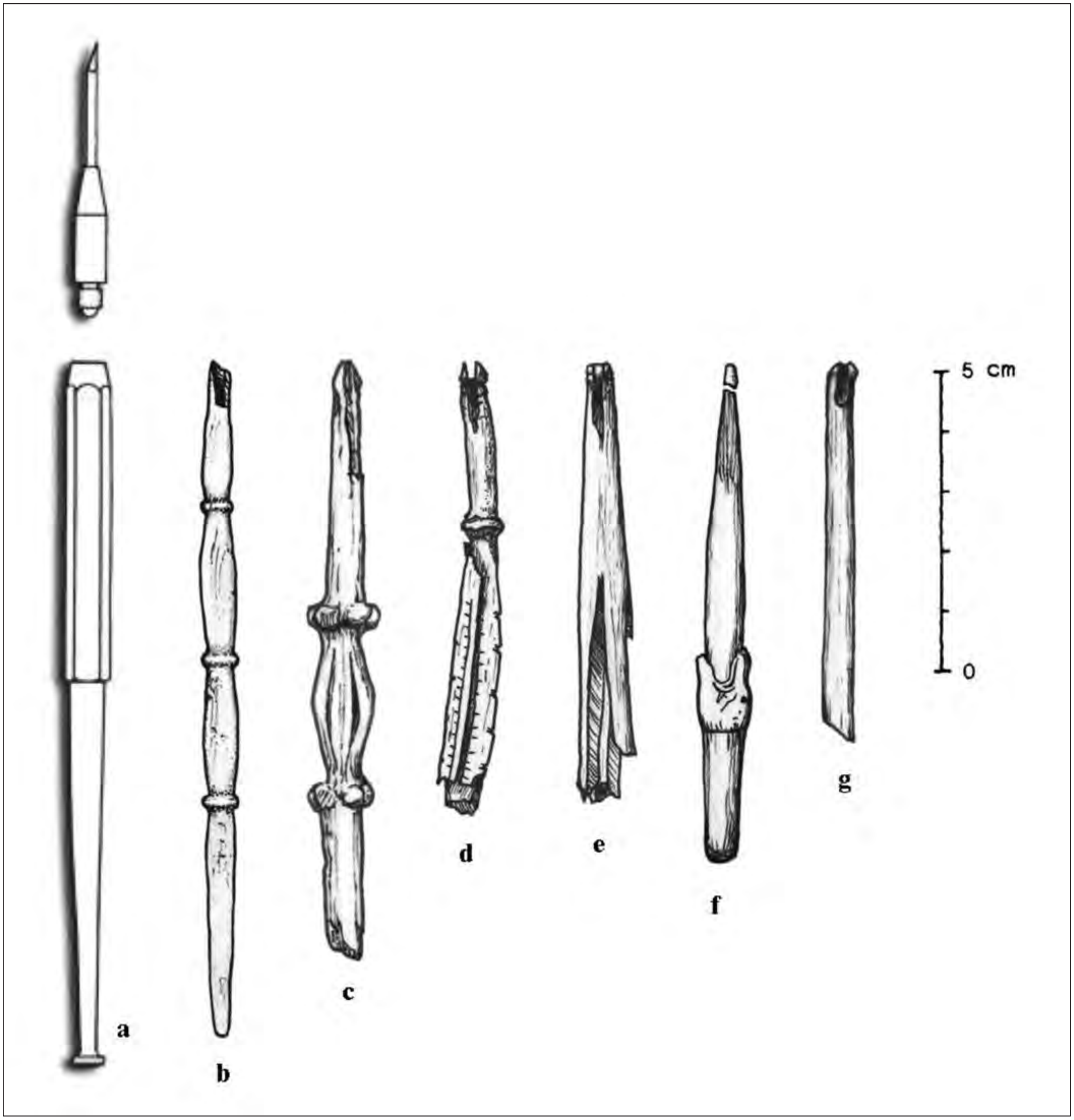

Figure 3. Handles: (a) modern scriber handle and bit of metal; (b–f) handles/fragments of ivory; and (g) handle fragment of bone. Source: (a) Canemco and Marivac Tools Catalog #283-5 and 283-50; (b) Croxton UA2000-066-0516; (c) Pt. Hope 1-1941-4899; (d) Pt. Hope 1-1941-4405; (e) Pt. Hope 1-1941-4618; (f) Deering DRG-99-1724; (g) Pt. Hope 1-1941-4461. Note: all artifacts are from University of Alaska Museum of the North.

including charcoal or other colored pigments, and may essentially have been multipurpose tools. The choice of the term scriber avoids confusion implied with the term *engraving*, a complex art form separate from grooving, shaping and reduction sequences discussed here. The term *burin* we reserve for lithic bit descriptions (e.g., Giddings 1956). Multiuse of these scriber tools is also supported by Larsen and Rainey's Point Hope Ipiutak finds of both nonmeteoric iron and ground squirrel teeth as bits in scriber handles (for an example of a scriber with a ground squirrel tooth as bit, see Rainey 1941:368 plate 3). As with modern scalpels and scribers, these pencil-shaped tools may have been optimally used by drawing or pulling the tool toward the user, and may have been used in working softer material, such as wood, as well more resistant antler, bone, or ivory. These tools are included in this discussion because of their potential role in grooving, and in holding needles or iron bits at their tips, not because any known link exists to bird bone needle manufacture.

The thought that iron bits were used in the Bering Sea region, particularly in association with Ipiutak artifacts, is not new. Handles have yielded iron fragments in bit slots from Point Hope, Deering, and St. Lawrence Island (Bandi 1969; Bowers 2009; Collins 1937b, 1961; Larsen and Rainey 1948; Witthoft and Eyman 1969:20). In Siberia, Gusev and Zhilin (2002:144) note the presence of iron at nine sites (for further discussion regarding iron as a trade material in the Bering Strait see Mason 1998 and Discussion below).

To summarize, fine decoration on wood, ivory, bone, or antler requiring less force could have been accomplished with bits of stone, iron, or other material installed in thin scriber handles, sometimes with thickened central portions for added control. Grooves of more depth on decorated objects or those used in the manufacture of toggling harpoons or other shaped objects may have required heavier handles for the application of greater force; handles may have been slotted at one end and lashed to pinch two halves to hold a bit in place. Grooves for major reduction of large linear portions of organic material may have required a larger handle with enough surface area to comfortably transfer greater force. There are, of course, other handles and hafting styles, but for clarity, we chose to examine those types described above, with the assumption that they were relevant to bone reduction sequences on material such as bird bone. Bits for grooving would have been initially of lithic material, and lithic burins, as shown through experimentation and microscopic examination, have different groove characteristics than iron (see Gusev and Zhilin 2002:140).

BIRD BONE TAPHONOMY

As noted above, the bone element used nearly exclusively for needle manufacture was the humerus, one of the major wing long bones, although occasionally the ulna was used. Several interesting taphonomic points are relevant here: avian long bone structure has a relatively compact cortex or lamella, which enhances its capacity to be polished to a smooth finish with minimal effort; this compactness also appears to inhibit fungi and bacteria from entering bird bone and thereby inhibits degradation (Nicholson 1996). Lack of vascularization may discourage absorption of material that might be attractive to scavengers, discouraging consumption of bird bone compared to other bone. In addition, humeri of some bird species are hollow but do not contain marrow (MacGregor 1985), which would perhaps make manipulating the bone during the manufacturing process easier in comparison to bones with marrow, as well as make it less desirable to scavengers. However, other less-desirable characteristics of bird bone, including small size in general, may discourage preservation (cf. Gál 2005). More work is required to understand marrow and bone dynamics in regard to bird bone taphonomy.

Research has shown that avifauna humeri tend to have thicker cortical walls at the central portion of the shaft (central diaphysis), while shaft portions nearer the ends (the metaphysial region) are thinner (Higgins 1999). This characteristic would encourage snapping needles from the core at the termination of grooves nearest the proximal and distal articulations and would tend to give a naturally tapered shape along the length of the needle. Still other research suggests wing bones are differentially preserved relative to other elements of the skeleton; for purposes of deciphering taphonomic agents and processes and for understanding patterns of material use, this is of interest (Bovy 2002). For biomechanical research on bird bone and small mammal bone such as fox, see Bernath et al. 2004, Cubo and Casinos 2000, McAlister and Moyle 1983, and Suhai et al. 2006.

AVIFAUNA RANGE AND SEASONALITY

Geese are large, vocal birds, with some species, such as lesser snow geese (*Chen caerulescens*), greater white-fronted geese (*Anser albifrons*), and a lesser Canada goose species

(*Branta canadensis taverneri*) currently seasonally available along Kotzebue and Norton sounds as well as in areas between Point Hope and Point Barrow (Rothe 2009). Emperor geese (*Chen canagica*) presently have a much smaller range, with small breeding populations on the Seward Peninsula, the Yukon-Kuskokwim Delta, and the Aleutian chain. Greater Canada geese (*Branta canadensis*) usually range south of the Seward Peninsula (Ridgely et al. 2007). A number of subspecies of Canada geese, and black brant (*Branta bernicla nigricans*), have localized ranges in coastal areas such as Cook Inlet and the Yukon-Kuskokwim Delta. In general, spring geese migrations take place in May, nesting begins by early June, and return migrations to points thousands of miles distant occur in late August. Geese are most numerous during seasonal migrations and vulnerable during the molt for about a month over the summer.

Albatrosses are migratory in a more limited way, shifting from winter to summer ranges within the North Pacific. The black-footed albatross's (*Phoebastria nigripes)* range is slightly farther north into the Bering Sea than the Laysan (*Phoebastria immutabilis*); both are large, silent pelagic feeders that come ashore only to breed. Large breeding colonies are located on Hawaii and other outlying islands in the Pacific and on several Japanese islands (Bird Life International 2011). Geese and albatross ranges are of course subject to change over time.

For geese species, wing molt that limits flight is significant: this loss of flight feathers occurs for snow geese in mid-June, beginning with sub-adults and ending with breeding adults in August. Birds are essentially flightless and vulnerable for twenty-one to twenty-eight days; wing molt begins in breeding pairs about two to three weeks after chicks hatch. Drives involving large groups of people for procuring waterfowl were recorded by Klein (1966) in the Yukon-Kuskokwim Delta, with social aspects of such activities noteworthy. Also, a "molt-migration" by non-breeding birds has been recorded for snow geese, in which flocks move from nesting grounds to another less vulnerable location for a period of time during wing molt before rejoining breeding pairs (Hohman et al. 1992). Snow geese are strongly philopatric (returning to their birth location). Bird bone cores from Ipiutak sites appear to be from fully grown birds, and research has shown seasonal availability of waterfowl may have influenced settlement strategies (Burch 1972; Holliday 1998; McFee n.d.; Milne and Donnelly 2004; Ray 1964).

ASSOCIATED DATES[1]

Ipiutak houses from which the bird bone cores, needles, and scriber handles were recovered are not specifically dated by radiocarbon techniques, but Mason (2006) suggests that the Ipiutak occupation of the Point Hope spit began before AD 600 with the majority of the occupation dating between AD 650 and 870. The bird bone cores and iron-tipped scriber from Deering were recovered from an Ipiutak house that dates between cal. AD 680 and cal. AD 890 (1230 ± 40 ^{14}C yr BP [Beta-138562] in Bowers 2006). Bird bone cores and needles were also recovered from the Deering *qargi* that have similar dates to the Ipiutak house (Larsen 2001). Radiocarbon age estimates on hearth charcoal and organic artifacts at Croxton Locality J indicate that the Ipiutak occupation(s) date between cal. AD 420 to cal. AD 980 (1350 ± 140 ^{14}C yr BP [GX-8633] and 1135 ± 135 ^{14}C yr BP [GX-8634]; although controversial, the inland Ipiutak occupation at Croxton may extend to cal. AD 1170 to cal. AD 1280 (790 ± 40 ^{14}C yr BP [Beta-132909]) and into more recent time periods than considered by other cultural historical frameworks established for late Holocene northern Alaska prehistory (Gerlach 1989; Gerlach and Mason 1992; Reuther 2003; Reuther and Gerlach 2005).

Several other artifacts confirmed Croxton Localities J and K as another example of inland Ipiutak occupation (Gerlach and Hall 1988) with similarities to the Bateman site (Reanier 1992), Feniak Lake (Hall 1974; McFee n.d.) and Hahanudan Lake (Clark 1977). A possible farther north example of Ipiutak is at the coastal site of Nuvuk (BAR-00011) at Point Barrow, which recently yielded a bird bone needle core and artifacts typical of Ipiutak assemblages (Jensen 2009).

The selected Aleutians sites (ADK-00103, RAT-00031, RAT-00036, and RAT-00060) have less secure dating than the northern Ipiutak sites (see Dumond 2001b and Dumond and Bland 1995 for discussion on reliability of radiocarbon dates from the western Aleutians). Desautels et al. (1971) provided dates on charcoal recov-

1. All ^{14}C yr BP dates quoted in the text were calibrated to 2σ using CALIB 5.0 calibration program and the INTCAL04 terrestrial model atmospheric radiocarbon curve (Reimer et al. 2004; Stuiver et al. 2005). None of the ^{14}C yr BP dates quoted were produced on marine samples that would require a reservoir correction.

ered from RAT-00031 and RAT-00036: cal. 100 BC to cal. AD 380 (1890±95 ^{14}C yr BP [I-4737]) for RAT-00031 and cal. 720 BC to cal. 40 BC (2245±95 ^{14}C yr BP [I-4738]) for RAT-00036. The archaeological component at the Clam Lagoon site (ADK-103) has been suggested to date to around cal. 800–900 BC or younger (~2700 ^{14}C yr BP in O'Leary 2001:224).

A bird bone core from St. Lawrence Island at the Kukulik site was associated with material dating from the protohistoric occupation of the island (Geist and Rainey 1936). The core assemblage from Crag Point relates to the Kachemak deposit that dates between cal. 90 BC and cal. AD 1250 (1890 ± 90 ^{14}C yr BP and 910 ± 60 ^{14}C yr BP in Clark 1984 and Jordan 1992).

METHODS

Cores, needles, and blanks were examined under a 26–130 digital zoom microscope (Carson Optical zPix 200 MM-740). Numbers of grooves on each core, maximum groove width, maximum cortical thickness, groove depth, and the range of spaces between grooves (widths of needle blanks) were recorded and photographed. Cortical thickness on cores was measured at the point where needle blanks were snapped or cut from the bone; cortical thickness on needle blanks and needles was the maximum thickness along the length of the blank or needle. Needles were measured and described in relation to common needle sizing (Talbot 1943). Discussions in the literature of bird bone use in general were reviewed, as well as taphonomic properties of bird bone. In addition, six scriber handles or handle fragments were examined, with particular attention paid to measurements of the slot in which a bit would have been placed (Table 3). When possible, we identified the avian species, genus, or subfamily from which the cores were made (Tables 1 and 2) using personal and University of Alaska Museum of the North ornithological reference collections.

At the Croxton Site Localities J and K on Tukuto Lake (XHP-00311), the initial excavations in 1981–82 by Gerlach (Gerlach and Hall 1988; Gerlach 1989) recovered eleven needle cores crafted from geese humeri; six are examined here. In 2000, we recovered from Locality J an additional needle core and needle core fragment with a needle blank attached (which prompted this study). The Point Hope Ipiutak Site (XPH-00003) has at least nine needle cores in its assemblage; from the Deering Ipiutak component (KTZ-00299) there are seven cores and as many needle blanks and needles, many of which were added to our data set. From the Croxton site in 2000, we recovered an engraving tool handle very similar to those pictured in Larsen and Rainey's 1948 Ipiutak monograph (see Fig. 3b).

Bird bone needle cores have been recorded at a number of sites throughout the Aleutian Islands (Jochelson 2002 [1925]) and have also been recovered at Mink Island (XMK-030), a site located across the Shelikof Strait from Kodiak Island (Bjorn Iverson, pers. comm., 2008). From Aleutian sites on Amchitka Island in the Rat Islands group (RAT-00031, 00036, and 00060), from Clam Lagoon on Adak Island (ADK-00202), and from Crag Point on Kodiak Island (KOD-00044), ten needle cores and eight needle blanks were added to our study. A single bird bone core collected by Geist in 1931 was examined from the St. Lawrence Island Kukulik site.

Experimental grooving was performed on bone from several species of birds with metal and stone bits for the purposes of understanding problems associated with grooving in general and needle manufacture specifically. These experiments are ongoing and are not discussed here.

RESULTS

A total of thirty-two bird bone needle cores, twenty-two needle blanks, and five needles were examined. In our data set of identifiable elements, all needle cores are either distal or proximal humeri except one, which was a proximal ulna. Many cores have numerous grooves that terminate at the proximal or distal end of the bone and include the articulation (Fig. 4). Some cores are on cut long bone fragments without articulations, which makes species identification difficult (Fig. 5). The characteristics and placements of grooves on bird bone humeri created during the manufacture of needles appear to reflect differences in bit material and methods of bone reduction (Figs. 6 and 7).

GROOVES

Grooves made with stone, according to studies by Gusev and Zhilin (2002), have different types of parallel lines in groove troughs and have slightly more rounded shoulders. While some grooves on cores from Ipiutak sites excavated in the past were not clearly visible due to var-

Table 1. Bird bone cores, needles, and needle blanks (C = Core, N = Needle, NB = Needle Blank). Anserini are members of the geese tribe in the Anserinae waterfowl subfamily; Unid. Avian is unidentified avian species. All artifacts are from UAMN collections.

Site	Accession Number	Species	Element	Side	Max. Cortical Thickness
Ipiutak, Pt. Hope	1-1941-4389; H33; C	Anserini	Dist. Humerus	Right	1.3 mm
	1-1941-4590; H38; C	*B. canadensis*	Prox. Humerus	Left	1.0 mm
	1-1941-4591; H38; C	*B. canadensis*	Prox. Humerus	Right	1.3 mm
	1-1941-940; DH-1; C	*C. caerulescens*	Prox. Humerus	Left	1.3 mm
	1-1941-4533;H36; C	Anserini	Dist. Humerus	Right	1.3 mm
	1-1941-5100;H59; C	Anserini	Prox. Humerus	Right	1.1 mm
	1-1941-103;H59; NB	Unid. Avian	?	?	1.5 mm
	1-1941-5306; H66; C	*C. caerulescens*	Dist. Humerus	Left	1.2 mm
	1-1941-5307; H66; C	*C. caerulescens*	Prox. Humerus	Left	1.1 mm
	1-1941-5304; H66; C, NB	*C. caerulescens*	Prox. Humerus	Right	1.4 mm
Croxton, Localities J & K	UA2000-066-0529; C	*C. caerulescens*	Prox. Humerus	Left	1.1 mm
	UA2000-066-0478; NB	*C. caerulescens*	Prox. Humerus	Left	1.5 mm
	UA81-119-383;N	Unid. Avian	?	?	1.3 mm
	UA81-119-384; C	*C. caerulescens*	Prox. Humerus	Right	1.0 mm
	UA81-119-476; C	Anserini	Dist. Humerus	Right	1.3 mm
	UA81-119-530; NB	Unid. Avian	?	?	1.3 mm
	UA81-119-541; C	*C. caerulescens*	Dist. Humerus	Right	1.1 mm
	UA81-119-613; C	*C. caerulescens*	Prox. Humerus	Right	1.0 mm
	UA81-119-2027; C	*C. caerulescens*	Prox. Humerus	Right	0.9 mm
Deering	DRG-99-1808; C	*C. caerulescens*	Dist. Humerus	Left	0.9 mm
	DRG-99-1034; C	Anserini	Dist. Humerus	Left	1.2 mm
	DRG-99-296; C	*C. caerulescens*	Prox. Humerus	Right	1.2 mm
	DRG-99-1892; C	*B. canadensis*	Prox. Humerus	Left	1.3 mm
	DRG-99-1243; C	*C. caerulescens*	Prox. Humerus	Left	1.0 mm
	DRG-99-700; C	Anserini	Prox. Humerus	Right	1.7 mm
	DRG-99-459; NB	Unid. Avian	?	?	1.4 mm
	DRG-99-448; NB	" "	?	?	1.2 mm
	DRG-99-1335:NB	" "	?	?	1.4 mm
	DRG-99-1941 (4 pcs); NB	" "	?	?	1.6 mm
	DRG-99-1167; NB	" "	?	?	1.3 mm
	DRG-99-NLUR 4143; NB	" "	?	?	1.2 mm
	DRG-99-NLUR 4120; C	" "	?	?	1.3 mm
	DRG-98-007;N	" "	?	?	1.5 mm
Kukulik	1-1931-2804; C	Unid. Avian	?	?	1.3 mm
Crag Point, Kodiak	UA86-202-579; C	Unid. Avian	?	?	1.4 mm
	UA86-202-787; C	" "	?	?	1.0 mm
	UA86-202-790; C	" "	?	?	2.0 mm
	UA86-202-800; C	*Phoebastria* sp.	Prox. Ulna	Left	1.6 mm
	UA86-202-970; NB	Unid. Avian	?	?	1.2 mm
	UA86-202-1589;N	" "	?	?	1.2 mm
	UA86-202-1600;N	" "	?	?	1.4 mm
	UA86-202-1712; NB	" "	?	?	1.7 mm
	UA86-202-1917; C	" "	?	?	1.1 mm
	UA86-202-2273; NB	" "	?	?	1.2 mm
Amchitka	UA72-55-2036; NB	Unid. Avian	?	?	1.5 mm
	UA72-57-0195; C	" "	?	?	1.2 mm
	UA72-57-0410; NB	" "	?	?	1.6 mm
	UA72-57-2187; NB	" "	?	?	1.1 mm
	UA72-57-3158a; C	" "	?	?	2.1 mm
	UA72-58-257; C	" "	?	?	0.9 mm
Clam Lagoon	UA383-4548; C	*Phoebastria* sp.	Dist. Humerus	Right	1.2 mm
	UA383-4549; C	*Phoebastria* sp.	Prox. Humerus	Right	1.9 mm

Table 2. Groove characteristics on bird bone cores, and needle blanks (C = Core, N = Needle, NB = Needle Blank). All artifacts are from UAMN collections.

Site	Accession Number	Number of Grooves Per Core	Max. Width of Grooves	Range of Spaces Between Grooves/ Needle Width	Groove Type (Stone/ Metal)
Ipiutak, Pt. Hope	1-1941-4389; H33; C	11	1.0 mm	1.4 to 2.6 mm	Metal
	1-1941-4590; H38; C	10	0.7 mm	1.1 to 3.1 mm	Metal
	1-1941-4591; H38; C	12	0.9 mm	1.5 to 2.4 mm	Metal
	1-1941-740; DH-1; C	11	0.9 mm	0.8 to 3.5 mm	Metal
	1-1941-4533;H36; C	7+	0.8 mm	1.6 to 2.1 mm	Metal
	1-1941-5100;H59; C	11	0.7 mm	0.6 to 2.2 mm	Metal
	1-1941-5103;H59; NB	1	0.8 mm	1.3 mm	?
	1-1941-5306; H66; C	10	1.1 mm	1.2 to 1.7 mm	Metal
	1-1941-5307; H66; C	9	1.2 mm	1.2 to 1.9 mm	Metal
	1-1941-5304; H66; C, NB	8	0.8 mm	0.6 to 2.8 mm	Metal
Croxton Localities J & K	UA2000-066-0529; C	11	0.7 mm	1.6 to 3.9 mm	Metal
	UA2000-066-0478; NB	3	0.8 mm	1.2 to 4 mm	Metal
	UA81-119-383;N	N/A	N/A	2.2 mm	Metal?
	UA81-119-384; C	6	1.1 mm	1.8 to 3.1 mm	Metal
	UA81-119-427; NB	N/A	N/A	4.9 mm	?
	UA81-119-476; C	11	1.2 mm	1.4 to 2.5 mm	?
	UA81-119-530; NB	1	0.8 mm	2.8 to 4.2 mm	Metal?
	UA81-119-541; C	11	1.2 mm	1.6 to 2.6 mm	Metal
	UA81-119-613; C	11	1.2 mm	1.3 to 2.7 mm	Metal
	UA81-119-2027; C	8	1.1 mm	1.4 to 2.5 mm	Metal
Deering	DRG-99-1808; C	9	2.5 mm	1.7 to 2.5 mm	Metal
	DRG-99-1034; C	6	1.1 mm	1.3 to 3.0 mm	Metal
	DRG-99-296; C	8	0.9 mm	1.5 to 2.8 mm	Metal
	DRG-99-1892; C	10	0.5 mm	1.2 to 4.1 mm	Metal
	DRG-99-1243; C	~5	N/A	2.5 to 3.9 mm	?
	DRG-99-700; C	14	1.1 mm	1.5 to 3.2 mm	Metal?
	DRG-99-459; NB	N/A	N/A	1.5 mm	?
	DRG-99-448; NB	N/A	N/A	1.6 mm	Metal
	DRG-99-1335; NB	N/A	N/A	1.8 mm	Metal
	DRG-99-1941; NB	N/A	N/A	0.8 to 3.2 mm	Metal
	DRG-99-1167; NB	N/A	N/A	4.7 mm	?
	DRG-99-?NLUR 4143; NB	N/A	N/A	1.8 mm	?
	DRG-99-?NLUR 4120; C	1	1.1 mm	1.5 mm	Metal
	DRG-98-007;N	N/A	N/A	1.9 mm	?
Kukulik	1-1931-2804; C	4	0.9 mm	1.9 to 4.0 mm	Metal
Crag Point, Kodiak	UA86-202-579; C	9	0.4 mm	0.9 to 2.5 mm	Stone
	UA86-202-787; C	5	0.6 mm	0.7 to 1.5 mm	?
	UA86-202-790; C	5	0.9 mm	1.0 to 3.4 mm	Stone?
	UA86-202-800; C	4	1.0 mm	1.3 to 4.5 mm	Stone
	UA86-202-970; NB	1	0.2 mm	0.4 to 1.4	Stone
	UA86-202-1589;N	N/A	N/A	2.5 mm	?
	UA86-202-1600;N	N/A	N/A	1.8 mm	?
	UA86-202-1712; NB	N/A	N/A	1.5 mm	?
	UA86-202-1917; C	2	0.8 mm	2.6 to 4.8 mm	?
	UA86-202-2273; NB	3	0.5 mm	1.0 to 2.8 mm	Stone?
Amchitka	UA72-55-2036; NB	1	1.1 mm	2.2 to 3.9 mm	Stone
	UA72-57-0195:C	5	1.0 mm	1.5 to 4.1 mm	Stone
	UA72-57-0410; NB	1	1.0 mm	2.0 to 4.4 mm	Metal?
	UA72-57-2187; NB	1	0.8 mm	0.6 to 2.6 mm	Stone
	UA72-57-3158a; C	6	1.3 mm	1.1 to 6.3 mm	Stone
	UA72-58-257; C	4	1.1 mm	3.7 to 3.9 mm	Stone
Clam Lagoon	UA383-4548; C	7	1.2 mm	1.7 to 4.6 mm	Stone
	UA383-4549; C	10	1.4 mm	1.4 to 3.9 mm	Stone

Table 3. Scriber handle and scriber socket (slot) dimensions. All artifacts are from UAMN collections.

Site	Accession Number	Scriber Handle Length	Scriber Handle Max. Dia.	Scriber Handle Tip Dia.	Bit Slot Dimensions		
					Length	Depth	Width
Deering	DRG-99-1724 (NLUR3800) ivory	81.7 mm (reworked)	8.6 mm	2.6 mm	7.4 mm	1.4 mm	2.6 mm
Croxton	UA2000-66-0516 ivory	114.3 mm complete	6.3 mm	3.6 mm	8.0 mm	1.5 mm	2.0 mm
Ipiutak, Pt. Hope	1-1941-4461; H36 bone	62.7 mm fragment	4.9 mm	4.1 mm	7.8 mm	2.3 mm	2.2 mm
Ipiutak, Pt. Hope	1-1941-4405; H35 ivory	74.4 mm fragment	7.1 mm	4.2 mm	8.7 mm	2.2 mm	1.2 mm
Ipiutak, Pt. Hope	1-1941-4618; H40 ivory	73.2 mm fragment	8.7 mm	4.5 mm	9.5 mm	2.6 mm	1.2 mm
Ipiutak, Pt. Hope	1-1941-4899; H53 ivory	101.3 mm nearly complete	9.2 mm center 11.2 mm "knobs"	4.8 mm	6.9 mm	2.4 mm	1.3 mm

Figure 4. Grooves on proximal articulations of bird bone humeri used in needle manufacture: a) albatross, Clam Lagoon, Adak, Aleutian Islands (UA383-4549); and b) goose, Ipiutak, Pt. Hope (1-1941-4591).

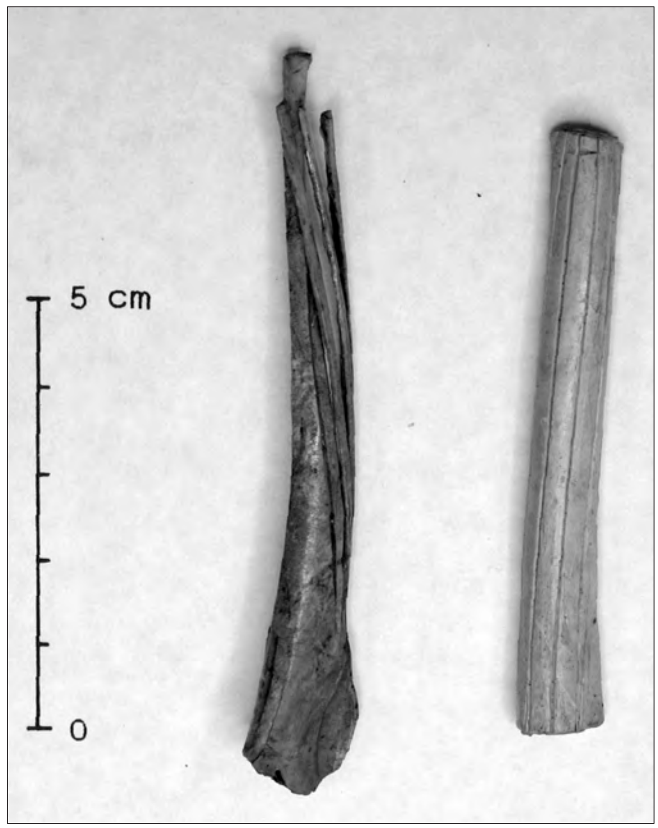

Figure 5. Sections of bird long bone shafts with needle blanks or preforms in stages of manufacture: a) needle blanks not yet snapped from proximal end of shaft, Ipiutak, Pt. Hope (1-1941-5304; H66); and b) needle blanks on tubular section which has been cut from shaft, Crag Point, Kodiak Island (UA86-202-790).

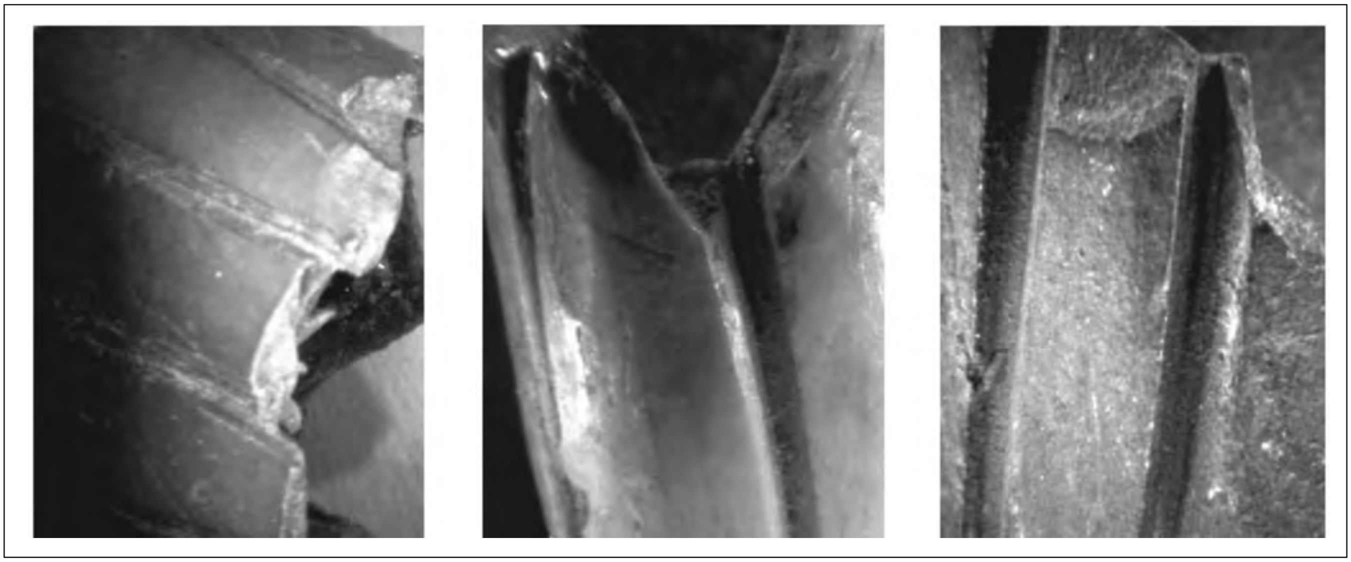

Figure 6. Grooves (~1 mm in width) with distinct shoulders, a characteristic of metal bits.

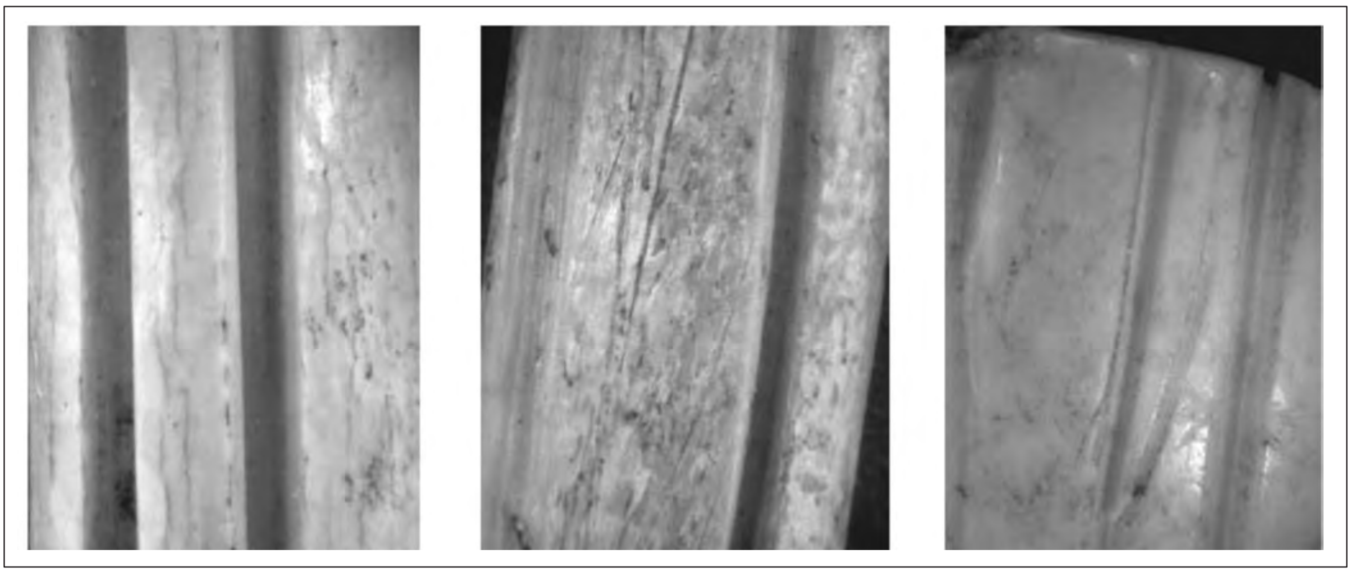

Figure 7. Grooves (~1 mm in width) with indistinct shoulders, a characteristic of lithic bits.

nishes or coatings on the cores, microscopic examination of groove shoulders on the uncoated Ipiutak goose cores were sharper in general than the Aleutian albatross cores, and groove wall angles were in general more consistent and had less stepping than Aleutian cores. This appears, as observed by Gusev and Zhilin, to be due in part to the ability of iron to hold a sharp edge, while a lithic edge develops microscopic concoidal fractures that dull the cutting angle. The fractured edge produces striations and stepping, which give the impression of rounded shoulders and more scooped grooves in general. The overall width of material used to create a groove is less significant than the angle of the cutting edge, especially when grooving thin material such as bird bone.

REDUCTION SEQUENCE

Beyond groove characteristics, cores preserved at the Aleutian sites and the Crag Point site on Kodiak exhibit other differences in the reduction sequence from cores found at Ipiutak sites. For example, Aleutian cores were made with longitudinal grooving on the humeral shaft, followed by transverse cuts across the shaft below the flare of the deltoid crest, which separated the grooved shaft as an intact tubular piece (Fig. 8). This piece was then grooved deeper in a final step to separate individual needle blanks. The Ipiutak cores, however, were created by longitudinal grooves on the humeral shaft that extended toward epiphyses and cut completely through the shaft, defining one needle blank from the other before removal. Needle blanks were then removed from the core by snapping, somewhat like block matches (as shown in Fig. 5). No evidence of transverse cutting is seen consistently on Ipiutak shafts. However, the photograph of the core found at Nuvuk, at Point Barrow, dated to cal. AD 140–380, clearly shows transverse grooving (Jensen 2009). The number of longitudinal grooves on both Ipiutak and Aleutian cores suggests standardization in concept and spacing related to optimal widths of needles, diameter of the bone, and size of bit used for grooving.

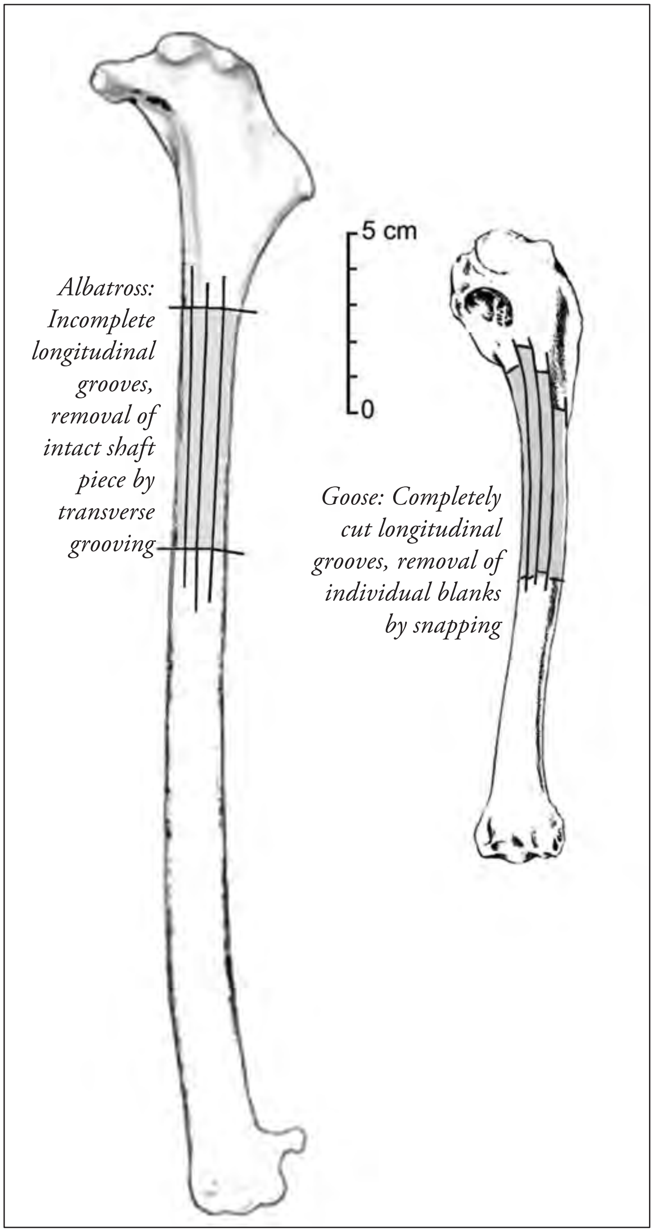

Figure 8. Albatross and goose humeri with typical placement of grooves near proximal ends and methods of needle blank removal (element drawings based on Gilbert et al. 1996 [1985]).

On heavier bone and ivory, as well as wood, nicks sometimes observed along the sides of grooves indicate that during reduction sequences the separation of linear blanks was accomplished by blows on the end of wedges placed into grooves or possibly by direct percussion (Gelvin-Reymiller et al. 2006; Knecht 1993; Margaris 2006; Semenov 1976 [1964]). Bird bone cores, however, do not exhibit nicks or any evidence that additional tools such as wedges were used in grooves to separate blanks; this action may have been unnecessary due to the thinness of the bone or the desire to retain smooth edges.

NEEDLE MEASUREMENTS

Needles that were measured in the sample were necessarily only those recognizable as made of bird bone. Needle sizes were consistent, measuring from about 1.5 mm to 2.5 mm in width and usually less than 1.5 mm in thickness. Most needles and needle blanks were less than 60 mm in length. The fineness of some needles is truly remarkable; the length and beveled tips of some of the eyed needles are similar to modern steel glovers' needles between sizes #1 and #2/0, commonly used for skin or leather sewing (Talbot 1943). Eyes in needles that were examined vary from nearly perfectly round to tiny slots parallel to the needle's length. The exactitude of the round needle eyes are reminiscent of engraved round holes in Ipiutak decorated surfaces and may have been accomplished with a metal-bitted drill, although jade bits were also recorded in the region by early observers (Belcher 1861).

SCRIBER HANDLES

Scriber handles are not numerous or perhaps preserve poorly for reasons unknown. The midshaft slots that run parallel to handle lengths were difficult to measure because of breakage (apparently a common breakage point) in all but one example, but midshaft slots were estimated to be about 15 to 20 mm in length.

Measures of scriber tip slots (similar to the chuck that accepts a drill or a collet that holds a bit in a Dremel or Foredom tool) average about 1.5 mm by 2.3 mm in width and depth and about 8 mm in length. This bit material could have been iron, perhaps commonly traded in a particular size, or could have been another material, such as ground squirrel teeth, bone—including bird bone needles which are approximately that size, or lithic spalls.

Modern arctic ground squirrel (*Spermophilus parryii*) incisors average from 1.7 to 2.0 mm in width and from 2.5 to 2.8 mm in thickness, tapering at the tip. This is slightly larger than bit slot sizes, although teeth vary in size. Teeth are curved and hollow along the first quarter to third of the root and solid toward the tip. Based on a limited number of teeth examined, upper incisors measure approximately 30 mm in length and lowers approximately 40 mm, with usable solid curved tip material about 10 to 15 mm in length.

Sizing of slots for bits may be related to other unknown factors. Larger slotted or split handles were not measured in this study due to time constraints, although a cursory look at slot dimensions indicates some similarities to scriber handles. The data gathered here does not allow conclusions to be drawn about handles used in grooving bird bone. Further examination of larger slotted handles, as well as experimentation, might add clarity.

IDENTIFICATION OF SPECIES

Identifying species of goose versus albatross was straightforward because the morphological differences between the Anserini tribe and *Phoebastria* genus are pronounced. Distinctions between *Chen caerulescens* and *C. canagica* as well as between members of the *Chen* genus and *Branta* genus are much more subtle, but several characteristic differences were apparent, at least in the comparative specimens available for this study (two to three specimens for each of five goose species). Variability, of course, may be greater if more specimens were assessed. There are distinct size ranges that separate the species; for example, black brant and cackling geese have noticeably smaller humeri than snow and emperor geese, and greater Canada geese humeri are noticeably large. Distinctions are present on the proximal humerus: for example the proximal margin of the humeral head appears less pointed in greater Canada geese than in snow geese, and the distance between the deltoid and bicipital crest attachment points on the diaphysis is greater in greater Canada geese than in snow geese. There also appear to be differences in the morphology of the mesial crest and the average size of the pneumatic fossa in the various species. Other distinctions on the distal portion of humeri include the shape of the attachment point of the anterior ligament, which is almost vertical on Canada geese and tilted on snow geese. While these distinctions render a definitive identification of particular goose species less certain on artifacts on which diagnostic morphology is partially or completely missing, the identification to Anserini tribe is certain.

DISCUSSION

This initial look at the presence of grooved bird bone cores at Alaska sites indicates continuity of use through time as well as broad geographic range for this use of bird humeri. At these sites, the proximal articulation of humeri with a portion of the shaft intact were also crafted as awls (the shaft beveled to a point) or bodkins, which are large pointed tools similar to awls but often with large eyes, and are found at sites with cores. Perhaps sets of bones were part of the well-rounded seamstress or seamster's tool kit. These uses of the humerus for needle- and awl-making were typical, though a number of albatross humeri from Amchitka were cut transversely and have no longitudinal grooving present, possibly for use as bone tubes, beads, or fishhooks, or perhaps they were in an early stage of reduction.

Characteristics such as hardness, strength, flexibility, thickness, or relative smoothness of the interior medullary surface may be responsible for the frequent use of bird bone in needle manufacture. Bird bone morphology, particularly the broadened proximal articulations of humeri that encourage ease of handling during reduction by grooving (but which is not exclusive to avian species) might also be a factor. Preference by many cultures for complete use of an animal may be an additional factor, exemplified by bird bone drinking tubes, needle "keepsafes" or feather procurement in addition to needle or awl manufacture (Serjeantson 2009). The sharpness and hardness (edge-holding ability) of a bit was a critical variable in successful needle manufacture, as was the moisture content or state of the bone being worked and whether lubricants were used, as noted in experimental results by Gusev and Zhilin (2002). Soaking of material before working was commonly recorded by early ethnographers. Types of lithic materials with different fracture characteristics and hardness would leave different traces on various organic materials, as would iron. Studies of use-wear patterns on organic material and experimental tool-making give valuable insights into grooving techniques, especially when microscopic observations are also recorded (cf. LeMoine 1989, 1994; Margaris 2006).

Relevant to the discussion of handles used in the grooving process, LeMoine (1994) points out that microscopic examination is best combined with other sources of information to understand tool manufacture and use, which guards against the acceptance of assumptions about tools, manufacturing processes, and tool usage. The decorative treatment and slotting of scriber handles, which are generally less than 1 cm in diameter, required considerable effort; we speculate that midshaft slots may have facilitated wrapping with leather for added comfort, similar to neoprene or rubberized sections added to modern-day pencils and pens. Alternatively, the mid-shaft slots may have been used for affixing the handle to a longer shaft meant for drilling. In addition, the design of handles may represent an instance of skeuomorphism, or replication in bone or ivory based on original designs in wood or metal (cf. Sherrat 2006).

In terms of seasonality, migrations of snow geese from Japan and Siberia to nesting grounds in Alaska were recorded in the mid-1900s (Austin 1949). A large migration over the Brooks Range and Kotzebue Sound en route to Wrangel Island has also been recorded, for which Tukuto Lake may have been a resting place. The season of occupation for Tukuto Lake may have been at the optimal time for capturing geese. This time would have been during spring or early summer concentrations (May/June) or during fall migration (August/September). Whether a resident population was available for capture in drives during the molt in midsummer is unknown. Geese migration coincides with caribou migration, which has been suggested as the purpose for the Tukuto Lake site and may have influenced Ipiutak site locations (Burch 1972; Gerlach 1989; Moss and Bowers 2007).

The symbolism of goose species or waterfowl that relates to women and the female role of needlework may also play a part in material chosen for needle making. Ethnographic records suggest that geese and water birds in general figure prominently in mythology and cosmology, may have affected their visibility in the archaeological record. Tales connected to geese include subjects such as motherhood and female tasks in general, including sewing and distinctions between materials from the land, sea, and air (Borgoras 1902; McGhee 1977; Nelson 1983[1899]; Pearce 1987). Geese in particular represented connections to migration, childbirth, and the female role in needlework, including stitching of clothing (including bird skin/ and feather clothing) and household items (Laugrand and Oosten 2005; Pearce 1987). Geese figure in Alaska Native creation myths, in which Raven attempts to keep a migrating goose as a wife (Lantis 1938:160–161; Nelson 1983 [1899]:462). In Siberia, birds in general are associated with connections between worlds and facilitate shamanic travels (Balzer 1996).

Other factors encouraging the use of particular waterbird species for needle making were related to differences in cosmology or ritual treatment of spirits. Proscription of the use of needles by women during certain times, a widespread practice in circumpolar regions, or requirements of giving offerings of needles when certain furbearing animals were caught (Ellanna and Sherrod 2004; Gubser 1965; Mannermaa 2008; Rasmussen 1929; Van Deusen 1997) may be related to associations between land and water or water birds. Apparently some of these requirements extended into historic times; the use of iron, as well as the use of "sharp or pointed instruments [needles and awls]" during certain hunting seasons, for example the beluga hunting season in Norton Sound, was forbidden (Nelson 1983 [1899]:438). In addition, intriguing connections between Siberian shamanism and symbolic bird humeri, crafted of iron and attached to shaman's coats (Balzer 1996:306), support the idea that the wing itself and its association with flight were of significance.

Parts of birds had symbolic meaning and special uses in Alutiiq society; albatross feathers were used as amulets and their beaks were used by warriors as pincers to extract arrows from wounds (Jochelson 2002 [1933]). Ethnographic accounts record the hunting of these birds not only for food but also for purposes of gathering quills, bones, and whole bird skins for clothing; procurement may have been opportunistic and nearly year-round in this region. Auks and cormorants were formerly hunted extensively in the North Pacific, and some smaller shaft fragments used for needle manufacture at Kodiak and Aleutian sites were likely from cormorants (Jochelson 2002 [1925]). Ethnographic information tells us birds were taken from boats and on land by using darts, bolas, traps, snares, and nets as well as by bow and arrow with special bird projectile tips and by organized drives (Jochelson 2002 [1933]; Ray 1964; Nelson 1983 [1899]). Jochelson (2002 [1933]) recorded cormorants on most Aleutian Islands being hunted in January on land while birds were sitting on nests. Albatrosses would have been hunted from boats, since these birds' habits rarely brought them to land.

According to Black and Liapunova (1988:56–57), Unangan or Aleut people had "a strict division of labor" with men working bone, metal, and wood, and women working primarily skins and fibers. However, needles, most commonly made of bird bone, were made by women.

This division of labor and material use by sex suggests that we might not see the use of iron for grooving in needle manufacture, even though it may have been regularly used by men for other purposes.

Skill was probably a factor in needle manufacture because dexterity in placing grooves on a curved surface likely required practice. Differences in skill (from beginners with reduced manual dexterity to the aged with less visual acuity) might be recorded in grooves, but these differences would not change the overall effect of a bit's characteristic signatures (cf. Milne 2005; Weedman 2002). Jochelson (2002 [1925]:79–83) discussed Aleut manufacturing techniques and the skill required in choosing material as well as in the execution of tasks. Referring to ivory and bone, he stated material must be of the same "density" throughout the piece in order for implements to maintain straightness; grooves and scoring were used to mitigate anticipated warping or curvature in linear tools resulting from "unfitness of material" and "lack of skill of the maker."

Studies of the technological processes within societies and research that examines processes of change in manufacturing techniques sometimes note causal factors such as chance, individual choice, cultural expectations, necessity, or combinations of these factors. Change detectable in artifactual data can be linked to factors such as population movements or trade, increases or restrictions in the supply of raw materials, the introduction of novel techniques, ideas, and materials, or innovation. Arctic and subarctic environments, often considered hostile for human habitation, encouraged ingenuity (Arutiunov 1988; Buijs 1997; McCartney and Veltre 1999). A possible example of technological changes facilitated through the use of introduced material is toggling harpoon manufacture in the Bering Strait region which, according to Semenov (1976 [1964]) and Gusev and Zhilin (2002), was substantially enhanced by the use of iron bits for shaping the deeply undercut grooves of line slots and other features. Although the timing and magnitude of significance of the introduction of iron in the Bering Strait may be debated, detectable changes in grooves and accompanying techniques used in the reduction of organic materials can be used as indicators of contact or trade, innovation, or changes in cultural processes.

The form in which iron would have been traded and made available, whether as rods, flat "blades," disks, etc., is another question difficult to answer without the recovery of artifacts of iron, which unfortunately readily degrade over time. However, Gusev and Zhilin (2002:142), based on their own and other Siberian archaeologists' analyses and on limited finds of iron artifacts, conclude that iron bits were about 1 mm thick and approximately 5 to 30 mm in length. The brief examination of our small sample of scriber handles that may have been fitted with iron bits and needle cores that may have been grooved with iron bits concurs with Gusev and Zhilin's description of probable bit size (see Table 3). One could logically surmise that iron was an extremely important material for numerous reasons, including its novelty, edge and point holding properties, ability to be resharpened, and general resilience in contrast to lithic material.

The postulated introduction of iron in the Bering Strait region may have been followed by the cessation of bone needle core production, since iron needles could have replaced bone ones. This cessation and replacement of bone needle manufacture does not appear to have been the case until much later, although it is possible that iron technology at the time of its introduction did not produce needles with traits superior to bone. In addition, iron may have been available only to a very small percentage of people due to sociopolitical dynamics or distance from Asian production. Iron bits for grooving, if available to women, may have sped up the process of bone needle production, or alternatively, shifted production to a different member of a group. However, changes in techniques and materials are much more complex than simple adoption of new processes or materials. For example, as noted by Margaris (2006), manufacture of bone tools on Kodiak Island using traditional techniques continued (scoring and snapping methods), with metal replacing lithics, but not necessarily with the adoption of new crafting techniques such as sawing with metal. In any case, the introduction of iron could have caused shifts in "operational sequences" or "cascades" in technological processes (Lemonnier 1992; Schiffer 2005). By about AD 900–1100, the scale of iron production in Asia was much greater, and later still, the introduction of steel needles is noted by several researchers as important to northern cultures in general (Buijs 1997; Gelegdorj et al. 2007; Nelson 1983 [1899]).

According to paleoenvironmental data, warming of temperatures occurred roughly during the BC/AD temporal juncture, a time also associated with the initial occupations of several archaeological sites in Alaska with material cultures and settlement patterns defined as Old Bering Sea, Punuk, Okvik, and Ipiutak (Mason and Gerlach 1995). These sites have been described as having Asiatic connections, and efforts to understand temporal relationships between these sites and cultural designations are ongoing (Bronshtein 2006 [1986]; Dumond 2001a; Giddings 1967; Mason 2006; Morrison 1988). Early research exploring the introduction of iron indicated this material may have been traded out of the Manchurian region during the second century BC (Chard 1960; Collins 1961) and is thought to have been a part of the material culture of groups expanding north along the Bering Sea coast during warming trends. This is corroborated by the rare presence of iron at Chukotka sites such as Uelen and Ekven (Gusev and Zhilin 2002) and at later sites such as Sivuqaq on St. Lawrence Island (Collins 1961).

Sherratt (2006), Sinor (1998), and others discuss the likelihood of a metallurgic center in central Siberia between 4000 and 3500 BP. Technology was based on bronze casting, but sophisticated iron casting techniques were developed by the second century BC in Mongolia for such items as chariot wheel hubs. North of Mongolia, a chance discovery in 1999 in the Barun-Khul Valley on the western shore of Lake Baikal suggests iron smelting technology, indicated by iron slag and wood charcoal deposits, was developed by approximately 2000 ^{14}C yrs BP (Kozhevnikov et al. 2001). In later centuries, craftsmen developed high-temperature metallurgical techniques by using coal rather than wood-fired forges (Gelegdorj et al. 2007). Mason (1998) suggests another pathway for the introduction of iron to eastern Bering Strait populations via smelting centers in Korea and Japan, traded northward along the Kamchatka Peninsula and to East Cape on the Chukota Peninsula. Recent work by Park and Gordon (2007) on Korean bronze technology suggests high-quality forged iron was produced in Korea by AD 300, associated with Chinese technological and political influence. Others also suggest that iron was traded along already established obsidian trade routes (Bowers 2009).

Regardless of the pathway by which traded metal artifacts reached distant Alaska locations throughout the centuries, remote populations were affected by material supplies and technological advances within regional economic systems. Clearly, new materials such as iron broadened available technological choices for Late Holocene prehistoric craftspeople, despite distance from centers of industry.

The thorough treatment of the subject of the use of needles themselves aside from their manufacture from bone cores is beyond the scope of this paper. We acknowledge the critical nature of needles and clothing within northern cultures (cf. Chaussonnet 1988), but for purposes of conjecture and because the topic is inextricably related to needles (or at least very small, sharp, pointed implements), we explore the idea that needles produced from waterfowl wing bones may have also been used in tattooing. Krutak (1998) found the placement of tattoo marks had a variety of meanings and purposes, some of which were indications of sex, age, status, clan affiliation, and hunting merit or other attribute. Tattoo marks, sometimes stitched into skin using needles that pulled pigmented threads, suggested to Krutak a detailed understanding of points on the body similar to those used in Asian acupuncture, which led him to conclude that tattooing was also used for prevention or cure of physical ailments (see Lo [2002] for a discussion of the transition of bone and stone to metal in acupuncture needle material). Bloodletting was also commonly performed in northern cultures as a curative method using "small lancets of stone or iron" (Nelson 1983 [1899]:309). Were so-called engraving tool handles used for this purpose? Recording on the skin the endurance of pain has significance in many cultures, and women, the wielders of needles, were commonly the tattooists (Krutak 2007). Perhaps sharp bird bone needles, in addition to the role of clothing construction, were integral to prehistoric tattooing or other curative processes.

CONCLUSION

Needle production shows variation in grooving technology over time and space and records the use of different bit materials. In general, the northern sites from which bird bone was examined date to more recent times than do the Aleutian, Kodiak, and St. Lawrence Island sites; in this study, the sites span approximately 2,100 years. Differences appear to reflect the use of iron at Ipiutak sites and stone at Aleutian and Kodiak sites. Radiocarbon dating suggests metal may have been available at least by AD 400. Most Aleutian sites date to several centuries prior to this time, and grooves reflect the use of stone bits. Some cores have been subjected to post-depositional effects or other processes that make identifying bit material with certainty more difficult. Though bit material used in needle manufacture appears to be discernible in many instances, the character of the handle of the grooving tool is undetectable. Our understanding of prehistoric technologies will improve with further study of existing collections, as well as with the discovery of additional tools or iron objects.

We have identified the properties that make bird bone inherently advantageous for needle use, although these advantages may decrease over time as the needle ages and becomes brittle. Luckily for archaeologists, these properties encouraged the continuous production and the regular discard of needles and needle production waste into the archaeological record. However, the source bone of many needles, especially the most delicate, is often unknown. More work is required on characteristics of bird bone relative to small mammal bone with similar cortical thickness in regard to needles and their manufacture. Bone of small mammals, such as fox and hare, terrestrial birds and other waterfowl could be shaped as needles and subjected to stress testing to compare elasticity, tensile, and flexural strengths.

Our research indicates bone needles were crafted from several avian species, primarily snow geese and Canada geese at Ipiutak sites in northwestern Alaska. Early accounts of spring snow geese migrations following routes north along the upper Koyukuk and the upper Kobuk drainages suggest that Tukuto Lake, where the Croxton site is located, was along a regular flyway. Bone and other materials from large seabirds formed part of the material culture base for human inhabitants of the Aleutians and Kodiak Island, where needle cores were made from albatrosses (*Phoebastria* genus, formerly *Diomedea*); two species were noted as historically numerous, the Laysan (*Phoebastria immutabilis*) and black-footed (*Phoebastria nigripes*) albatrosses.

Ethnographic accounts reveal migratory waterfowl in northern cultures were integrated into mythology and symbolism in interesting ways. The use of bird wing bones shows remarkable continuity in needle manufacture, a technological process often associated with women. Obviously, needles were critical for survival in arctic and subarctic cultures and have a variety of uses, some of which may have been related to curative and decorative processes. The use of introduced iron to produce bone needles or to fashion complex tools in innovative ways may reflect a shift in social processes. Material acquisition systems necessary to obtain iron, as opposed to stone, may have differed in significant ways. Continuation in the use of humeri or ulnae from particular bird species for needles, however, indicates stability of functional, symbolic, or other factors.

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REINDEER AND POTATOES ON THE KUSKOKWIM RIVER: A FAMILY HISTORY IN WESTERN ALASKA

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ABSTRACT

The Alaska Reindeer Project brought Saami reindeer herders from Finnmark in northern Norway to the Seward Peninsula of Alaska to teach their traditional herding techniques and lifeways to Eskimo hunter-gatherers at the turn of the last century. The arrival of the Saami on the Seward Peninsula was overshadowed by the Nome gold rush, but the herders and their families established themselves and the foundations of a herding economy in western Alaska. In 1903, the Sara and Spein families, members of the Saami group who arrived at Unalakleet in 1898, delivered a herd of reindeer to the Moravian Mission at Bethel and settled in the Kuskokwim River region where they helped to found a herding industry at Akiak. Adams Hollis Twitchell was a trader newly arrived in the Kuskokwim region when the Sara and Spein families arrived at Bethel. Twitchell was married to a Yup'ik Eskimo woman and was a collector of Yup'ik cultural objects who supplied hundreds of items to museums and major collectors. Twitchell sold his merchandizing business in Bethel to purchase reindeer from the Saami and establish his own herd near the Beaver Mountains, supplying reindeer meat to the Iditarod and Innoko District gold mines. When the Reindeer Act of 1937 ended their herding livelihoods, the Saami and Twitchell families turned to other western Alaska economic activities, including placer gold mining, store keeping, raising produce, and fur trapping.

KEYWORDS: reindeer herding; Saami, Yup'ik Eskimo, economic and cultural change

INTRODUCTION

This paper profiles the history and context of a family who lived and worked in the Kuskokwim River region of southwest Alaska during the territorial days at the end of the nineteenth and first half of the twentieth century. This period was a time of significant social and economic changes in that part of the world, including the Nome gold rush in 1898 that brought the first wave of prospectors to western Alaska and the rise and fall of the United States government's Alaska Reindeer Project.

The author's family history reflects these larger events on a more personal scale; her great grandparents, Nils Persen Sara and Inger Maria Mortensdatter Sara, were among the larger of the two emigrations of Saami herders in the 1890s. Concurrent with their arrival at Unalakleet was the arrival in Nome of a gold miner with roots in rural New England, the author's paternal grandfather Adams Hollis Twitchell, and the immigration of fifteen-year-old Jens Anton Kvamme from Finnmark, Norway to the U.S. The Sara family and Twitchell arrived at Seward Peninsula at about the same time, but there were no known interactions between them until after the Sara family arrived in the Kuskokwim River valley in 1903. Within a decade, reindeer herding and family ties would link these families, through the marriage of Adams Hollis Twitchell's son

Benjamin to Berntina Kvamme, the youngest daughter of Jens Anton Kvamme and Ellen Marie Sara.

THE ALASKA REINDEER PROJECT

The subsistence lifestyle of the indigenous people in northwestern Alaska was considered meager and abject as measured by the agrarian-based standards of missionaries and educators based in the continental U.S. At a time when the whaling industry was reaching farther north in search of diminishing resources and new gold discoveries in the Yukon and Alaska were creating rushes of people northward, a U.S. government-funded program spearheaded by Dr. Sheldon Jackson, a religious leader of the Moravian Church, brought a group of Saami reindeer herders from Finnmark in northern Norway to the Seward Peninsula of Alaska to teach herding culture and skills to Eskimo hunter-gatherers. The Alaska Reindeer Project was a unique effort played out during a time of great social and economic changes in a land that continues to engender broad social experiments (e.g., the Alaska Native Land Claims Settlement Act).

The Alaska Reindeer Project was the vision of Dr. Jackson, who convinced the U.S. Congress to fund the establishment of reindeer herding in Alaska with reindeer imported from Siberia and Saami reindeer herders imported from Finnmark to teach animal husbandry to indigenous Alaskans. Although the project was originally conceived as a way to provide a reliable and consistent food source and livelihood for Eskimo on the Seward Peninsula, it gradually evolved into an effort to create a new Alaska economy modeled after the reindeer economy of the Scandinavian countries.

At first, the reindeer herds grew quickly and the reindeer commission expanded reindeer herding geographically, but ultimately, growth of the herds exceeded market demand and the boom and bust cycle of early gold mining combined with the national economic collapse of the Great Depression reverberated within the reindeer industry as well.

Initially, Dr. Sheldon Jackson brought a small group of Saami to Alaska in 1894 to serve three-year herding contracts. Following that pilot effort, a larger, more permanent colony was recruited in Norway during the winter of 1898. Under contract to the U.S. government, most of the Saami herders were paid a monthly salary of $22.33 plus food and clothing for the first two years of service, then the herder could elect to be paid in reindeer. Three unmarried Saami women were also hired to wash and mend clothing for the unmarried herders; they were paid $4.46 per month. At the end of their service, the herders could remain in the U.S., pay for their own return to Norway, or have the government pay their way home—provided the herder worked six months with no salary. Seventy-two persons signed the January 24, 1898, contract.

As a result of the recruitment in Finnmark, 113 men, women and children destined for Unalakleet and more than five hundred reindeer (purchased at ten dollars per head for the ill-fated Yukon Relief Expedition) assembled at Bossekop, on Altafjord, Norway. The Saami had traveled overland, bringing the deer through the mountain passes down to the coast during a protracted and bitterly cold blizzard that developed into hurricane winds that rattled buildings and threatened to blow in the windows of the hotel at Alta. The Saami and all their sleds, harnesses and bags of lichen for feeding the deer were loaded on the steamship *Manitoban* which departed from Bossekop on February 2, 1898, bound for the stockyards of New Jersey. The ship was an old freighter configured to haul livestock and the Saami were treated like cargo, relegated to open steerage in the hold of the ship for the duration of the Atlantic crossing (Sakariassen 2002).

The February crossing of the stormy North Atlantic took twenty-three days, during which a fierce nine-day storm battered the ship, crushing a lifeboat, planking, and stanchions and ripping the figurehead from the bow. Virtually every person in the crowded and reeking hold was seasick. The pitching waves were so severe it was difficult to stand up and the food was carelessly contaminated by an indifferent and dirty cook who walked on the stored meat with the same boots he wore through the dirty water and manure in the reindeer pens. The reindeer that were penned in stanchions on deck had to the endure the storm, including two days without food due to hurricane-force winds when no one ventured above deck.

THE SARA FAMILY IN ALASKA

Among the group of herders and their families who made the harrowing North Atlantic crossing were Nils Persen Sara, his wife Inger Marie Mortensdatter Sara, and their five youngest children, Ellen Marie Sara, who at fifteen was the oldest of the five children who traveled with their parents, and her brothers Mikkel (twelve), Morten (six), Klemet (four) and Mathias (two). An older brother, Per (Peter) Sara, traveled independently several years later and rejoined his family during their relocation to the Kuskokwim Valley.

The Atlantic crossing in the dead of winter was only the first part of an epic journey. The arrival of the *Manitoban* and its exotic cargo at the stockyards of New Jersey created a sensation in New York (*New York Times* 1898). Both the reindeer and the Saami herders and their families crossed the U.S. by train, where crowds of curious people gathered at stopping points to stare at and touch the clothing of the Saami travelers. Berntina Venes, Ellen Marie's daughter, wrote that her mother had been impressed by the train journey:

> She told us of crowds of people at train stops along the way that were curious about these strange people in their colorful clothing, and about the reindeer. She said people tried to reach out and touch their clothes and stared at them. To a young girl straight from the mountains of Lapland, the sights and sounds along the way of their journey to their new home must have been truly amazing (Venes 1971).

They arrived in Seattle on March 7 and encamped for two weeks in Seattle at Woodland Park, the only fenced area of Seattle, where they became a local attraction viewed by more than ten thousand people. During the protracted wait in Seattle the youngest Sara child, three-year-old Mathias, succumbed to an illness he had struggled against during the entire trip and was buried in Washington (Sakariassen 2002). The group was split up while the reindeer and men were shipped to Haines for the Yukon Relief Expedition; in the interim, the women and children were taken to Port Townsend to wait for their return. The herders returned to Port Townsend on May 18 and the Saami resumed their journey to Unalakleet on June 22; the two ships carrying the party arrived there on July 29 and 31, 1898. Two Saami families from the 1894 immigration and an Alaska Native family had brought the government herd from the Teller Station near Port Clarence to Unalakleet while Dr. Jackson was in Norway recruiting herders for the 1898 expedition.

The arrival of the new Saami herders at the chosen site of the future Eaton Reindeer Station, eight miles upriver from Unalakleet, was finally accomplished on August 5, 1898. The Saami were issued tents and food rations and immediately began to construct log houses to live in before winter set in.

One year later, Nils Persen and Inger Maria Sara, their sons Morten and Clement, and forty-two reindeer were taken to St. Lawrence Island to begin reindeer herding among the Siberian Yupiit at Gambell. Within two years of their arrival in Alaska, a marriage was arranged for Ellen Marie Sara to Per Mathisen Spein, one of the Saami herders who had also arrived on the *Manitoban*. They were married on January 4, 1900.

As reindeer herding spread across western Alaska from its beachhead on the Seward Peninsula, some Saami families were charged with bringing starter herds to missions and villages in other parts of the Territory. In February 1903, the Sara family, together with Per Mathisen Spein, was tasked with bringing deer from Unalakleet to replenish the Moravian mission herd at Bethel. They also brought two herds of 100 deer each on loan from the government to establish their own private herds in the Kuskokwim region to support their families, because the meager rations provided to the herders by the U.S. government could not be extended to areas beyond the immediate region of the Seward Peninsula reindeer stations.

When the herd reached the Yukon River, the herders found that the tundra between the Yukon and Bethel was covered with a thick layer of ice, preventing the deer from finding food. Because it would have been perilous to continue with the deer, the family spent the spring, summer and fall grazing the herd in the Andreafsky Hills near St. Marys.

When Carl Lind reached the group in September, he discovered that Ellen Marie Spein had given birth to a baby just four days prior to his arrival and the herders had no milk and very little food in camp, and no ammunition to hunt wild game. They had not obtained more supplies at the nearest store because their government-authorized account with the merchant was so small they were reluctant to purchase what they needed. Mr. Lind was able to purchase a few tins of food, including one can of milk, from a riverboat galley cook and had them sent to Mrs. Spein (Lind 1904).

The Yukon River crossing and subsequent drive across the frozen tundra between the Yukon and Kuskokwim rivers was not accomplished until after Thanksgiving, when the river ice was sufficient to allow the herders and their charges to cross the river. To the credit of the Saami herders, only one deer was lost on the journey from the Yukon to Bethel—an old and lame animal that was butchered for meat after it fell on the glare ice of a lake crossing and was unable to continue (Lind 1905). The herders finally reached Bethel on December 3, 1903 and took the herd to the Moravian Mission reindeer camp on

Figure 1: Morten, Ellen Marie, Berit, and Clement Sara soon after their arrival in Alaska.

the Kisaralik River. The reindeer commissioner reported a total of 1,046 reindeer in the Kuskokwim valley in 1904; of these 283 were owned by Nils Sara and 242 were owned by Per Spein.

The Sara family and marriage-related Spein family (see Appendix) established their own herds, grazing their deer in the Kuskokwim and Aklun mountains, and eastward into the Tikchik Lakes region (Fig. 2). In addition to Nils Sara and Per Spein, the young Sara brothers, Peter, Morten and Clement, eventually established their own reindeer herds. Several separate herds grazed ranges on the Kwethluk, Kisaralik, Fog, Salmon, and Aniak rivers, all tributaries of the Kuskokwim, and as far as the headwaters of the Togiak River (Sara n.d.). The Saami herders supplied reindeer meat for the some of the early placer mining camps in the Kuskokwim region.

> Three men and five dogs had brought a herd of five hundred marketable animals, in addition to their pack deer. The men spoke only a limited amount of English but I gathered that this was about as many as three men could handle, particularly as they were being moved away from their familiar grazing round….
>
> The herd was soon shaped up for the night and the boss herder called his dogs. A hundred feet, more or less, from the outer edge of the herd he made a mark on the ground and gave a command to one of the dogs. The dog sat down facing the herd. Taking the other dogs, the Lapp made a complete circle of the herd, making four more marks at regular intervals, with a dog stationed at each mark and apparently understanding that he had a definite post to patrol during the night (Peckenpaugh and Peckenpaugh 1973:79).

Reindeer could be driven to a location near the mining camps for purchase and butchering so the miners did not have to buy more meat than they could store short term. The small crew of men building the first mine on Marvel Creek in 1912 arranged to purchase two deer to supply the camp's meat and made arrangements for resupply in two weeks' time. The arrival of the Saami provided not only meat for the camp but also an opportunity for socializing in the remote wilderness.

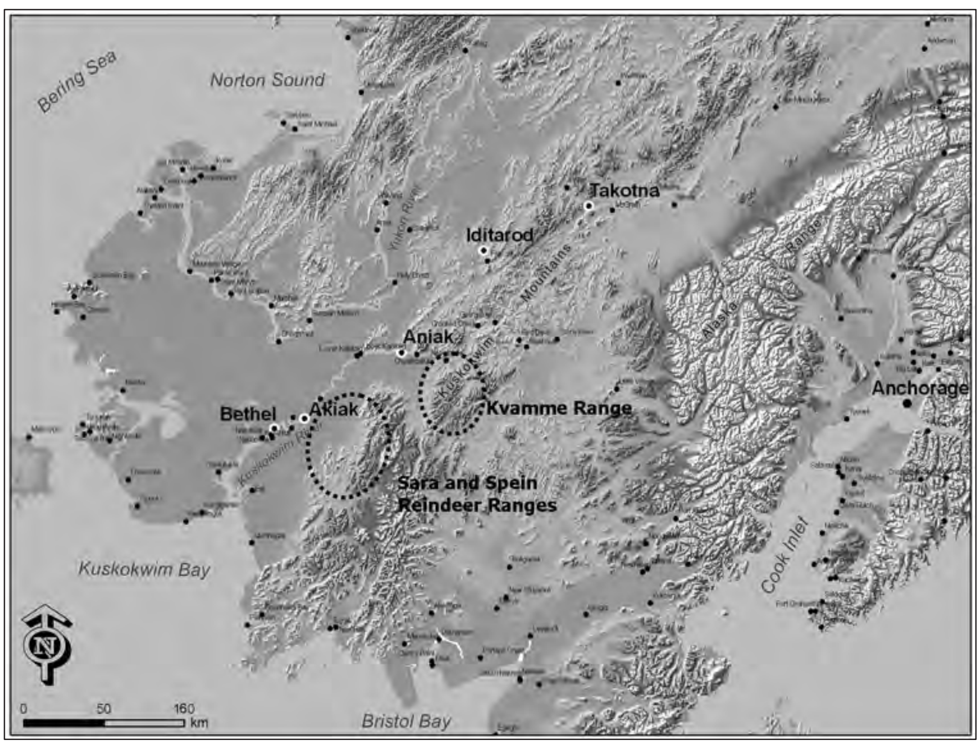


Figure 2: Map of the Sara and Spein reindeer ranges

> Being above timber we had no means of hanging the deer while they were being drawn and skinned so they had to be "butchered in the skin," as an old time cowboy would have done it. This was the Lapp's usual method and they were experts…. Counting the correct number of ribs on the left side of the animal, the boss herder placed the point of his knife between the two ribs opposite the center of the heart, striking the end of the handle a sharp blow with the palm of his hand. Simple and quick. The blood settled against the diaphragm. By the time the animal was skinned and opened, it could be removed in one mass. Cooked with the brain, liver, and other tidbits, it was their meal supreme.
>
> We squatted on the hides covering the floor, Turk fashion, rolled Bull Durham cigarettes, and sipped black coffee. The cups were too few to go around, so we drank in relays. They spoke little English and we spoke their language not at all, but they were glad to have us and we were happy to be with them (Peckenpaugh and Peckenpaugh 1973:80).

The Sara family had chosen to make its future in Alaska instead of returning to Norway at the end of their contracted government service. The Sara and Spein families settled in the Kuskokwim region where Nils Persen Sara and Inga Maria Mortensdatter Sara, who were forty years old when they immigrated to Alaska, lived out their lives as reindeer herders. Several of the Sara children married into local Yup'ik Eskimo communities. Across the Kuskokwim River from the Village of Akiak, where residency was restricted to Alaska Natives and church and school workers, the Saami families helped found a community largely made up of Norwegian immigrants. Akiak became the center of the Saami reindeer industry on the Kuskokwim River (Miller 1930).

Ellen Marie and Per Spein had three children, Mary, Mathew and Anna, before separating in about 1914. On November 20, 1915, Ellen Marie Sara married

Jens Anton Kvamme Andersen, a Norwegian immigrant born on Altafjord in the Finnmark region of Norway who left the country at the age of fifteen to join relatives in Michigan (Venes 1971). Jens was a restless young man and had moved westward to the gold camps in California and Oregon, ultimately following the gold strikes to Alaska. His arrival in southwestern Alaska was from the mining camps at Nome and Deering, where he heard about the new rush to the Iditarod River (Anderson 1957). In order to travel to Iditarod during winter, he purchased sled-trained reindeer, paying $20 per head, and sleds from Native herders at Unalakleet. Reindeer did not require their food to be carried on the sleds; instead the deer were able to forage for themselves along the way. Jens arrived at Iditarod after nearly two months camping along the trail. Once he arrived, Jens found the good ground was already staked but there was no meat in town for the miners who were wintering there. He butchered a few of his deer, selling the meat for seventy-five cents a pound. He purchased more deer from the Saami families at Akiak, driving the herd north to supply meat for the Iditarod miners.

By that time, Jens had developed a sharp eye for gold mineralization, and he returned to some promising-looking ground he had observed on the reindeer range while he was obtaining reindeer from the Saami herders on the Kwethluk River. He discovered a small, rich placer deposit and filed claims on Canyon Creek, a Kwethluk River tributary, in 1913 (Holzheimer 1926). Jens successfully defended his discovery against claim jumpers rushing to his strike from Bethel (Lenz and Barker 1985). He invited other Akiak people, including Per Spein and Joseph Venes, another Norwegian immigrant, to participate in the gold strike, and ultimately, he sent for his brothers Alfred and Ole Andersen to operate the placer mine (Andersen 1957). The brothers worked the mine for nearly thirty years. Canyon Creek continued to be a source of income for the next generation as well, passing to Jens's son, Albert Kvamme, and finally to his grandson Albert Kvamme, Jr. before being consumed within the great expansion of the Yukon-Kuskokwim National Wildlife Refuge in the 1980s.

Jens Kvamme established a new reindeer herd in 1914 with 289 deer acquired from Ellen Marie's brothers, Peter, Mikkel and Clement Sara, and 140 deer Ellen received from her father. The Kvamme family took their herd into the headwaters of the Buckstock and Aniak rivers and established a new herding range, constructing cabins and brush corrals in an area that had never been utilized by any other herd (Miller 1930). The Kvamme summer range camp was located on the East Fork of Aniak River (Atsaksovluk Creek, near Timber Creek ([Fig. 3]).

> My mother was separated from her own family and people when she and my father moved to the middle Kuskokwim area with their own reindeer herd. They settled down in the Napaimute-Aniak area. My mother was pretty much assimilated into the surrounding lifestyle of the area. She no longer had anyone to speak the Lapp language with and she saw her own folk only occasionally when she made the trip to Akiak to visit them. She learned to speak Eskimo and she had many friends among the Eskimo people in Aniak and the surrounding area (Venes 1971).

The Kvamme herd grazed among the high ridges and spurs along the divide between the Swift and Holitna river headwaters to the south and the Aniak, Holokuk, and Oskawalik rivers on the north side. The high ridges were preferred in summer by the reindeer because the biting

Figure 3: The Kvamme family at their Timber Creek summer camp in 1930. Ellen and Jens with children (left to right) James, Anna, Berntina, Ellen, and Albert Kvamme.

flies and mosquitoes were suppressed when the wind was blowing across the bare ridges, and the willow and dwarf birch thickets in the higher elevations could be utilized by the reindeer to brush off mosquitoes when the winds were calm. The deer were wintered at lower elevations because these areas had less snow-cover, allowing the deer easier digging through the snow to reach the lichen they consumed all winter. Travel to summer and wintering areas was accomplished with sled deer and pulks [sleds] on late spring and early winter snow (Fig. 4).

> There were some things that were a part of the Lapp way of life that were practiced in our everyday life. My mother now lived in a different culture, but she clung to some of her Lapp ways of doing things. . . . We were not aware of the things we learned from her as she never consciously taught us about her culture, but we learned things that were part of the traditional ways of Lapp everyday life. . . . My mother spoke of taming and training reindeer, training her own sled deer, driving them, and taking her children with her in their unique sleds called *pulkas.* The youngest child, the baby, was wrapped up in the cradle that they called the *komsa*. This traveling cradle was made of a split birch log hollowed out. The headpiece, a half round canopy, was fastened to the cradle and the whole thing was covered with fabric. My mother's cradle was covered with a khaki drill material; it was trimmed with her hand-woven trims (Venes 1971).[1]

Figure 4: Jens Kvamme with freighting pulks stored at Timber Creek.

The Kvamme family initially spent the winter seasons at Kangirmiut ("Inikpuk #2 [Kungegamiut]" in Oswalt 1980:43) on the Kuskokwim River above Napaimute, where Jens built a cabin for the family. When a territorial school opened in Napaimute in the 1920s, Jens built another cabin there so that his children could attend school. In 1930, the family relocated to Aniak, where they lived temporarily in a log cabin owned by trader Tom Johnson, who had established a trading post at the mouth of the Aniak River, while Jens built a two-story log home for his wife and five children, together with a warehouse, smokehouse, shop building, and a large garden space on land just east of Johnson's buildings.

The family was musical and acquired a piano, violin, accordion and guitar, and they had bookcases for their family library. The children slept upstairs and there was enough room on the main floor for dancing. Jens later built a lean-to on the back of the building that served as the master bedroom, which left enough space in the main room for a large console radio and a wind-up Victrola phonograph, the modern technology of that era.

The little shop building was later occupied during the winter by miner Joseph Konechney, who spent many years drifting along the mineralized veins exposed in the headwall of Mission Creek in the Russian Mountains northeast of Aniak. Konechney spent summers at his cabin in Mission Creek Valley, well above treeline, and sheltered at Aniak during the winter. Jens's shop building (AHRS# RUS-027) is the sole remnant of the original Kvamme home site and is now the oldest structure in Aniak (Mobley 2004).

The Reindeer Act of 1937 brought an abrupt, government-mandated end to the reindeer herding life of the Alaska Saami by barring reindeer ownership within Alaska to all but Alaska Natives. The Saami were promised that they would be treated as whites (in contrast to the ethnic discrimination they experienced in Norway) but the disadvantage was that they were included in the non-Native category of reindeer owners. The non-Native-owned herds were condemned and appropriated by the U.S. government, who compensated their owners at $3.00

1. Anna Spein Twitchell used the cradle for her children. It is now located in the Anchorage Museum at Rasmuson Center.

per head for reindeer registered with the U.S. Reindeer Service and nothing for unregistered deer. After implementation of the Reindeer Act, Jens Kvamme and his family focused on the mine at Canyon Creek. Peter, Michael and Clement Sara were similarly forced to sell their herds, and the Sara family's reindeer herding life ended.

> The Lapps lived an adventurous life by the standards of today. It was a hard life with a lot of work. Yet they didn't think their life was so outstanding. They came to a land foreign to them from across the world, and made it their home. They were good citizens living from day to day, taking things as they came. In one lifespan, they left their native land in Norway and came to a strange land, bringing their traditional herding lifestyle with them. When that was taken away from them, they adapted to a new way of life (Venes 1971).

In 1942, the Kvamme family built a home across the Kuskokwim River from the Native village of Akiak (Fig. 5). The south side of the river was the home of Ellen Kvamme's brothers, Peter and Michael Sara, and other Norwegian immigrant families and homesteaders. From that time, the Kvamme family split their residency between these two villages, spending summers at Aniak catching and putting up their winter supply of salmon and growing produce in their large garden. They spent winters at Akiak, from which they sled-hauled freight to the Canyon Creek Mine once snow-cover permitted overland travel.

The Saami families on the Kuskokwim River remained to garden, smoke and put up fish, pick berries, hunt, trap, operate stores, and generally participate in the mix of subsistence and frontier enterprise that is characteristic of rural Alaska. Today, the small community across the river from the Native village of Akiak has disappeared, falling victim to shifting rural populations and economies. Little remains of it today but the cemetery, where some of the former residents and their descendents still maintain the family graves.

THE TWITCHELL CONNECTION

When the Sara and Spein families arrived at Bethel in late 1903 with deer for the Moravian mission, a trans-

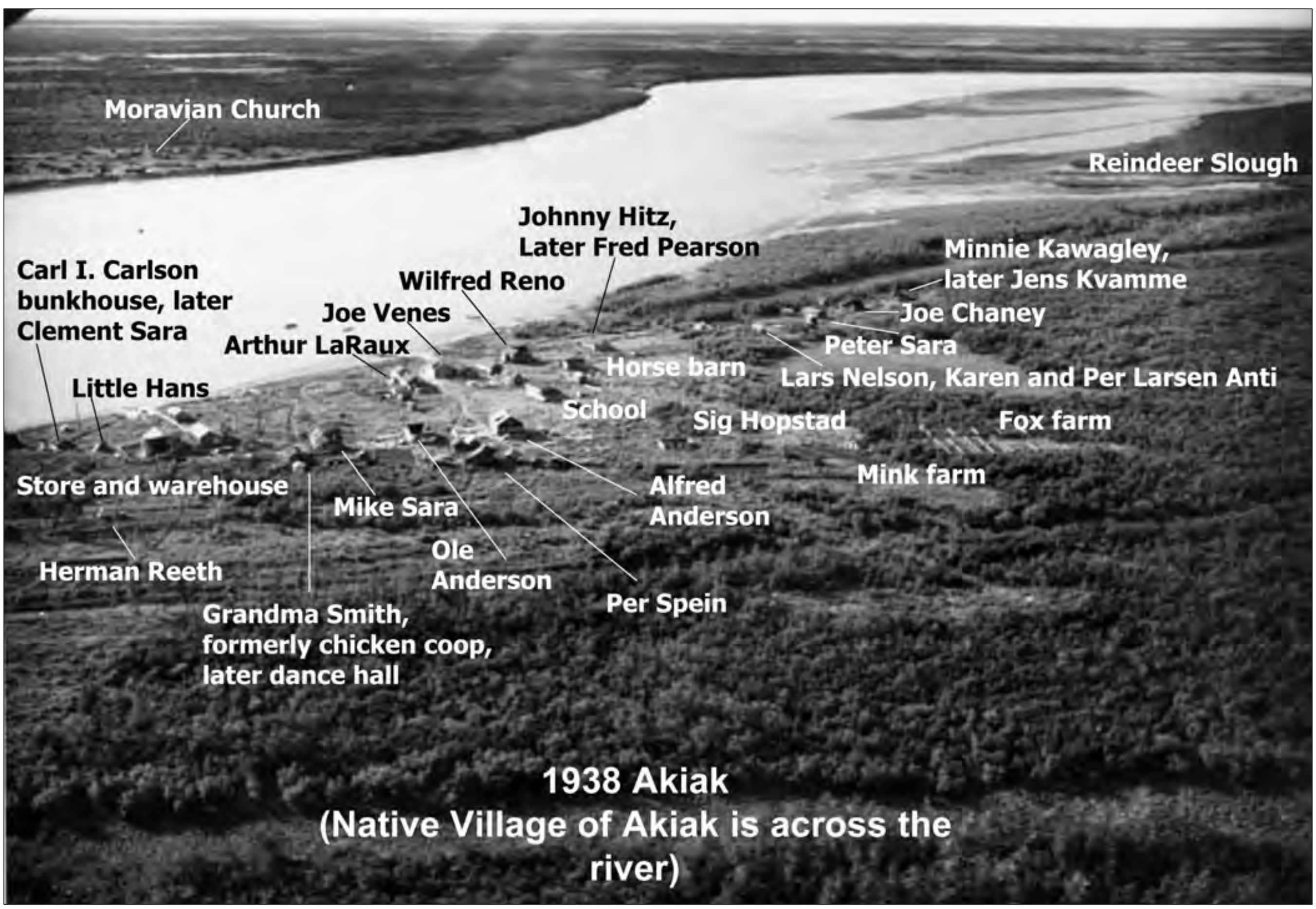


Figure 5: The non-Native community at Akiak, 1938.

planted New Englander from Vermont, who had followed consecutive gold rushes north, was fur trading on the Kuskokwim. Carl Lind, the U.S. reindeer superintendent who accompanied the Saami herders and their charges across the treeless, frozen tundra, and glare-ice-covered lakes between the Yukon and the Kuskokwim, noted his surprise at finding a white man living in a small Native village not far from Bethel (Lind 1905:69). That man was Adams Hollis Twitchell.

"A. H.," as he was commonly known, was born in 1872 in Jamaica, Vermont, a small farming community. As a young man, A. H. left New England for the West and joined the gold rushes to at Dawson, the Cassiar, and Nome, along with many other young men of his time. He and his partner, Charles Fowler, for whom Fowler Island on the Kuskokwim River is named, were in Nome in 1902. The following winter, A. H. was in the Kuskokwim River delta, investigating the prospects for fur trading and commercial merchandising (Fienup-Riordan 1996:249).

A. H. Twitchell fared well in the Yup'ik villages. He knew the Yup'ik language, ate the Native diet, participated in the local culture, and flourished. He was a man who knew the value of fresh food, having seen in the Nome, Council and other mining camps the effects of inactivity during the long frigid winters and the restricted diet of flour and beans some of the wintering prospectors ate. Many miners holed up in their tents, doing less and less as their strength and energy waned. But those who braved below-zero temperatures to hunt, get wood, or visit Native settlements to get fresh seal, rabbit, or ptarmigan meat, did not suffer from scurvy and other "cabin-fever" ailments (Twitchell 1960).

A. H. Twitchell married a young Yup'ik woman from a small Native village, Nunacuaq. Qecik (Fig. 6) was baptized Elena (or possibly Irene) by the Russian Orthodox priest who made occasional visits to the tundra villages. A. H. entered the marriage record in the ancient Twitchell family Bible: "Adams Hollis Twitchell, Son of Adams Twitchell and Laverna Livermore Twitchell, married Ireene Kocheek of Kuskokwim District, Dec. 30, 1904, by Constantine Pavloff, priest."

A. H. established both a family and a trading company at Bethel by 1905, buying out trader Edward Lind and sailing from Nome to eighty miles up the Kuskokwim River on his shallow-draft vessel *Zenith* (Oswalt 1980:30). It was the first ocean-going vessel to arrive at Bethel, and the event was celebrated by flag-flying and gunfire. That year A. H. and two partners, Charles Fowler, miner and former Texas cowboy, and Frank Joaquin, a California merchant of Portuguese descent, founded a new company, Joaquin, Twitchell & Fowler, and built a store and warehouse in Bethel. Four years later the partners incorporated as the Kuskokwim Commercial Company to sell goods at Bethel and along the river with a sternwheeler, the *Quickstep*, which they imported from the Yukon River.

The Kuskokwim Commercial Company was sold to John W. Felder and Maurice Gale in 1915. The following year A. H. invested in the reindeer industry, purchasing two hundred reindeer from Per Spein plus additional reindeer from Spein's son Matthew and from Nils Sara and his son Peter Sara (Fig. 7).

A. H. relocated his family to the Iditarod mining town of Flat and moved his reindeer herd to a new range between the Iditarod and Innoko mining camps (Fig. 8). He applied to U.S. Reindeer Commissioner John H. Kilbuck and was granted an exclusive right to his herding range on the Dishna River near the Beaver Mountains (Twitchell

Figure 6: Irene (Qecik) Twitchell, left, and friend at Bethel, early 1900s.

1914–1946). Here, the prevailing winds created lush summer pastures on the southwestern side of the mountains and drier pastures on the northeastern side that were ideal for winter grazing due to sparser winter snow accumulation (Vorren 1994:97). A.H. moved the herd in a broad rotational succession of spring and summer grazing pastures between the Dishna River and the Beaver Mountain massif and wintered the herd on Tolstoi Creek.

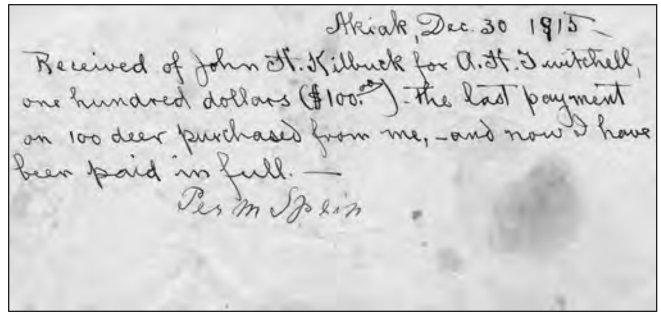

Akiak, Dec. 30 1915
Received of John H. Kilbuck for A. H. Twitchell, one hundred dollars ($100.00) the last payment on 100 deer purchased from me, — and now I have been paid in full. —
Per M Spein

Figure 7: Bill of sale from Per Spein.

On the Twitchell Range (Fig. 9), A.H. and his partners built corrals and several far-flung range cabins whose locations are still noted on topographic maps of the area. The herders practiced range rotation, moving from one grazing area and camp to another during the summer, eventually arriving back at the wintering grounds on Tolstoi Creek after completing a circuit of grazing areas between Mt. Hurst, Camelback Mountain and Crater Mountain in the upper reaches of the Dishna River (Vorren 1994:97).

The Twitchell family lived at Flat and the children attended school there and later at the Jesuit Holy Cross Mission on the Yukon River. A.H. marketed sides of reindeer meat to the miners at Flat, Moore Creek, Ophir and other Innoko District mine camps. A source of fresh meat was valuable in the remote mining districts, and in Flat there was a subterranean cold house especially built for meat storage.

Figure 8: A. H. Twitchell and children Alice and Benjamin with pack horses and sled deer

A.H.'s formal education ended at sixth grade, but he was a self-educated naturalist who corresponded with biologists and other men of science. He read scientific papers and reports and critiqued the written English of his college-educated sons.

During his earlier trading years in the Bethel area, A.H. collected more than two hundred Yup'ik cultural objects, most of which went to the compulsive collector of Native American art, George Gustav Heye. The ethnological objects A.H. collected for Heye and George Byron Gordon, director of the University of Pennsylvania Museum, and included examples of women's handicrafts such as deftly stitched and pieced skin bags and clothing articles. However, the objects that generate the greatest attention were the sixty-four dramatic dance masks and ceremonial objects he obtained from Napaskiak and perhaps other villages near Bethel (Fig. 10).

A.H. believed that these expressions of Yup'ik spirituality and world view were about to disappear under the influence of the Christian missionaries in the region, who discouraged or forbade the traditional ceremonial dances that expressed relationships with the Yup'ik spiritual world. The mask collection is notable for A.H.'s notes identifying the Yup'k names of the representations and occasional explanations of their significance. One hundred years later, these names and brief descriptions provide information on spirits otherwise known to Yup'ik elders only through oral tradition (Fienup-Riordan 1996:257).

A.H. owned ornithology reference books and was keenly interested in scientific papers about insects and parasites. He collected specimens of worms, insects, birds, mammals and plants for scientists and museums, including the National Museum of Natural History and the Cleveland Museum, and contributed notes about wildlife abundance and range extent to scientific journals. In a 1929 letter to his son Ben, A. H. touched on specimen collecting:

> Ask Tim for that little paper on new species of tape worms and tell me what the college could do with such material—note it is a species new to science. A new species of animal parasite is of particular value. I have found several new species of parasite and others that are rare in collections. When I began collecting nose bots, I believe the Smithsonian Museum had but one and Biological Survey none. By collecting in a little known country, I have extended the known range of many birds, animals, and insects, and many valuable records will be kept in Washington and elsewhere that would possibly be of no interest to [the] college. I have sent out many specimens of a biting beetle—a parasite of beaver like a louse that in the immature stage is like a worm. These are common here but rare in collections. I think I would collect many specimens for colleges if there was some prospect of getting some pay at some future time. There is no big money in such work but some of my specimens get me fair pay for my work while most of them are donated and I do not even get the postage (Twitchell 1914–1946).

A. H. maintained a personal correspondence with Edward W. Nelson, touching on personal matters, wildlife observations and territorial game commission corruption, a sore point with both men that A. H. took an active part in reforming (Twitchell 1914–1946).

When Herbert Brandt of the Bird Research Foundation in Cleveland and Olaus Murie of the U.S Biological Survey made a winter dogsled journey from Fairbanks to Hooper Bay in March, 1923, to see firsthand the arrival of the great bird migrations first reported by Edward Nelson, they met up with A. H. Twitchell at a roadhouse near Ophir on the trail to Iditarod. A. H. took Brandt on a side trip to his winter reindeer camp at the foot of the Beaver Mountains, providing Brandt his first observation of rock ptarmigan, as well as a chickadee eating reindeer suet—which Brandt collected, taking it for a boreal chickadee, only to later learn it was an uncommon gray-headed chickadee (Siberian Tit) south of its normal range. Brandt was so impressed by his visit to the Twitchell reindeer camp he devoted a chapter to it in his memoir, *Alaska Bird Trails: Adventures of an Expedition by Dogsled to the Delta of the Yukon River at Hooper Bay*, and also included a photograph of the ill-fated chickadee (Brandt 1943).

A. H. utilized his cabin-building experience to construct a series of small cabins on his grazing range. He also built three cabins for the territorial road commission along the trail to Iditarod (Fig. 11) as replacements for the worn canvas wall tents then being used as public shelters along that stretch of the trail (Sommers 1921).

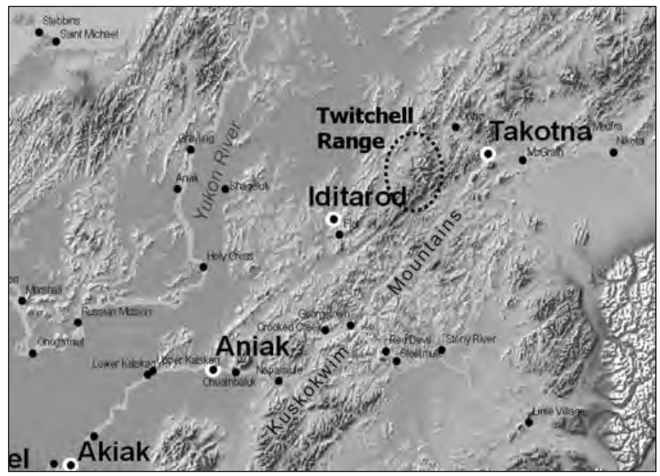


Figure 9: A. H. Twitchell reindeer range map (for location of detail map, see Fig. 2).

Figure 10: A. H. Twitchell, right, displaying Yup'ik dance masks collected after a lower Kuskokwim dance ceremony.

While still a young woman, Irene Twitchell became ill with tuberculosis and returned to the Kuskokwim River, nearer to her own family. She died on October 11, 1926 at the hospital at Akiak and was buried there. A. H. continued to live in the mining town of Flat until 1929, eventually selling his cabin there when the Guggenheim dredge mined through the town site; he then relocated to Takotna. Relating these events in a letter to his son, Ben Twitchell, who was attending college in 1929, A. H. told him: "I have sold my house at Flat. I sold it because it must be moved. Nearly every one except Mr. Dave Brown and the girls on the row must move (Twitchell 1914–1946).

Figure 11: Frank Joaquin, Charles Fowler and A. H. Twitchell at Iditarod cabin

A. H.'s reindeer herding enterprise was also terminated by the 1937 Reindeer Act but, true to his New England farming roots, he was already cultivating potatoes, turnips, rutabagas, and other root crops at Takotna with his long-time business partner Charles Fowler and maintaining a small store business.

A. H.'s oldest son, Timothy Twitchell, was the first Alaska Native to graduate from the University of Alaska, in 1937. He taught school at Eklutna and operated the post office at Aniak, where he met and married Anna Spein, daughter of Per Spein and Ellen Marie Sara in 1939, forming the first familial ties between the Twitchell family and the Saami families on the Kuskokwim. In 1946, A. H.'s second son, Benjamin Twitchell (a 1933 graduate of the University of Washington and Alaska Territorial school teacher) married Jens and Ellen Kvamme's youngest daughter, Berntina, further linking the Twitchell and Sara/Kvamme families.

Ben left his teaching career and Civil Communications Administration work to assume A. H.'s farming and storekeeping operations in the late 1940s. A. H.'s farm fields and his general store business at Takotna became central to Benjamin and Berntina's life. A. H. was in his seventh decade by then and was grateful to turn over his operations to Ben. Timothy Twitchell and his family also relocated from Akiak to Takotna in 1946. Adams Hollis Twitchell died in September 1949 during a hunting trip with Ben on the Takotna River; he is buried there beneath a Vermont-marble headstone ordered and shipped from his birthplace. Next to his stone is another marking the grave of Per Spein, who came to live with Anna and Tim Twitchell at Takotna.

Ben Twitchell brought increased mechanization to his father's farm fields, shipping in a plow, potato harvester, and steel wheels for the International Harvester tractor. These arrived by river barge on the Kuskokwim River to Candle Landing below McGrath. With several fields under cultivation and a sizeable root cellar to keep the produce from freezing, Ben was able to keep the store supplied with winter produce and even ship the surplus to customers down river, where the Twitchell potato crop was renowned.

The potato harvest at Takotna in early fall was occasion to dismiss children from the little one-room school to put in the crop that everyone would consume during the winter months (Fig. 13). Although the potato digging was now mechanized, filling buckets with potatoes and emptying the crop into jerry-can crates for the trip to the root cellar was work done by many hands; many of those hands belonged to women and children. Even the Territory's missionary-schoolteacher joined in the community effort.

Log cabins of that period were often built over a root cellar to protect a winter supply of vegetables and costly shipped-in boxes of apples and oranges. The root cellar beneath the general store also kept butter and eggs, but the largest root cellar in Takotna held the commercial potato and other root crops.

The Takotna Territorial School was closed in 1956 due to the community's dwindling population, which precipitated the Twitchell family's relocation and Ben's return to teaching. The family left Alaska in 1957 and traveled across the U.S. from the Pacific to the Atlantic and back again, eventually settling in Oregon. Ben Twitchell went back to college and was reaccredited to teach school in Oregon. The family maintained a link to the farming tradition as Ben hired himself and his children to harvest fruit and garden produce during summer breaks between school sessions. Picking cherries, strawberries and green beans was a traditional means of earning school money in Oregon's Willamette Valley in the 1950s and 1960s. Even when Ben's teaching positions took the family from the green Willamette Valley to the Oregon sagebrush country, the family returned to the valley orchards during cherry season to help clean the trees of their fruit.

Figure 12: Charles Fowler and Berntina Twitchell with the 1949 potato harvest at Takotna.

Ultimately, all of Ben and Berntina Twitchell's Alaska-born children returned as adults and now work for federal land and resource agencies, business entities created by the 1971 Alaska Native Claims Settlement Act and private corporations.[2] Their family history in Alaska (see Appendix) is intimately tied to the history of the Alaska Reindeer Project and the gold discoveries that overshadowed it. These events provided links, both business and personal, between the Saami immigrant herdsmen, the Norwegian and Yankee gold-seekers, and the indigenous Yup'ik people of the Kuskokwim region during a unique period in Alaska's history. Although the herding and farming cultures of the Sara, Kvamme and Twitchell families failed to gain a permanent hold in the Kuskokwim region, they did provide an adventurous and prosperous life for people who were committed to a new land, a new country, and to new opportunities for themselves and their descendents.

ACKNOWLEDGEMENTS

From childhood, I was aware of my family's connection to reindeer herding and the Saami immigration to Alaska. My parents were both children of reindeer herders and possessed, if not experience, at least firsthand awareness of the reindeer industry in southwestern Alaska where both were born. This heritage lived in the background of my life but the story unfolded for me when my mother, Berntina Venes wrote down for her children the story of how her parents and grandparents came to Alaska from Finnmark in northern Norway and what happened to them after they arrived. Place names and dates extracted from government reports provided historical context to family recollections, but my mother was the first in her family to weave those threads together.

Likewise, my father, Ben Twitchell, wrote a character study about the

Figure 13: Takotna school children harvest potatoes near the log home built in 1952 by Ben Twitchell.

2. June McAtee, Calista Corporation; Margie Brown, Cook Inlet Region, Inc.; Adams Hollis Twitchell, U.S. Fish and Wildlife Service; Michael Twitchell, McKesson Corporation. Berntina Irene Steele, born in Oregon, is a U.S. Forest Service biologist.

uncommon life of his father, Adams Hollis Twitchell, as a gold-seeker, trader, reindeer herder, farmer and collector of cultural objects and biological specimens. I am indebted to both father and son for preserving correspondence and personal papers that provide insight into a wide-ranging curiosity that drove an unusual life. Recognition of individual character, accomplishment and pride in our distinctive heritage was ingrained in all of us through our parents' examples.

Chris Wooley, Katherine Pendleton, and Amy Russell each provided me historical documents that contain references to the Kvamme and Twitchell families in Alaska as they encountered them in their own research, helping expand my understanding and document the lives of my grandparents in western Alaska. Faith Fjeld and Nathan Muus researched the history of the Alaska Saami immigrations and located historical photographs of my relatives on eBay, graciously giving these images of the past back to the family. I am particularly indebted to Ann Fienup-Riordan for bringing Adam Hollis Twitchell's history as a collector of cultural objects—and the ultimate disposition of those objects—to new awareness among his descendents, as well as to a wider community.

APPENDIX: FAMILY TIMELINE

February 2, 1898 Nils Persen Sara, Inger Maria Mortensdatter Sara and their children Ellen Marie, Mikkel, Morten, Klemet and Mathias, reindeer herders from the Kautokeino area, are among the Saami departing Bossekop to go to Alaska as part of the U.S. Government's Alaska Reindeer Project.

February 28, 1898 The Steamship *Manitoban* arrives in New Jersey. The following day, the people and reindeer are loaded on rail cars and begin traveling across the continent to Seattle, Washington, becoming objects of public curiosity along the way.

March 1898 The train arrives in Seattle on March 7 and the people and deer are taken to Woodland Park, where the Saami camp during a two-week long wait for boat transportation which is delayed by the war in the Philippines. The Sara's youngest child, Mathias Nilsen Sara, dies at Seattle and is buried there. The Saami women and children are moved to Port Townsend to wait while the Saami men and reindeer are taken to Haines to begin the Yukon Relief Expedition reindeer drive to Dawson. The men return on May 18.

June 22 to July 29, 1898 The Saami in Port Townsend travel in two ships to the Eaton Reindeer Station near Unalakleet and the men are immediately put to work constructing buildings that will be their shelter for the winter.

1898 Adams Hollis Twitchell arrives in Nome during the Gold Rush.

1898 Jens Anton Kvamme, age fifteen, immigrates from Alta, Norway to Michigan.

1899 Nils Persen Sara and Inger Marie and sons Morten and Klemet are taken to St. Lawrence Island to introduce reindeer herding to Siberian Yupiit at Gambell.

1900 Marriage is arranged between Ellen Marie Sara and Per Mathisen Spein, the first Saami marriage in Alaska.

1903 The Sara family and the Spein family bring a herd of reindeer to the Moravian Mission at Bethel plus reindeer to establish the two families own reindeer herds on ranges in the Kuskokwim and Aklun mountains.

1904–1905 Adams Twitchell marries Qecik (Irene), a Yup'ik woman from Nunacuaq and buys out trader Edward Lind. Twitchell sails the *Zenith* from Nome to Bethel, the first arrival of an ocean-going vessel in Bethel.

1909 Twitchell incorporates the Kuskokwim Commercial Company at Bethel with partners Charles Fowler and Frank Joaquin.

1913 Jens Anton Kvamme travels from the gold camps on the Seward Peninsula to a new strike at Iditarod. He acquires deer from the Saami herders at Akiak and discovers gold on Canyon Creek, a tributary of the Kwethluk River.

1915 Jens Kvamme marries Ellen Marie Sara and they establish their own reindeer herd in the headwaters of the Aniak River with deer purchased from the Sara family.

1916 A. H. Twitchell buys reindeer from the Saami herders at Akiak and drives them to a range near the Iditarod and Innoko mining camps, settling his family at Flat.

1924 Herbert Brandt makes winter dogsled journey from Fairbanks to Hooper Bay and visits A.H. Twitchell at the Tolstoi Creek winter reindeer camp.

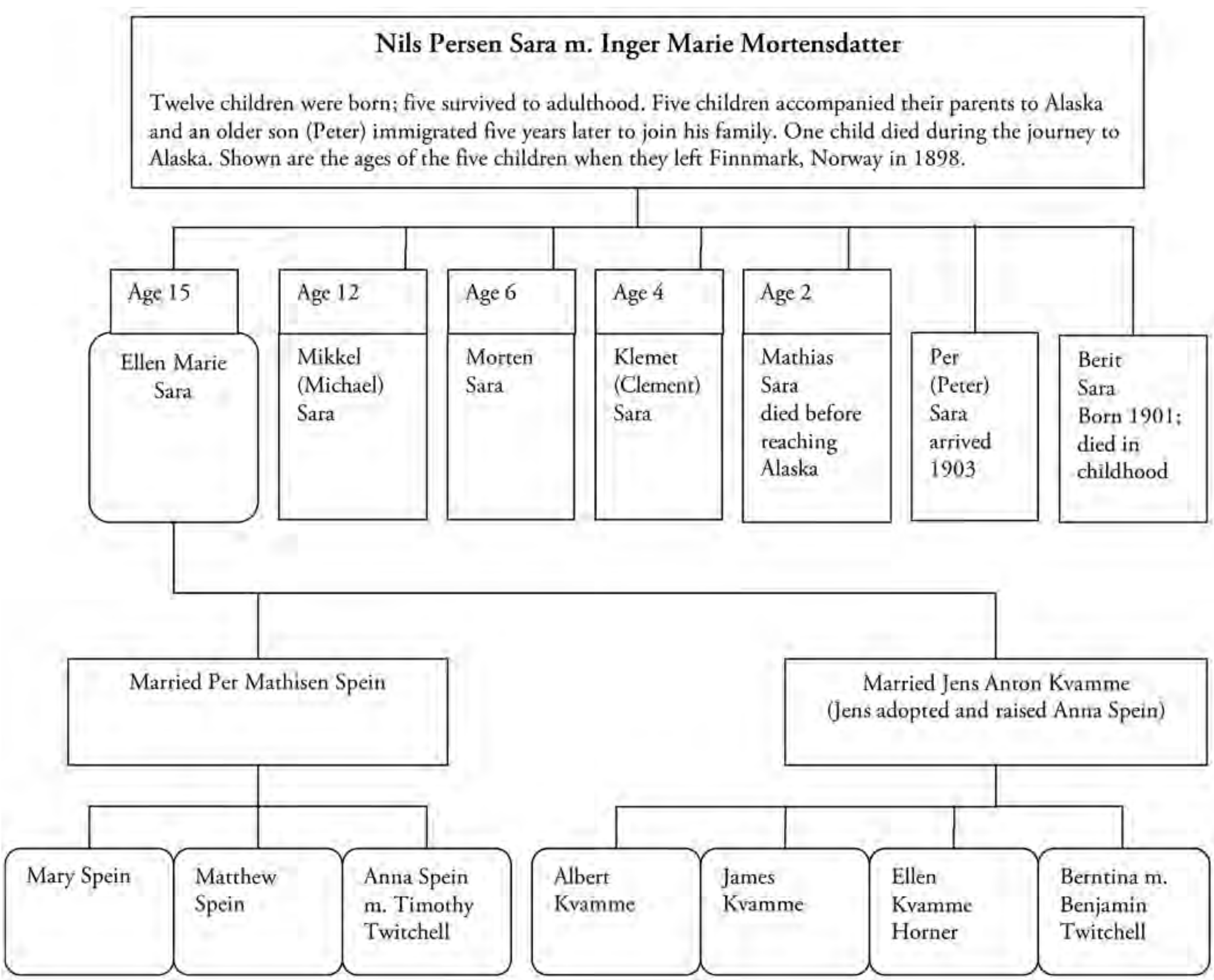
Twitchell relocates to Takotna when the townsite of Flat is dredge mined.

Reindeer Act regulation ends non-Alaska Native reindeer herd ownership.

1942 Jens Kvamme's family builds home in non-Native community at Akiak and begins living there and raising a garden and fishing at Aniak.

Benjamin and Berntina Twitchell move to Takotna to take over farm and store operations from A.H. Twitchell. Timothy Twitchell's family relocates to Takotna from Akiak.

1957 Timothy Twitchell family's leaves Takotna; the territorial school closes and the Benjamin Twitchell family leaves Alaska to settle in Oregon.



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THE EASTERN BERINGIAN CHRONOLOGY OF QUATERNARY EXTINCTIONS: A METHODOLOGICAL APPROACH TO RADIOCARBON EVALUATION

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ABSTRACT

Debate continues on the global phenomenon of human dispersal and subsequent megafauna extinctions. In Eastern Beringia, species chronologies are only generally established and do not provide enough information for comparisons to Late Pleistocene human colonization and climate change. To establish an accurate chronology for these species, 948 radiocarbon dates associated with *Mammuthus*, *Equus*, *Bison*, and archaeological occupations were compiled and rated for reliability through a standardized method. The results indicate that 8.7% of the radiocarbon dates were reliable, 85.4% were moderately reliable, and 7.3% were unreliable. Using refined species chronologies can significantly influence interpretations of radiocarbon date frequencies and paleodemographic studies.

KEYWORDS: Eastern Beringia, megafauna extinctions, radiocarbon dates

INTRODUCTION

A diverse and contentious literature exists on the initial human dispersal and subsequent selective extinctions of large mammals throughout the world, including once abundant woolly mammoth (*Mammuthus primigenius*), steppe bison (*Bison priscus*), and caballoid and hemionid horses (*Equus*) in Beringia (Barnosky 1989; Choquenot and Bowman 1998; Ficcarelli et al. 2003; Guthrie 2003, 2006; Hughes et al. 2003; Kurtén and Anderson 1980; Solow et al. 2006; Stuart 1991; Weinstock et al. 2005). Numerous models have been offered to explain this phenomenon (Haynes 2009), including overhunting by humans (Alroy 2001; Martin 1966, 1984), climate change (Guthrie 1984, 1990), hyper-disease (Greenwood et al. 2001), a comet explosion over Canada (Firestone et al. 2007), and variants of these hypotheses (Bulte et al. 2006; Burney and Flannery 2005; see Koch and Barnosky 2006 for a full review). These models cannot be critically evaluated until a refined and reliable ^{14}C chronology is available to use (Burney et al. 2004; Fiedel 2009; Guthrie 2003, 2004, 2006; Haile et al. 2009; Harington 1977, 1978, 1980a, 1980b, 1984, 1997, 2003; Harington and Clulow 1973; Harington and Eggleston-Stott 1996; Johnson 2005; Kuzmin and Tankersley 1996; MacPhee et al. 2002; Mead and Meltzer 1984; Orlova et al. 2003; Rasic and Matheus 2007; Roberts et al. 2001; Shapiro et al. 2004; Solow et al. 2006; Spriggs 1989; Spriggs and Anderson 1993; Stuart et al. 2002; Vasil'ev et al. 2002). This paper presents a standardized methodology for evaluating ^{14}C dates which is then applied to the chronologies of *Mammuthus, Equus*, *Bison*, and human occupations during the Pleistocene and Early Holocene in Eastern Beringia, the landmass bordered on the east by the Mackenzie River (Northwest Territories, Canada) and on the west by the Bering and Chukchi seas (Hopkins 1967, 1996).

BIASES OF THE FOSSIL RECORD IN EASTERN BERINGIA

Since gold was discovered in the Klondike in 1896 and in the Fairbanks mining district of Alaska in the early 1900s, stripping operations at placer mines have yielded an unprecedented volume of Pleistocene faunal remains washed out of frozen ground (Frick 1930; Froese et al. 2009; Geist 1955; Morse 2003). Pleistocene fauna from Alaska and Yukon Territory are also known from the fossil collecting efforts of Otto Geist and Childs Frick in the 1930s and 40s. Most fossil localities are known from creeks and drainages, areas with greater surface exposure through erosion (Hopkins 1996; Irving and Harington 1973; Jackson and Harington 1991; Jopling et al. 1981; MacPhee et al. 2002; Schweger 2008; Zazula, McaKay, et al. 2009). For instance, numerous fossil bones were recovered in the Old Crow Flats, Yukon Territory, eroded from river banks and redeposited on river bars and beaches (Harington 1975, 1977, 1978, 1980a, 1980b, 1984, 1989, 1996, 1997, 2003, 2007; Harington and Clulow 1973; Harington and Eggleston-Stott 1996; Morlan 1990; Morlan and Cinq-Mars 1982). Sea dredging in the Chukchi Sea, Bristol Bay, and St. Lawrence Island maritime zones also produced Pleistocene fauna (Dixon 1983; Guthrie 2003, 2004).

Faunal remains from Eastern Beringia have long been exposed to cold mean annual temperatures, commonly appearing well preserved with little surface cracking and subaerial weathering. Only in rare cases are complete or mostly complete skeletons found, occasionally with preserved hair, hide, and soft tissue (Guthrie 1990; Guthrie and Stoker 1990; Harington 2007; Zazula, McaKay, et al. 2009). Many curated specimens are of Pleistocene age and retain well-preserved collagen, ideal for ^{14}C dating (Guthrie 1990, 2003, 2004, 2006; MacPhee et al. 2002). However, because of the concentration of mining activities and other early expeditions, discoveries of Pleistocene faunal remains are biased to the Old Crow Flats and the Dawson City and Fairbanks mining districts, leaving much of the Kuskokwim drainage, Kenai and Alaska peninsulas, Aleutian Islands, Brooks Range, and southwest Alaska underrepresented. This geographic bias of fossil localities is compounded by researcher bias toward the terminal Pleistocene.

Many fossil remains have been recovered from muck deposits, loess aggraded with permafrost, which is preferentially found on north- and east-facing slopes (Froese et al. 2009; Kotler and Burn 2000); thus, the distribution of loess and permafrost influences fossil preservation and discovery (Surovell and Brantingham 2007; Surovell et al. 2009). For instance, loess accumulations are usually restricted to small areas near glacial outwash deposits and large braided rivers (Walker and Everett 1991). Soil type, temperature, and geothermal characteristics affect permafrost distribution. Permafrost is found discontinuously across Eastern Beringia (Brown 1960; Froese et al. 2009) and consists of only 23% of the land area in the northern hemisphere (Jorgenson et al. 2001). Further, terminal Pleistocene sediments tend to be poorly preserved in Yukon Territory (Zazula pers. comm. 2009; Zazula, Hare, et al. 2009). Despite the incomplete fossil record, geographically separated fossil loci and occasional discoveries across the study area provide a relatively large and widely distributed sample size (Guthrie 1990, 2003, 2004, 2006; Porter 1986, 1988; Thorson and Guthrie 1992; Weber et al. 1981).

Recent paleodemographic approaches have used temporal frequency distributions of archaeological occupations as a relative measure of human population sizes; population increases should be reflected by an increase in the number of ^{14}C-dated archaeological occupations (Bever 2006; Graf 2005, 2008, 2009; Mason et al. 2001; Potter 2008; Surovell and Brantingham 2007; Surovell et al. 2009; Wygal 2007, 2008, 2009, in press). A similar NISP (number of identified specimens) approach can be applied as a relative measure of extinct faunal population size. However, taphonomic processes also influence the likelihood that sites will be preserved. While younger sites and fossil remains tend to be over-represented in the fossil record, they are also exposed to taphonomic processes biased towards surficial weathering and erosion. Therefore, the probability that a site will survive increases with time as it is buried and protected from surficial destructive processes (Surovell and Brantingham 2007; Surovell et al. 2009). Biases in site preservation can be corrected using Bayesian methods and ratio measures of dated remains to their geologic contexts to accurately reflect paleodemographic histories (Buck and Bard 2007; Debruyne et al. 2008; Drummond et al. 2005; Solow et al. 2006; Surovell et al. 2009).

METHODS OF ANALYSIS[1]

A total of 948 *Equus, Mammuthus, Bison,* and archaeological ^{14}C dates ranging from 54,000 cal. BP to the mid-Holocene from 258 localities was derived from published literature. Many of the dates (40%) were cross-referenced in the Canadian Archaeological Radiocarbon Database, particularly those derived from the Old Crow Flats and Dawson City mining districts (Morlan 2008). Recent ^{14}C dating programs (Barnes et al. 2007; Debruyne et al. 2008; Guthrie 2003, 2004, 2006; Shapiro et al. 2003, 2004) have substantially augmented available chronometric data for mammoth, bison, and horse. While this study aimed to identify all ^{14}C dates associated with *Mammuthus*, *Equus* and *Bison*, it did not quantify all archaeological occupations, especially those occurring after megafauna species extinctions. Therefore, archaeological sites spanned 14,500–7,500 cal. BP with an emphasis on Late Pleistocene and Early Holocene sites. A comprehensive list of *B. bison* ^{14}C dates was not compiled because this species did not become extinct as did *B. priscus* (Shapiro et al. 2004; Wilson et al. 2008). Faunal remains from archaeological sites also were used to evaluate temporal frequency distributions of extinct fauna.

Radiocarbon ages were converted to calendar years using the Cologne Radiocarbon Calibration and Paleoclimate Research Package HULU curve to facilitate comparison to paleoclimate proxy records (Danzeglocke et al. 2007; Johnsen et al. 1995; Langway et al. 1985). Dates can be calibrated back to 26,000 cal. BP (Reimer et al. 2004), but beyond 12,400 cal. BP the precision decreases because the earlier proxy records are coarser (Beck et al. 2001; Fiedel 1999, 2000, 2002; Ramsey et al. 2006; Reimer et al. 2004). Radiocarbon dates are statistical age estimates, but their median values were treated as single points in this study, after Wygal (2007, 2008, 2009, in press).

Although the capable range of the ^{14}C technique conveniently overlaps the time span affecting North American Quaternary extinctions, interpreting data associated with ^{14}C dates is both a methodological and qualitative exercise (Hedges and van Klinken 1992; Stafford et al. 1991; Surovell and Brantingham 2007; Van der Plicht 2000). Beyond selectively accepting or rejecting ^{14}C determinations on a case by case basis, a standardized method quantifying the reliability of age determinations is essential to eliminate researcher bias. This analysis was modeled after previous studies of ^{14}C evaluations that focused on either the archaeological record (Graf 2005, 2008, 2009; Pettitt et al. 2003; Wygal 2009, in press) or extinction chronologies (Burney et al. 2004; Gillespie et al. 2006; MacPhee et al. 2002; Mead and Meltzer 1984), but this method is more flexible in that it is easily adapted and applied to both archaeological and paleontological questions. Evaluative criteria were subdivided into seven categories: material dated, pretreatment methods, association with event, geologic context, reported age, precision, and averaged dates (Table 1). Each date was rated blindly to prevent preferential scoring or evaluation.

We next describe how each of the categories was considered in our rating system.

MATERIAL DATED

The type of material used for radiocarbon dating is a significant consideration because not all organic material produces equally reliable determinations. For instance, consider the caribou tibia flesher from Old Crow originally dated to 31,320 ± 2970 cal. BP (GX 1640) (Bonnichsen 1979; Harington 1975; Irving and Harington 1973). This age was disputed because it significantly predated the accepted age for the human colonization of North America (Guthrie 1980). A later attempt to acquire a reliable date on the specimen used more advanced collagen extraction techniques that yielded a late Holocene age (1,260±150 cal. BP) (Morlan et al. 1990). A discrepancy of over 25,000 years from the first dating attempt of this bone tool indicated that radiocarbon dates derived from bone material must be carefully scrutinized because the porous nature of bone facilitates contamination from intrusive material (Gillespie et al. 2006; Morlan et al. 1990).

To compensate for discrepancies caused by material type, this study scored dated material on a scale of 1–5 (following Mead and Meltzer 1984 and Pettitt et al. 2003). Soil carbonates, wood, and peat have a high probability of carbon contamination (Kuzmin and Tankersley 1996; Mead and Meltzer 1984) and were assigned one point. Apatite or unspecified bone fractions are slightly more reliable, receiving two points, and collagen, enamel, and ivory received three points. Most ages on mammoth and horse were derived from bone and teeth because they were museum specimens lacking associated organic material. Hair, tissue, hide, and horn were awarded four points. Associated charcoal or specifically targeted amino

1. All the ^{14}C ages included in this study were derived from the published literature with the exception of assay Beta-235489, on a *Bison priscus* skull from Denali National Park and Preserve (>42,000 ^{14}C yr BP, petrous bone). The entire corpus of ^{14}C ages is presented as a supplemental data file, posted on the *Alaska Journal of Anthropology* web site (https://www5031.ssldomain.com/alaskaanthropology/store/index.cfm?do=cat&cid=69). These data include laboratory numbers, radiocarbon ages, context, bibliographic citations and references, as well as the rating justifications employed in this study.

acids such as hydroxyproline and glycine are most reliable (Gillespie 1970; Hedges and van Klinken 1992) and scored five points (Table 1).

PRETREATMENT

Pretreatment methods have variable effects on date reliability. Complications occur when measured carbon is present in extremely low quantity or is contaminated (Pettitt et al. 2003; Taylor 1997), but new techniques and the visual examination of collagen for purity and contamination have reduced this complication (Burney et al. 2004; Stafford et al. 1982, 1987, 1991). In the literature we surveyed, pretreatment methods were rarely documented, but notable exceptions exist (Bonnichsen 1979; Guthrie 2003, 2004, 2006; Harington 1975; Irving and Harington 1973; Morlan et al. 1990). The advent of AMS (accelerator mass spectrometry) and advances in decontamination procedures reduced the need for bulk sample dating, required significantly less carbon, and produced more reliable results than standard radiometric counting (Aitken 1990; Beaumont et al. 2010; Gillespie et al. 2006; Long et al. 1989; Potter 2005; Stafford et al. 1982, 1987, 1988, 1991; Taylor 1987).

As a substitute for undocumented pretreatment processes, the primary criterion for pretreatment evaluation was the year in which a sample was analyzed because of significant methodological improvements that have occurred over time. Rated on a scale of 1–5, material dated before 1970 received one point (following Pettitt et al. 2003), those dated between 1971 and 1980 received two points, and those dated between 1981 and 1990 received three points. Between 1991 to present, pretreatment was scored four points when collagen was purified through gelatinization, acid wash, and other filtration methods. Following Burney et al. (2004), the highest score, five points, was used only when collagen was analyzed between 1991 to the present through gelatinization and alkali pretreatment methods, when specific amino acids were targeted, and/or collagen was visually inspected for pure white collagen (Table 1). These criteria do not reflect the quality of research, but are a relative measure of the available technology when samples were dated (Beaumont et al. 2010). For instance, most of Guthrie's (2003, 2004, 2006) specimens were derived from enamel and bone collagen and pretreated through the U.S. National AMS Radiocarbon Laboratory, Tucson, Arizona, with ultrafiltration (Brown et al. 1988). These specimens each received four points for pretreatment.

ASSOCIATION

Perhaps the most important criterion to evaluate the quality of ^{14}C dates is interpretive: the relevance of the dated sample to the research question. For instance, a wood sample recovered from the surface of a river point bar cannot confidently be justified as associated with the time of death of animal remains lying nearby. Rated on a scale of 0–4, dates were assigned a zero when the association of the sample to the research question was unknown or unclear. A score of one was applied when disturbance and/or recovery from a secondary context was documented. Two points were assigned for probable associations through spatial patterning or stratigraphic association. A score of three represents a high probability of association and was used when dated material was recovered in close association with archaeological and/or faunal remains remains pertinent to the research question or from a primary context. Finally, the highest score, four, was applied to samples that are diagnostic, or the association with the event or fossil is certain. For instance, directly dated hearth charcoal is diagnostic of human activity and directly dated collagen, apatite, or enamel are considered certain associations with the geologic date of the death of the animal (Table 1). Pettitt et al. (2003:1689) also rated the level of association between the research question and dated sample but did not develop specific criteria to distinguish associations of full certainty, high probability, probability, reasonable possibility, and low possibility. Associational criteria in this analysis were modeled from those developed by Graf (2009).

GEOLOGIC CONTEXT

An additional interpretive control on date reliability is the geologic context from which the sample was taken and its relationship to the research question. While the radiocarbon date itself provides a temporal context of a specimen, its reliability cannot be fully assessed in the absence of information from its geologic context (Solow et al. 2006). A score of zero was applied when geologic context was unknown or undocumented, or for surface finds. Unfortunately, detailed geologic contexts were not documented for many specimens because bones were rarely recorded *in situ* (Guthrie 1990). A score of one point was given if materials were buried but lacked additional dates to verify relative chronology, or if they came from a buried site in which dating reversals decreased the integ-

Table 1. Evaluation Method

Score	**Material Dated**
1	Wood, peat, soil carbonates
2	Apatite or unspecified bone fraction
3	Collagen, enamel, ivory
4	Hair, tissue, hide, horn
5	Charcoal or hydroxyproline, glycine
	Pretreatment Methods
1	Undocumented, or date analyzed before 1970
2	Analyzed between 1971–1980
3	Analyzed between 1981–1990
4	Analyzed between 1991–present, collagen is purified through gelatinization, acid wash, and other ultrafiltration
5	Analyzed between 1991–present, collagen is purified through gelatinization, alkali pretreatment and/or is visually inspected for pure white collagen
	Association with Event
0	Association unknown
1	High degree of disturbance or in secondary context
2	Probable association. Spatial patterning suggests association
3	High probability. In primary context
4	Certainty or sample is diagnostic
	Geologic Context
0	Geologic context unknown or from the surface
1	Buried in a stratified site with no corroborating dates or dates with reversals
2	Buried in a stratified site with 1 date in sequence, or from same occupation/stratigraphic layer which are statistically equivalent at 2σ
3	Buried in a neatly stratified site with three dates in sequence, or dates from the same occupation/stratigraphic layer which are statistically equivalent at 2σ
4	Buried in stratified site with >3 dates in sequence, or dates from the same occupation/stratigraphic layer which are statistically equivalent at 2σ
	Reported Age
1	Infinite Measurement
2	Measurements >40,160 cal. BP (35,000 rcybp)
3	Measurements <40,160 cal. BP (35,000 rcybp)
	Precision (Standard deviation of date, in radiocarbon years)
1	>150
3	51–150
5	0–50
	Averaged Dates
1	Dates are averaged with statistical outliers
2	Dates are averaged with no statistical outliers, or not averaged

rity of the geologic context. In buried sites, one date in stratigraphic sequence or two dates from the same strata equivalent at 2 sigma received two points. When three dates were in sequence, or were statistically equivalent at 2 sigma from the same stratigraphic layer, a score of three was applied. Dates from buried sites with more than three dates in sequence, or equivalent at 2 sigma in the same strata, were given four points (Table 1). These criteria were biased towards archaeological sites because they tended to receive more intensive geological evaluations and thus received higher scores in general. Pettitt et al. (2003) also developed criteria evaluating the geologic context based on the number of ^{14}C dates in sequence. Graf's (2009) criteria for geologic context employed the ratio of dates in sequence to assign reliability scores.

REPORTED AGE, PRECISION, AND AVERAGED DATES

While the radiocarbon technique is functional up to 40,000 BP, the method declines in accuracy with age, especially when determinations are close to this limit (Ramsey et al. 2006). Pettitt et al. (2003) used a stringent criterion (34,290 cal. BP/30,000 rcybp [^{14}C yr BP]) as the threshold for the upper bracket of ^{14}C date reliability. On a scale of 1–3, this analysis scored infinite dates one point, measurements older than 40,160 cal. BP (35,000 rcybp) were scored two points, and measurements younger than 40,160 cal. BP received three points.

Technological advances in radiocarbon dating have increased the precision of reported ages, allowing researchers to address progressively more complex questions. This analysis applied a scale of 1–5, in which dates with standard deviations greater than 150 were scored one point, dates with standard deviations between 51 and 150 were given three points, and those with standard deviations less than 50 were rated five points. Graf (2009) used five categories for date precision, with standard deviations up to ±1,000 years receiving the lowest scores for reliability.

Dates with overlapping standard deviations at 2 sigma were averaged when coming from single archaeological occupations or from the same faunal specimen. All non-overlapping dates at >2 sigma were eliminated. Long and Rippeteau's (1974) weighted averaging method was utilized to give more weight to the more precise dates. When dates were averaged but the original determinations were not reported, or were averaged with statistical outliers at 2 sigma, they received one point. Unaveraged dates or averaged dates with no statistical outliers at 2 sigma received two points. Comprehensive reliability scores were calculated by summing points assigned from each evaluation criterion to arrive at a number between 0 and 28 (Table 1). Higher scores represent more reliable ^{14}C dates.

RESULTS

The 948 evaluated ^{14}C dates were distributed normally across the complete range of possible scores (0–28) and grouped into three categories, unreliable, moderately reliable, and reliable dates (Table 2), analogous to Graf's (2009:694) "the Good, the Bad, and the Ugly." Scores between 0 and 14 represent unreliable dates, scores of 15–21 denote moderately reliable dates and should be accepted with caution, and scores 22–28 are considered reliable. Unreliable dates (n = 69) were derived from specimens lacking documented geologic context and association, and dated material primarily consisted of wood and peat, although several specimens dated using apatite and collagen fractions were included. Most unreliable dates ranged from 42,000 cal. BP to 35,000 cal. BP, and were published in the 1970s and 80s. Most of the Old Crow specimens which were dated multiple times were independently determined to be unreliable or at the lowest range of moderately reliable dates (Bonnichsen 1979; Harington 1977, 1989; Morlan et al. 1990). Redating these materials with current techniques may strengthen the reliability of these data in conjunction with additional geological investigations. Moderately reliable dates (n = 796) constituted the majority of this data set. They were derived primarily from collagen, apatite, and enamel in certain associations with the death of the animal. Pretreatment protocols included recent and older methods. Reliable dates (n = 83) always possessed documented geologic contexts, high degrees of association, and were calculated with recent technological advancements. Virtually every reliable determination was supported by multiple dates from individual sites. Thus, reliable dates were biased towards archaeological sites and many were from charcoal. No dates were calculated from identified amino acids.

MAMMUTHUS

The mammoth radiocarbon dates represented 49.4% of the entire data set (n = 468). Of these, 33 dates were considered unreliable (3.5% of all dates, 7.1% of the mammoth dates, and 48% of all unreliable dates). Substantially more mammoth dates were considered moderately reliable (n = 416), comprising over half of the overall moderately reliable set (52.3% of the moderately reliable dates, 88.9% of mammoth dates, and 43.9% of the entire data set) (Fig. 1; Table 2). The oldest mammoth dates, >54,000 cal. BP from Ikpikpuk River, were considered moderately reliable; of a total of five dates, each scored 16 points. An additional 103 infinite dates on mammoth remains also were included in this analysis and primarily considered moderately reliable (Debruyne et al. 2008). A specimen from Old Crow locality CRH-12 dated to 53,060 ± 4,060 cal. BP (Bonnichsen 1979; Harington 2003; Morlan et al. 1990) is considered unreliable (score = 14). Reliable dates (n = 19) comprised 4% of the mammoth sample, 22.9% of the reliable dates and 2% of the entire sample. The last known mammoth in Eastern Beringia, dated 6,40 ± 50 cal. BP, occurred at Qagnax Cave, St. Paul, Pribilof Islands (Veltre et al. 2004, 2008); the date is considered reliable (score = 25). The latest evidence for mammoths on the mainland occurred at Swan Point, a human occupation in the Tanana Valley dated to 11,960 ± 170 cal. BP. The date, on hearth charcoal, scored 24 and is considered reliable (Holmes 1998, 2001; Holmes et al. 1996). Trail Creek Cave, northwest Alaska, possessed Late Pleistocene mammoth remains, but they were not associated with a human occupation (Sattler et al. 2001; Vinson 1993). Dated 13,250 ± 110 cal. BP, this date is considered moderately reliable (score=18). Mammoth remains from Lost Chicken Creek were dated to 11,650 ± 280 cal. BP (score = 19) (Harington 2003).

BISON

Radiocarbon dates associated with bison remains represented 25.4% of the entire data set (n = 241) (Table 2). Of these, 18 dates are considered unreliable (1.9% of the entire data set, 26% of all unreliable dates, and 7.5% of the bison dates). Significantly more dates are considered moderately reliable (n = 199, 82.6% of the bison, 25% of the moderately reliable dates, and 21% of the entire data set). Fewer bison received a reliable score (n = 24), including the *B. priscus* carcass recovered from Tsiigehtchic, Northwest Territories, Canada (13,700 ± 70 cal. BP, score=23), which possessed preserved horn cores, sheath, and mummified soft tissue (Zazula, MacKay, et al. 2009). In sum, 9.9% of the bison ^{14}C dates are considered reliable; bison dates comprised 28.9% of the reliable dates and 2.5% of the entire data set (Fig. 2). The oldest bison date was 58,200 ± 3900 cal. BP from the Black River, Yukon Flats; it is considered moderately reliable (score = 16) (Shapiro et al. 2004). There were also 163 infinite dates that ranged from unreliable to moderately reliable (Shapiro et al. 2004). The youngest dated bison occurrence in Eastern Beringia in this sample, 3,090 ± 180 cal. BP, was derived from charcoal at Pelly Farm (score=18), but it represents *B. bison* (Lowdon et al. 1970; MacNeish 1964; Shapiro et al. 2004; Stephenson et al. 2001; Wilson et al. 2008). The youngest *B. priscus* remains, 10,070 ± 120 cal. BP, were derived from the Gerstle River site in the Tanana Valley (Potter 2005, 2007; Shapiro et al. 2004), and the date is considered reliable (score = 24). The Dry Creek archaeological site in the Nenana Valley also yielded *B. priscus* remains (Bigelow and Powers 1994; Hoffecker et al. 1996; Powers and Hoffecker 1989; Thorson and Hamilton 1977). They date to 10,640 ± 300 cal. BP, which is considered moderately reliable (score = 17). A cluster of ^{14}C dates associated with *B. priscus* remains from the Porcupine River, Engigstciak, and the Little John site also clustered between 10,110 ± 340 cal. BP and 10,940 ± 40 cal. BP (Fig. 2) (Easton et al. 2007; Harington and Morlan 2002; Shapiro et al. 2004).

EQUUS

The horse radiocarbon dates represented 17.2% of the entire data set (n = 163) (Table 2). Of these, 16 dates are considered unreliable (9.8% of the horse, 23.2% of unreliable dates, and 1.7% of the entire set), and 146 are considered moderately reliable (89.6% of the horse sample, 18.3% of

Table 2. Distribution of evaluated dates by reliability and taxon

Rating Category	Taxon	Frequency	% Taxon	% Rating Category	% Data Set
Unreliable					
0–14	All	69		100%	7.3%
0–14	Mammoth	33	7.1%	48%	3.5%
0–14	Bison	18	7.5%	26%	1.9%
0–14	Horse	16	9.8%	23.2%	1.7%
0–14	Human Evidence	2	2.6%	2.8%	0.2%
Moderately Reliable					
15–21	All	796		100%	84%
15–21	Mammoth	416	88.9%	52.3%	43.9%
15–21	Bison	199	82.6%	25%	21%
15–21	Horse	146	89.6%	18.3%	15.4%
15–21	Human Evidence	35	46.1%	4.4%	3.7%
Reliable					
22–28	All	83		100%	8.7%
22–28	Mammoth	19	4.0%	22.9%	2%
22–28	Bison	24	9.9%	28.9%	2.5%
22–28	Horse	1	0.6%	1.2%	0.1%
22–28	Human Evidence	39	51.3%	47%	4.1%

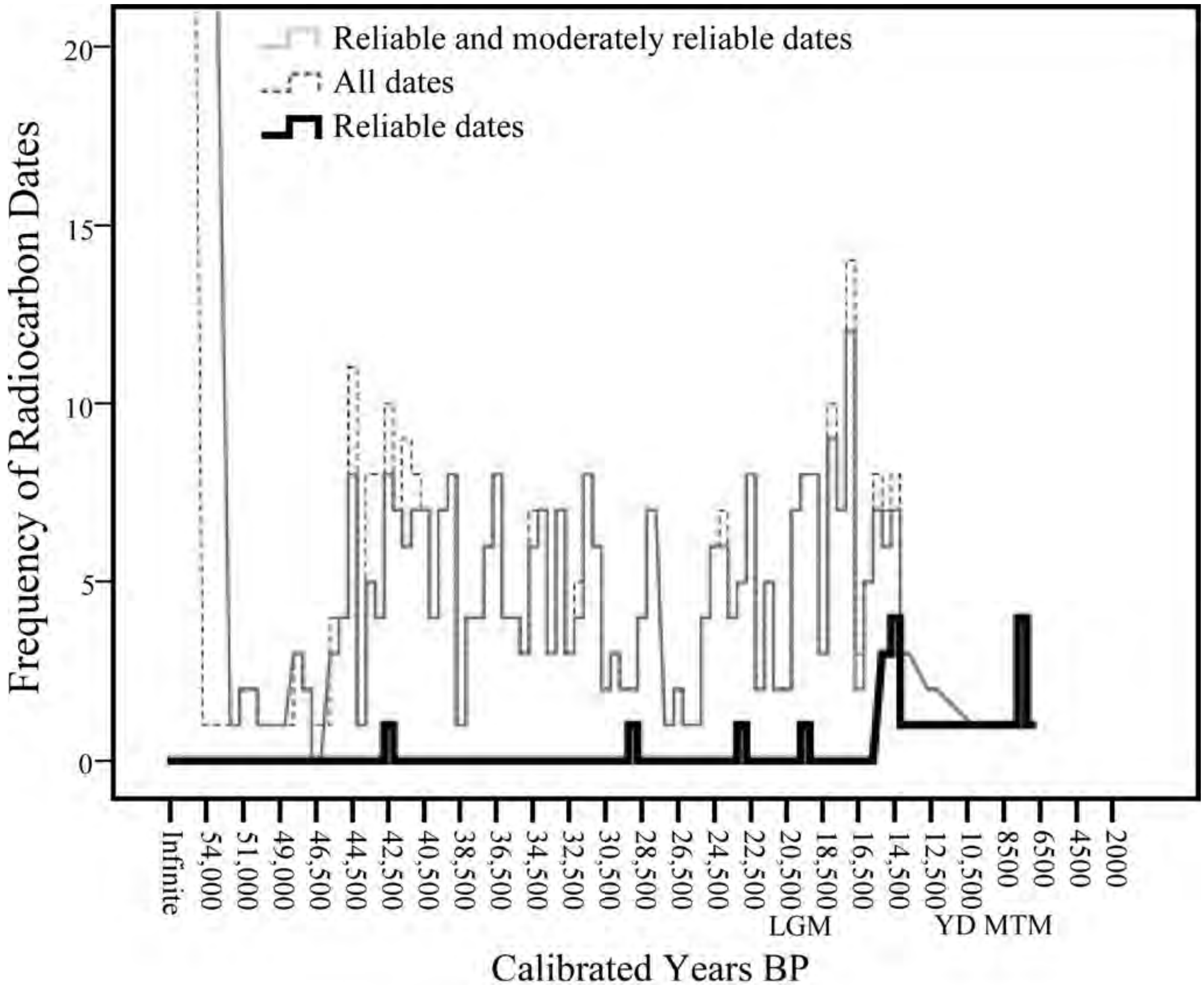

Figure 1. Frequencies of radiocarbon dates associated with mammoth remains. LGM = Last Glacial Maximum, YD = Younger Dryas, and MTM = Milankovitch Thermal Maximum.

the moderately reliable set, and 15.4% of the entire set; see Fig. 3). The oldest ^{14}C date associated with horse remains was >53,000 cal. BP from Hershel Island, Pauline Cove, Northwest Territories (Zazula, Hare, et al. 2009) (score = 15). Four additional infinite dates are considered moderately reliable (Zazula, Hare, et al. 2009). A specimen from Sixtymile Locality 3 is dated to 49,960 ± 1,640 cal. BP (score = 16) (Harington 2003).

Only one ^{14}C date on horse remains is considered reliable and represents the latest known occurrence of horse in Eastern Beringia. Derived from the Swan Point archaeological site, horse molar dentine collagen has been dated to 13,850±120 cal. BP (score = 23) (Holmes in press). Considered moderately reliable, horse remains from Bluefish Cave 3 were dated to 14,580±680 cal. BP (score = 16) (Burke and Cinq-Mars 1996; Cinq-Mars 1979) and a sample from Upper Cleary Creek was dated to 14,880 ± 150 cal. BP (score=19) (Guthrie 2006). Younger ^{14}C dates from spruce wood associated with horse remains at Lost Chicken Creek are considered unreliable (scores ranged from 11–14 on nine samples; Fig. 3) (Porter 1988; Trimble and Robinson 1989).

ARCHAEOLOGICAL OCCUPATIONS

Radiocarbon dates from archaeological sites (n = 76) represented 8% of the entire data set (Fig. 4; Table 2). Of these, two dates are considered unreliable, representing 2.8% of all unreliable dates, 2.6% of the archaeological site sample, and 0.2% of the entire sample. Unreliable dates were from the Tingmiakpuk site dated from caribou remains (8,320±70 cal. BP, score=11) (Mason et al. 2001) and the

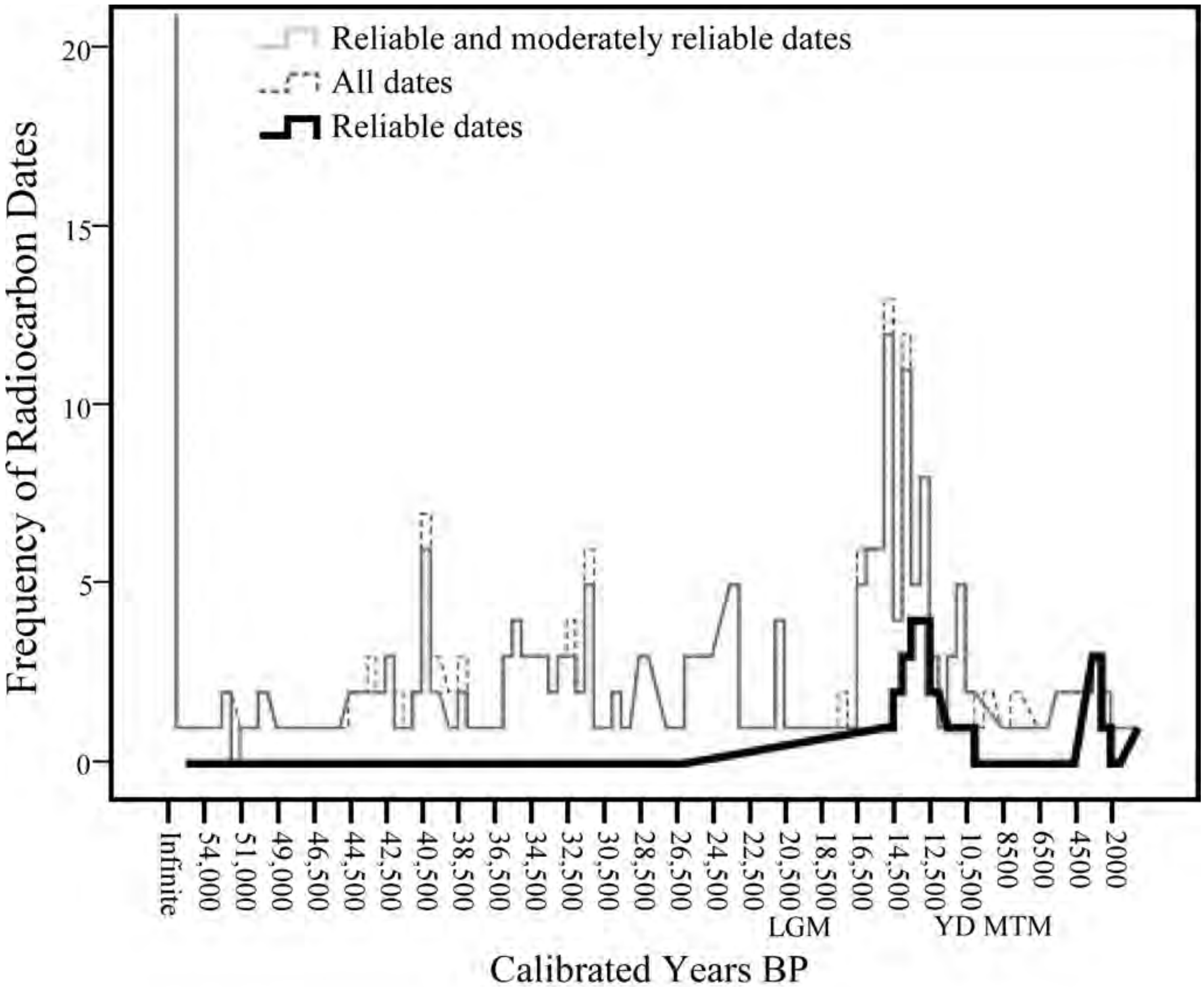

Figure 2. Frequencies of radiocarbon dates associated with bison remains. LGM = Last Glacial Maximum, YD = Younger Dryas, and MTM = Milankovitch Thermal Maximum.

Akmak occupation at Onion Portage dated to 10,900±210 cal. BP (score=13, K-1583) (Anderson 1988; Hamilton and Goebel 1999). Slightly less than half (n=35, 46.1%) are considered moderately reliable (4.4% of the moderately reliable dates and 3.7% of the entire data set). The Healy Lake ^{14}C dates from all stratigraphic levels (Cook 1969, 1996) fall within the low end of moderately reliable dates (scores 16–18). Over half of the ^{14}C dates associated with archaeological remains are considered reliable (n=39, 51.3%), constituting 47% of overall reliable dates and 4.1% of the entire set. The earliest archaeological occupation is dated to 14,100±110 cal. BP from Swan Point, Tanana Valley and is rated 28, the highest possible score (Fig. 4) (Holmes in press; Holmes and Crass 2003).

DISCUSSION

Patterns in the temporal distributions of human occupations and extinct fauna are here reconsidered after examining the sample of reliable and moderately reliable radiometric dates. A Q-Q plot of the reliability of radiocarbon dates indicated the data were normally distributed and that no time period was associated with more anomalous or moderately reliable dates than another. A single mammoth date older than 35,000 cal. BP was considered reliable. Two mammoths reliably dated between 35,000 and 20,000 cal. BP were recovered in the Brooks Range (Guthrie 2004, 2006). The single date considered reliable between 20,000 and 18,000 cal. BP was from a mammoth recovered from Epiguruk (Hamilton 1996; Hamilton et

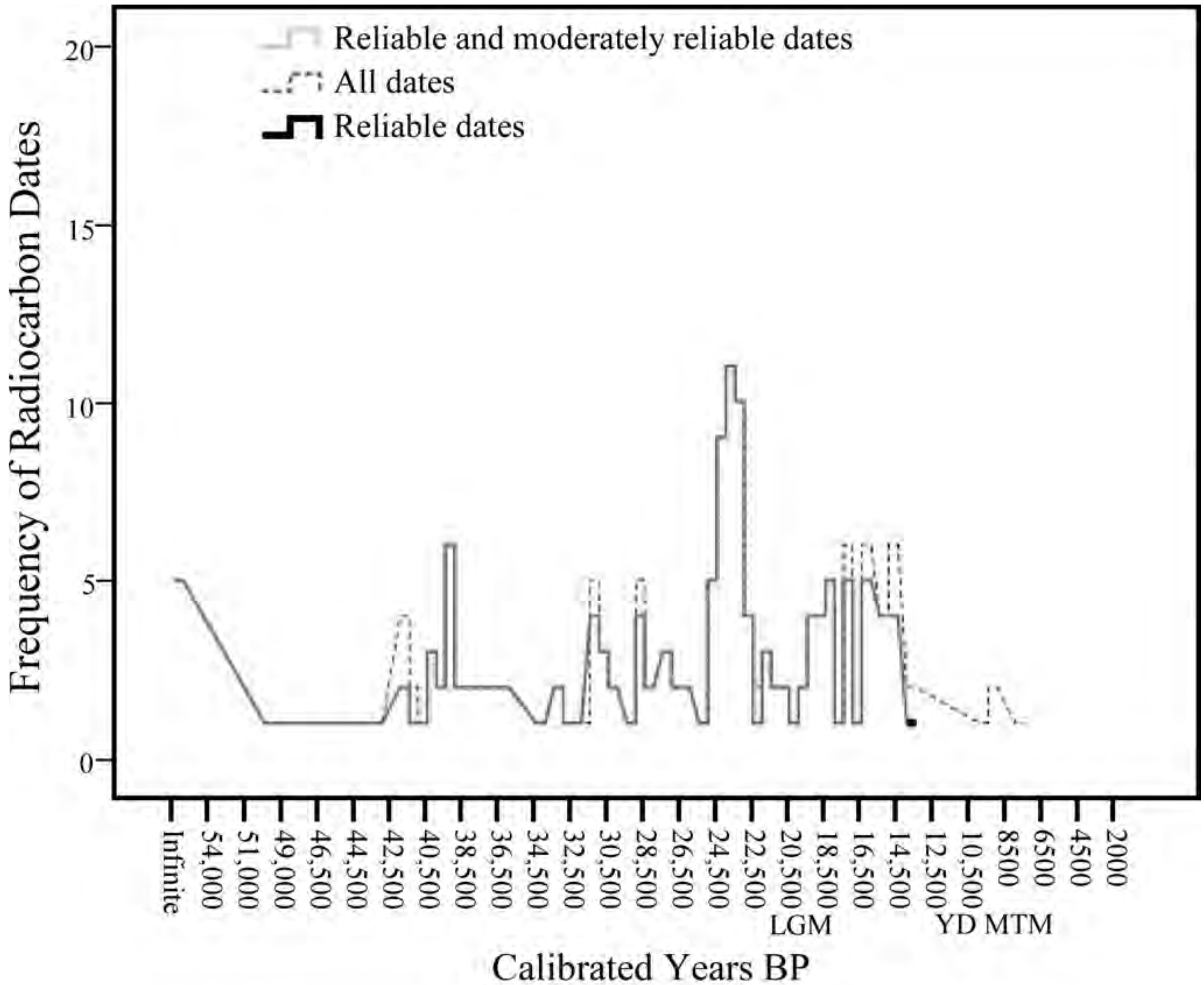

Figure 3. Frequencies of radiocarbon dates associated with horse remains. LGM = Last Glacial Maximum, YD = Younger Dryas, and MTM = Milankovitch Thermal Maximum.

al. 1993). From 18,000 to 16,000 cal. BP, just after the LGM, no ^{14}C dates were considered reliable (Table 3). Seven data points between 16,000 and 14,000 cal. BP were considered reliable, including bison remains from the Ikpikpuk River (Guthrie 2004, 2006) and mammoth remains from Swan Point (Holmes in press; Holmes and Crass 2003). Between 14,000 and 12,000 cal. BP a cluster of reliable dates includes 13 archaeological occupations from central and northern Alaska, 13 dates from bison remains from the Fairbanks area, and 5 dates associated with mammoth remains from the Tanana Valley (Table 3). The youngest ^{14}C date from horse remains was contemporaneous with the earliest human occupation in Eastern Beringia at the Swan Point site (Holmes in press; Holmes and Crass 2003).

The ^{14}C dates for some taxa are more reliable than others. A chi-square test indicated that there are differences in taxon reliability (p<0.001, χ^2=200.531, df=6). This was reflected in the high percentage of reliable archaeological sites (Table 2) and was largely a function of sample bias: many paleontological samples were recovered from undocumented contexts, but archaeological sites tended to be well documented. There were also differences in reliability between extinct taxa, excluding archaeological occupations (p<0.001, χ^2=20.846, df=4). Only a single horse date was considered reliable, in contrast to numerous mammoth and bison dates.

Numerous researchers have used ^{14}C dates as a proxy for population size (Bever 2006; Bocquet-Appel and Demars 2000; Buck and Bard 2007; Drummond et al. 2005; Graham et al. 1996; Guthrie 2006; Kuzmin 2008;

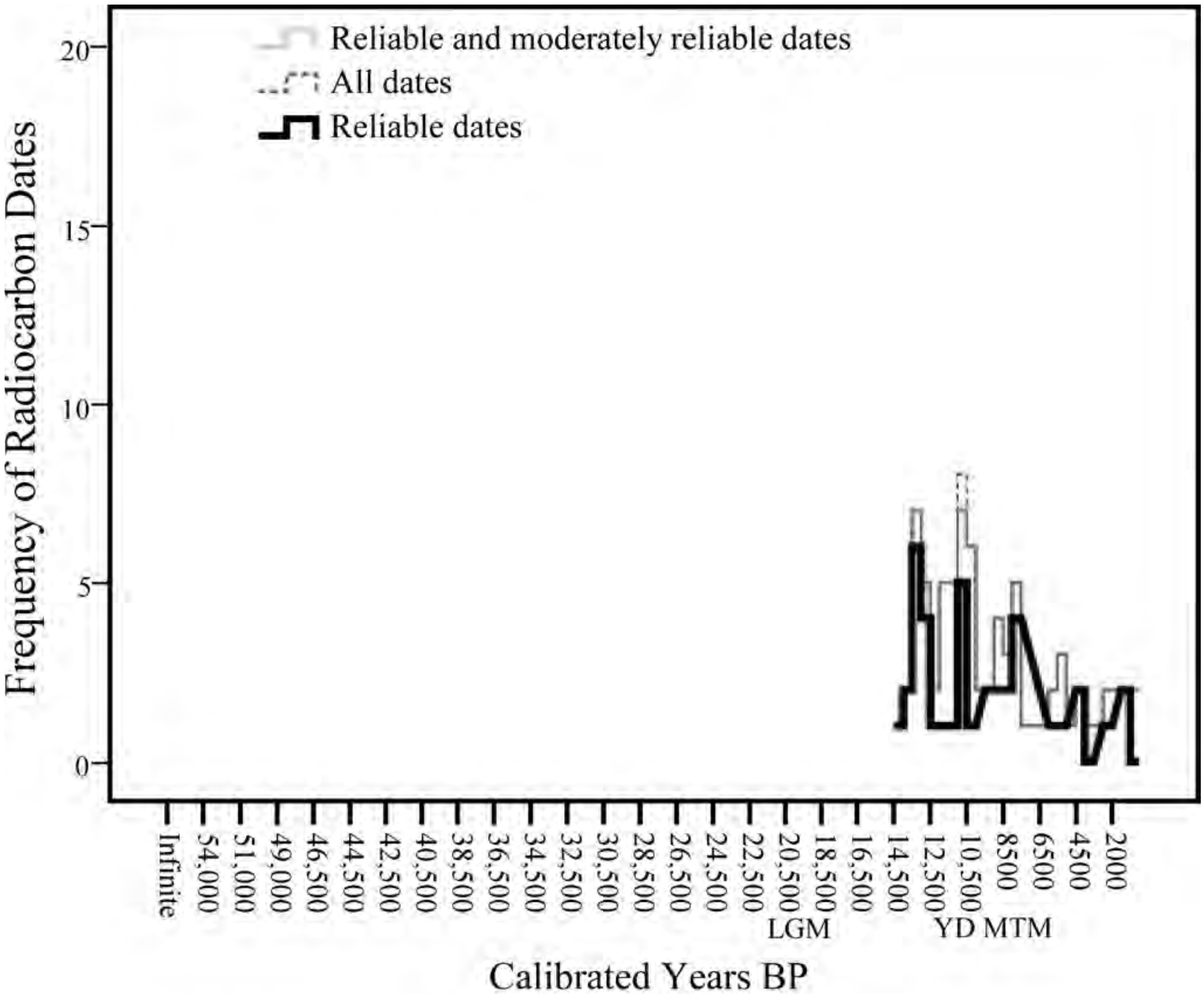

Figure 4. Frequencies of radiocarbon dates associated with archaeological sites. LGM = Last Glacial Maximum, YD = Younger Dryas, and MTM = Milankovitch Thermal Maximum.

Table 3. Temporal distribution of reliable and moderately reliable dates

Years cal. BP	Mammoth	Mammoth	Bison	Bison	Horse	Horse	Human Evidence	Human Evidence
	Moderately Reliable	Reliable	Moderately Reliable	Reliable	Moderately Reliable	Reliable	Moderately Reliable	Reliable
0–6,000	0	0	6	5	0	0	9	7
6,000–12,000	3	7	10	3	0	0	23	18
12,000–14,000	5	5	14	13	0	1	3	13
14,000–16,000	17	3	25	3	8	0	0	1
16,000–18,000	31	0	8	0	12	0	0	0
18,000–20,000	24	1	3	0	15	0	0	0
20,000–35,000	116	2	56	0	77	0	0	0
35,000–infinite	220	1	77	0	34	0	0	0

Kuzmin and Keates 2005; MacPhee et al. 2002; Mason et al. 2001; Matheus et al. 2003; Shapiro and Cooper 2003; Shapiro et al. 2003, 2004; Sher 1997; Stuart 2005; Surovell and Brantingham 2007; Surovell et al. 2005, 2009; Ugan and Byers 2007; Vasil'chuk et al. 1997). Surovell et al. (2009) demonstrated that when statistically correcting for sample bias, the general temporal frequency distribution pattern was not substantially different, but the relative intensity of ^{14}C frequency changes was significantly affected. While we did not correct for sample bias created by the likelihood that the fossil record is incomplete, it is essential that in the future evaluations are made of the temporal frequency distributions of species and dates before carrying out paleodemographic studies of mammoth, bison, horse, and archaeological occupations in Eastern Beringia. Molecular data and life history reconstructions derived from ^{14}C dates cannot be considered reliable unless the dates have been evaluated and standardized (Bever 2006; Debruyne et al. 2008; Drummond et al. 2005; Fox-Dobbs et al. 2006; Haile et al. 2009; Koch and Barnosky 2006; Mason et al. 2001; Potter 2008; Shapiro et al. 2004; Surovell and Brantingham 2007; Szpak et al. 2010; Wygal 2007, 2008, 2009, in press).

For archaeological sites, the overall pattern in ^{14}C frequencies was similar between the refined (moderately reliable and reliable dates) and unrefined records (the entire ^{14}C sample), but the relative intensity of ^{14}C fluctuations changes dramatically when the more refined radiocarbon record is used. In particular, an increase of ^{14}C dates at 11,000 cal. BP and decrease at 10,000 cal. BP were substantially more dramatic when eliminating the unreliable and moderately reliable dates (Fig. 4). The frequency of ^{14}C dates associated with archaeological sites (Fig. 4) in this study contradicted the findings of Bever (2006) and Potter (2008) in that this study showed a substantial decrease in the number of dated archaeological sites after the Early Holocene. Because this study focused on human occupations that were coeval with extinct Pleistocene taxa, sample size was more robust for sites post-dating the Early Holocene. These contradictory patterns also may be a reflection of the use of a refined ^{14}C record.

Radiocarbon date frequencies associated with mammoths consistently fluctuated from 50,000 cal. BP to the terminal Pleistocene with peaks occurring at 41,500 cal. BP, 35,000 cal. BP, and the end of the LGM 17,000 cal. BP. Reliable and moderately reliable ^{14}C dates are absent between 27,000–26,000 cal. BP and just after 13,000 cal. BP. These gaps expanded significantly when examining only the reliable dates, but the absence of ^{14}C dates immediately following 13,000 cal. BP reflected the last known mammoth remains on the mainland until the Mid-Holocene mammoths that survived on island refugia (Veltre et al. 2004, 2008). Mammoths and humans coexisted for approximately one to two thousand years before their extinction on the mainland.

Debruyne et al. (2008) presented a skyline plot of mammoth population estimates for the late Pleistocene which differs from the temporal frequency distribution of mammoth remains in this study. Based on 131 radiocarbon-dated samples and ancient DNA analysis, their data indicated regular population growth during Marine Isotope Stage 4 (MIS4) and decreased populations between 65,000 and 25,000 BP (MIS3) during an interstadial. In contrast, the ^{14}C frequencies associated with mammoths in this study increased between 54,000 and 41,500 cal. BP and decreased after 41,500 cal. BP. Further, a molecular analysis of "sedimentary" ancient DNA, or *sed*aDNA, demonstrated that woolly mammoth and horse survived to 10,500 BP in interior Alaska, later than radiocarbon-dated macrofossils (Haile et al. 2009). This is at least one millennium later than macrofossil evidence for extinctions. Perhaps a refined radiocarbon record would alter the conclusions of these studies (Debruyne et al. 2008; Haile et al. 2009).

Bison are thought to have entered North America during the middle Pleistocene between 300 and 130 ka (Kurtén and Anderson 1980; Shapiro et al. 2004). Reliable and moderately reliable ^{14}C dates show the presence of bison between 62,500 and 42,000 cal. BP and an increase at 41,000 cal. BP, 31,500 cal. BP, 23,500 cal. BP, and 14,000 cal. BP. However, if only the reliable dates are used, *Bison priscus* does not appear in the fossil record until 14,000 cal. BP. Unlike *Equus* and *Mammuthus*, the genus *Bison* did not become entirely extinct in the north, so the persistence of bison well into the Holocene reflects the existence of *B. bison*, not steppe bison (*B. priscus*). Rasic and Matheus (2007) demonstrated *B. priscus* in northern Alaska became extinct between 11,920 and 11,480 cal. BP, and their conclusion is consistent with our analysis. Modern and ancient DNA analyses of Russian, Alaskan, Canadian, Chinese, and lower North American bison samples indicated that bison genetic diversity and frequencies decreased drastically around 32,000 cal. BP, well before the first human occupation (Shapiro et al. 2004). However, examining the temporal frequency distributions of the moderately reliable and reliable bison dates from this study indicated a decrease at 32,000 cal. BP followed by a rebound at 23,500 cal. BP and 14,000 cal. BP. This difference may reflect the elimination of 18 unreliable dates from this analysis.

The frequencies of reliable and moderately reliable ^{14}C dates associated with horse remains were at their highest at 39,500 cal. BP and 24,000 cal. BP, followed by significant decreases and a slight increase of ^{14}C dates during the LGM. This differs from the entire horse sample, which shows high frequencies of ^{14}C dates at 42,000 cal. BP, 31,500 cal. BP, and 29,000 cal. BP. Unlike the mammoth and bison ^{14}C date frequencies, horse ^{14}C dates drop in number during and just before the LGM. Horse becomes extinct after the Bölling warm period, supporting Buck and Bard's (2007) conclusions.

HUMAN-FAUNA INTERACTIONS

Reconstructing prehistoric foraging strategies in Eastern Beringia largely depends upon identifications of fauna preserved in archaeological sites, especially from the Tanana and Nenana Valley sites, Alaska and southwest Yukon Territory (Easton et al. 2007; Holmes 1996, 2001, in press; Potter 2005, 2007; Yesner 2001). Yesner (2001:317) proposed that the human dispersal into interior Alaska was a "push" and "pull" phenomenon. While the flooding of the land bridge may have "pushed" people out of Western Beringia, the presence of appealing habitats supporting migratory waterfowl, bison, and wapiti in the east may have "pulled" early inhabitants into central Alaska.

Direct evidence of human-fauna interactions comes from archaeological sites where faunal remains are associated with prehistoric artifacts (*cf.* Haile et al. 2009). Mammoth tusk fragments dated 18,890±89 cal. BP (CAMS-9898, score=23) at the Broken Mammoth site in the Tanana Valley were recovered from a component dated between 13,660±170 cal. BP and 12,950±80 cal. BP (scores=24). This fossil ivory led Yesner (2001) to argue that old ivory had been scavenged from the Tanana River floodplain. These dates were considered reliable in this analysis and support Yesner's (2001) interpretation. Mammoth ivory at the nearby Swan Point site was dated to 14,020±160 cal. BP (NSRL-2001, CAMS-17045, score=24) (Holmes in press; Holmes et al. 1996) and was contemporaneous with charcoal dates from associated features (score=28), indicating humans were coeval with mammoths. Stuart et al. (2002) recognized the complications that scavenged ivory and bone in archaeological sites present for interpretation, and therefore dates and context alone are insufficient for strong interpretations of contemporaneity. The Tanana Valley is particularly significant because it has yielded the latest known reliable mammoth, horse, and *B. priscus* occurrences on the mainland, all of which were recovered from archaeological contexts. Undoubtedly, this phenomenon is a function of excellent preservation conditions as well as intense investigations in the region.

Based on the presence of fossil ivory in archaeological sites, ivory was probably scavenged and mammoths may not have been hunted. However, the lack of mammoth kill sites is balanced by the lack of bison, horse, caribou, sheep, and wapiti kill sites in Eastern Beringia (Solow et al. 2006; Surovell et al. 2005; Surovell and Waguespack 2009; Waguespack and Surovell 2003; Wygal this volume). Alternatively, bison were likely hunted based on the presence of postcrania and contemporaneity at Dry Creek (Bigelow and Powers 1994; Powers and Hoffecker 1989), Delta River Overlook (Holmes and Bacon 1982), Broken Mammoth (Holmes et al. 1996; Yesner 2001), and Gerstle River (Potter 2005, 2007). Horse remains at the Swan Point archaeological site also suggest humans may have hunted horses in the Late Pleistocene (Holmes in press).

CONCLUSIONS

This study developed a standardized method for evaluating the reliability of radiocarbon dates and evaluated a large percentage of published radiocarbon dates associated with mammoth, bison, horse, and archaeological remains. Of 948 evaluated dates, 8.7% (n = 83) were considered reliable, 84% (n = 796) moderately reliable and 7.3% (n = 69) unreliable. The final appearance of mammoths in Eastern Beringia occurred on an island refugium at 6,400 ± 50 cal. BP (Veltre et al. 2004, 2008), uncolonized by humans until the historic period (Rubicz et al. 2003). The last occurrence of *B. priscus* was in the Tanana Valley at the Gerstle River archaeological site, dated 10,070 ± 120 cal. BP (Potter 2005, 2007; Shapiro et al. 2004). *Equus* became extinct before *B. priscus* but was survived by *B. bison* and mid-Holocene mammoths (Buck and Bard 2007). The earliest reliable date for a human presence in Eastern Beringia comes from Swan Point (14,100±110 cal. BP) (Holmes and Crass 2003). Therefore, humans, mammoths, bison, and horses coexisted for several millennia in Eastern Beringia.

Interpretations based on biogeographic distribution may be substantially altered by including only radiocarbon data which are the most reliable. The overall pattern in ^{14}C frequencies was similar between the refined (reliable and moderately reliable ^{14}C dates) and unrefined (all ^{14}C dates) records of mammoth, bison, horse, and human occupations, but the relative intensity of ^{14}C frequency fluctuations differs when only the refined radiocarbon data are used. In particular, these frequency changes are dramatic when we eliminated (1) the unreliable and moderately reliable dates at 11,000 and 10,000 cal. BP with archaeological occupations and (2) dates of mammoth remains from 28,000 to 23,000 cal. BP. Using only the reliable dates significantly limited the sample size of dated megafaunal remains, also skewing ^{14}C frequencies. For instance, if only reliable dates are used, *Bison priscus* and horse do not appear in the fossil record until the Late Pleistocene. The use of unevaluated ^{14}C dates has the potential to significantly misrepresent patterns in temporal frequency distributions, but the problem can be addressed by using robust methods of date evaluation.

There were a number of biases in this study, including geographic preference towards fossil localities and an increased availability of specimens dating or post-dating the LGM. Therefore, higher ^{14}C frequencies at this time may simply reflect a greater research emphasis and/or a taphonomic bias toward better preservation of more recent organic material. Continued paleontological and archaeological investigations as well as ancient DNA and life history studies will enhance efforts to examine complex extinction processes in finer detail. Future studies using these refined data can correct for the incomplete fossil record following Surovell et al. (2009) when reconstructing paleodemographic histories relative to climate proxy records and human occupation of Eastern Beringia. These studies should be performed with refined ^{14}C dates because they clearly influence interpretations of temporal frequency distributions and, by extension, paleodemography.

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THE 1855 ATTACK ON ANDREEVSKAIA ODINOCHKA: A REVIEW OF RUSSIAN, AMERICAN, AND YUP'IK ESKIMO ACCOUNTS

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ABSTRACT

The 1855 attack on Andreevskaia odinochka is arguably the most mysterious incident of Native hostilities against the Russians in western Alaska. Published accounts of the attack itself are generally consistent, but descriptions of its aftermath are dramatically divergent. Russian accounts are inconsistent as to whether or not reprisals were taken against the perpetrators of the attack; however, American accounts describe a swift and ruthless Russian response that reputedly served as a turning point in ending Native atrocities against Euro-Americans in the region. After discussing the Russian and American sources, Native oral history accounts are considered. The latter provide the first glimpse of indigenous perspectives of this event and firmly anchor it in the local landscape. Although the oral accounts introduce further inconsistencies, they also reveal previously unknown details about the participants and their post-conflict actions.

KEYWORDS: Russian America, lower Yukon River, ethnohistory

INTRODUCTION

Sustained Russian presence in the lower Yukon River region (Fig. 1) began with the 1835 establishment of Ikogmiut odinochka (Arndt 1996:186; cf. Zagoskin 1967:201), a subordinate post of Mikhailovskii Redoubt (Black 1984a:32).[1] Named after the Yup'ik Eskimo village in which it was situated (i.e., *Iqugmiut*), the odinochka was on the right bank of the Yukon, roughly 125 km upriver from its mouth. Intended to control the Native fur trade along the Yukon-Kuskokwim Portage, Ikogmiut odinochka's functional life was short. It was destroyed by Natives of the Kuskokwim River in the spring of 1839 (Zagoskin 1967:200–201, 275; cf. VanStone 1979:79), apparently in response to the 1838–1839 smallpox epidemic (for which the Russians were blamed [Arndt 1985, 1996:45–46; Oswalt 1980:12; cf. Fortuine 1989:234–235; Zagoskin 1967:252]). Rebuilt in 1840, concerns that it was competing for furs with Kolmakovskii Redoubt on the Kuskokwim (cf. VanStone 1979:80; Zagoskin 1967:275) caused the Russian-American Company [or RAC] to abolish Ikogmiut odinochka in 1845 and replace it with Andreevskaia odinochka—located farther downstream on the Yukon (Arndt 1996:62–64; cf. Andrews 1989:124–129).

Andreevskaia stood on the Yukon's right bank about 63 km above the river mouth (Adams 1982:97) and 150 km from Mikhailovskii Redoubt.[2] This location was proximal

1. Bockstoce (2009:372) defines an odinochka as a "small outpost manned by one trader"; but such outposts typically employed additional workers, often local Natives (e.g., Black 1984a:31–33). The trader served as head of the odinochka and held the title of *baidarshchik*.
2. A report that Andreevskaia odinochka was situated "at the mouth of the Nygyklikh (now Andreafsky) River" (VanStone 1979:80) is incorrect; it was actually about 8 km west-northwest of the *Negeqliq* ("Nygyklikh") mouth. Due to its relative proximity to Mikhailovskii Redoubt, the odinochka had no fortifications (RAC 1856a; cf. Arndt 1996:103).

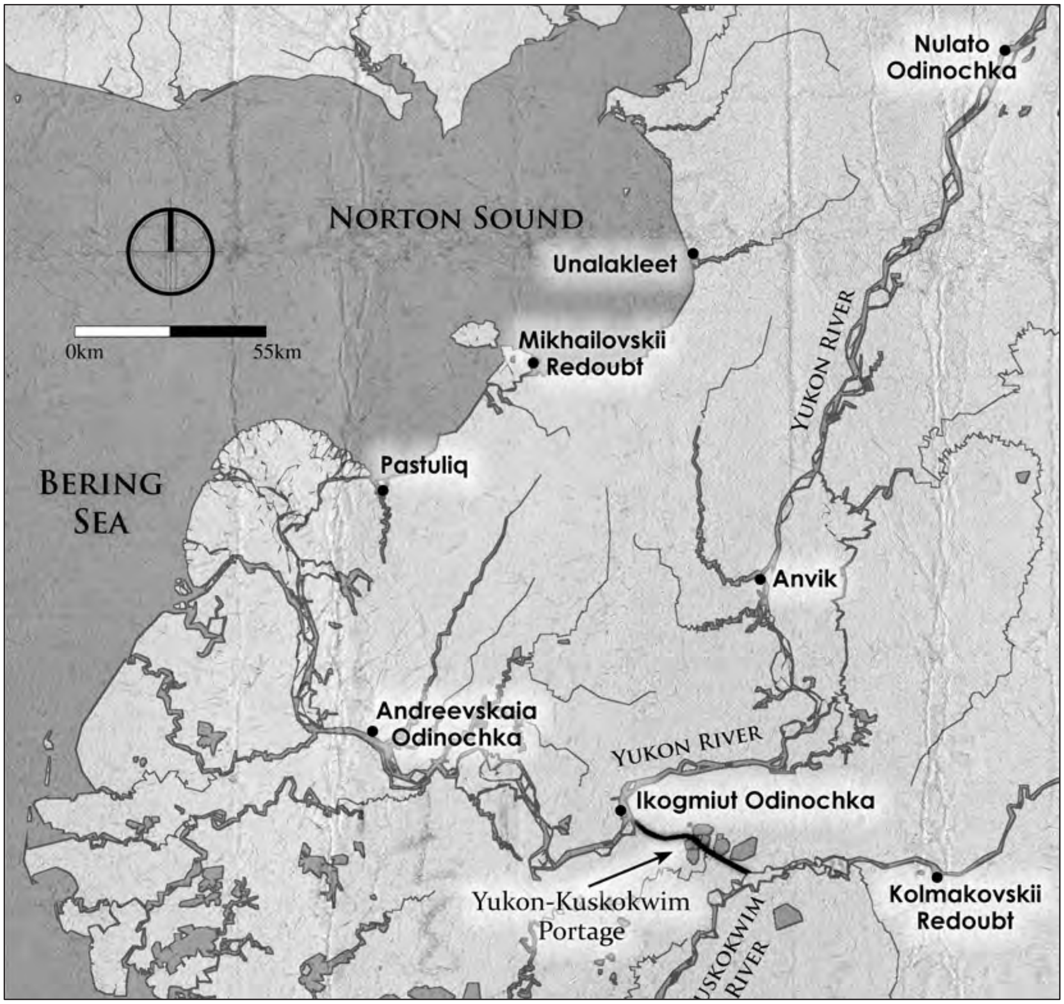

Figure 1: Study region

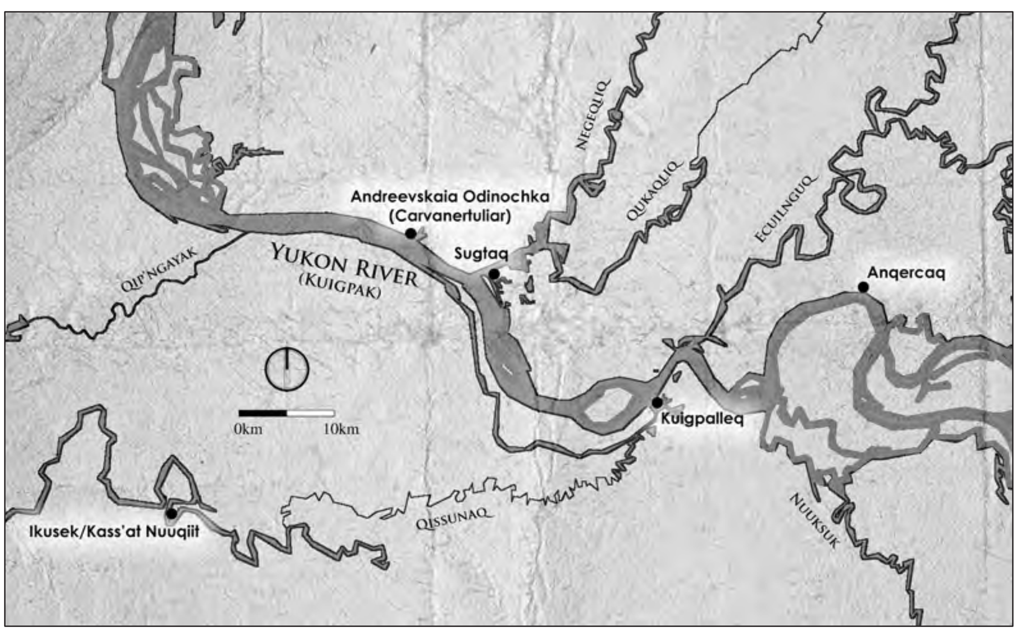

Figure 2: Detail map showing key sites mentioned in text

to the *Qissunaq* and *Qip'ngayak* rivers (Fig. 2; Table 1), key routes of Native travel and trade between the lower Yukon and the Bering Sea coast. These factors contributed to the relative success of Andreevskaia odinochka, which operated from 1845 to at least 1866 (cf. Black 2004:282; Raymond 1871:39; VanStone 1979:81). Its obscurity in the Russian America literature is surprising, especially given an 1855 attack that left two RAC workers dead and subsequently resulted in a number of Native deaths as well. This is the last known incident of Native hostilities against the Russians in what is now western Alaska; to date, it is also the least well documented.[3]

Table 1: Place name correlates

Native Place Name	Non-Native Place Name Correlate(s)
Taciq	Mikhailovskii Redoubt, St. Michael
Pastuliq	Pastol'skii, Pastolik
Kuigpak	Kvikhpak River, Yukon River
Qip'ngayak	Black River
Carvanertuliar	Andreevskaia Odinochka, Old Andreafsky
*Atiinaaska**	Andreevskaia Odinochka
Negeqliim Painga	Pitkas Point
Negeqliq	Konnekova River, Andreafsky River
Sugtaq [Also *Yugtaq*]	
Qukaqliq	East Fork Andreafsky River
Kuigpalleq	Starry Kwikhpak
Qissunaq [*Kuigpalleq*]	Kashunuk River
Ikusek	
Kass'at Nuuqiit	
Manignalek	Maninglik River
Ecuilnguq	Chuilnak River, Atchuelinguk River
Nuuksuk	Reindeer River
Anqercaq	Robbers' Village, Razboinicheskoe Zhilo, Ankachagmiut, Razbinsky
Iqugmiut	Ikogmiut Odinochka, Russian Mission

* Reported by Pilot Station elder Noel Polty (1985a), this name is evidently a Yup'ik rendering of the Russian word *odinochka*.

The limited data available about the attack come from written Russian and American accounts and oral history accounts collected from Yup'ik Eskimo elders of the lower Yukon River. For the sake of clarity, these accounts are discussed in sequence by their cultural groups of origin (i.e., Russian, then American, then Yup'ik Eskimo).

RUSSIAN ACCOUNTS

The earliest and best source of data on this incident consists of two official letters in the Records of the Russian-American Company (1856a, 1856b).[4] The first letter (titled, "On an attack of the savages upon Andreevskaia odinochka") was written to the RAC Main Office in May 1856 by Colonial Chief Manager Stepan Voevodskii. Following is an extended excerpt from the letter.

> The manager of Mikhailovskii redoubt, Andreianov, reports that in November of last year several savages made an attack upon Andreevskaia odinochka [and] killed two company employees, baidarshchik of the odinochka Aleksandr Shcherbakov and worker Ida Iakobson, a Finlander, who, as far as could be concluded from the incoherent reports, were in the bathhouse at the time of the attack; the worker Lavrentii Kerianin, a Finlander, who was at the odinochka, having saved himself by fleeing, was already exhausted from fatigue, cold, and hunger, but was met by a native in a baidarka heading along the Kvikhpak [Yukon] River for Mikhailovskii redoubt. [The native] took him aboard, warmed him, clothed him, and delivered him to the redoubt.
>
> The stocks at the odinochka…were plundered for the most part by those making the attack; what was left by them was carried off by other savages.
>
> Andreianov, having found out from a person arrested for suspicion of participation in this crime that it was committed by six savages of the so-called Robbers' village, learned the place sheltering them and sent against them several workers under the leadership of Ivan Kozhevnikov, appointed baidarshchik at the ravaged Andreevskaia odinochka.
>
> The murderers were found hiding on the tundra in a barabara and were surrounded, but to [the workers'] demand that they surrender and return the stolen company property, they answered with threats

3. This point is underscored by the absence of any mention of the Andreevskaia attack in a recent, authoritative, and highly relevant publication by Bockstoce (2009).

4. These letters were translated from Russian to English by Katherine Arndt.

> and one of them fired a gun, but missed, for which reason our employees were provoked to act decisively, the result of which was that five of the murderers were killed and the sixth saved himself by fleeing.
>
> Of our people no one was wounded.
>
> This order of Andreianov had a good influence on the other savages who, however, even without that, were indignant with the criminals . . . Kozhevnikov found part of the stolen property in the barabara and part buried there in the earth, and in addition he collected much in various settlements from the savages (RAC 1856a).

Later in May 1856, Chief Manager Voevodskii also wrote a letter regarding this incident to Ignatii Andreianov, the Manager of Mikhailovskii Redoubt (RAC 1856b). The letter designated rewards for the RAC employees who went after the Andreevskaia attackers, as well as for Kerianin's rescuer ("Aleksei," a Native from *Pastuliq*). It also noted that musketoons[5] were being sent to Andreevskaia odinochka, and urged that it be put "in as safe a defensive position as possible." For the purposes of this discussion, however, the letter's most important component was the following directive to Andreianov:

> Gather as much information as possible whether there were any injustices on the part of the late Shcherbakov which could have embittered the savages, and impress upon all the baidarshchiks that their treatment of and also their trade with the savages should be strictly just and gentle, needless to say with the most unremitting caution (RAC 1856b).

This directive was consistent with RAC regulations regarding the treatment of Native peoples (cf. Arndt 1996:108–110). It also clearly expressed the company's interest in determining if the attack on Andreevskaia could have resulted from misbehavior toward the Natives by its employees: apparently evidence of that sort was not found. Voevodskii's directive is particularly noteworthy in contrast to American accounts of the Andreevskaia attack. Before those are discussed, however, a comment is in order about the only Russian account of the event that is published in English: the 1978 edition of Petr Tikhmenev's history of the RAC.

Tikhmenev's account clearly was based on the same RAC correspondence just reviewed, but one crucial detail was modified. That is, he reported that the RAC employees who pursued the attackers found their hiding place, surrounded it, and "*forced them to surrender and return their booty*" (Tikhmenev 1978:351 [emphasis added]). Tikhmenev's decision not to mention that RAC employees ultimately killed most of the Native attackers is puzzling; it suggests a suppression of facts thought to be potentially damaging to the company's reputation. This is unfortunate given existing English-language records about the incident.

AMERICAN ACCOUNTS

The first American account of the attack was produced by William H. Dall, who visited the lower Yukon region in 1867. Dall's writings are often colored by an obvious lack of respect for his Russian counterparts and predecessors (e.g., Dall 1870:11–13, 432, 1877:26), an attitude that was not uncommon among some American newcomers to Alaska following the 1867 purchase (cf. Black 1988:80). But his comments on the Andreevskaia incident actually contain a hint of admiration for the reported Russian response.

> Andreaffsky [Fig. 3] . . . was the scene of a mournful tragedy. There was formerly [a Native] village near the fort. Several of the Natives were workmen at the fort. No trouble had ever occurred. Several of the garrison had gone up to Nulato with the annual provision-boat, and only the bidarshik and one Russian, besides the native workmen, were left in the fort. One Friday in August, the natives attacked the Russians as they came naked out of the bath, and killed them with clubs and knives. A Creole boy escaped to the hills, and finally crossed the portage to the vicinity of St. Michael's. When he reached that point the [manager] was away, and his secretary, Ivan [Kozhevnikov], was acting in his stead.
>
> The Russians had long murmured at the conduct of the Company, in leaving unavenged the Nulato massacre. The opportunity of settling accounts with the natives was too tempting to resist. [Kozhevnikov] and Gregory Ivanhoff, with two Creoles, immediately started for the fort. On reaching it they found everything in confusion. The dead bodies lay at the door of the bath-house. The natives, not knowing how to use flour, had merely carried off the sacks. They had also ripped open the beds, and carried away the ticking, while the mass of flour and feathers was left on the floor. After satisfying themselves that there was no liv-

5. Short, large-bore muskets (Bockstoce 2009:372).

ing thing in the fort, the Russians started for the village, which was about a mile off. As they approached, [Kozhevnikov] saw a man standing in the door of one of the houses and pointing a gun at the approaching party. It afterward turned out that the gun had no lock; but not knowing this, the Russians fired, and killed the man. The natives, who were few in number, came rushing out, and were shot down without mercy. The Creoles, who, when aroused, have all the ferocity of the aboriginal savage, attacked the shaman and beat out his brains with clubs. None were spared. The blood [that had been] shed at the fort was not yet dry, and the infuriated Russians resolved that the authors of that cowardly outrage should be exterminated without mercy. When they stayed their hands the work was done. Fathers, mothers, and children had passed their "evil quarter of an hour." The result was wonderful. From that day to this not a native on the Lower Yukon has lifted his hand against the whites. The bloody lesson was not thrown away. The strong hand, which alone commands the respect of savages, was worth a thousand missionaries. To this day the natives traveling on the river near the fort pass by on the other side. Large quantities of tobacco and other property, stolen from the fort, were found in the village. Around the necks of most of the dead, crosses were found hanging, indicating that the thieves and murderers were baptized converts of the Yukon Mission (Dall 1870:231–232; cf. Dall 1867a; Nelson 1882:664; US Census Office 1893:123).[6]

Frederick Schwatka penned a similar account in 1883; it may even have been based on the earlier account by Dall, but some details of the attack's aftermath differ. His report states the boy who escaped the attack:

> …reached St. Michael, which was temporarily in charge of the Russian [Kozhevnikov]… He, with one or two others, set out immediately in a small schooner…for the scene of the massacre provided with two howitzers loaded with scraps of iron, nails, etc. He demanded that the murderers be handed over or he would fire on the village. The natives showed no inclination to obey, thinking the guns would not go off, but [they] were soon brought to a realizing sense of their error by the discharge of the guns, which killed a number. The Russians, not satisfied with this, are said to have attacked the remainder with clubs, and to have killed many women and children (Schwatka 1900:356–357).

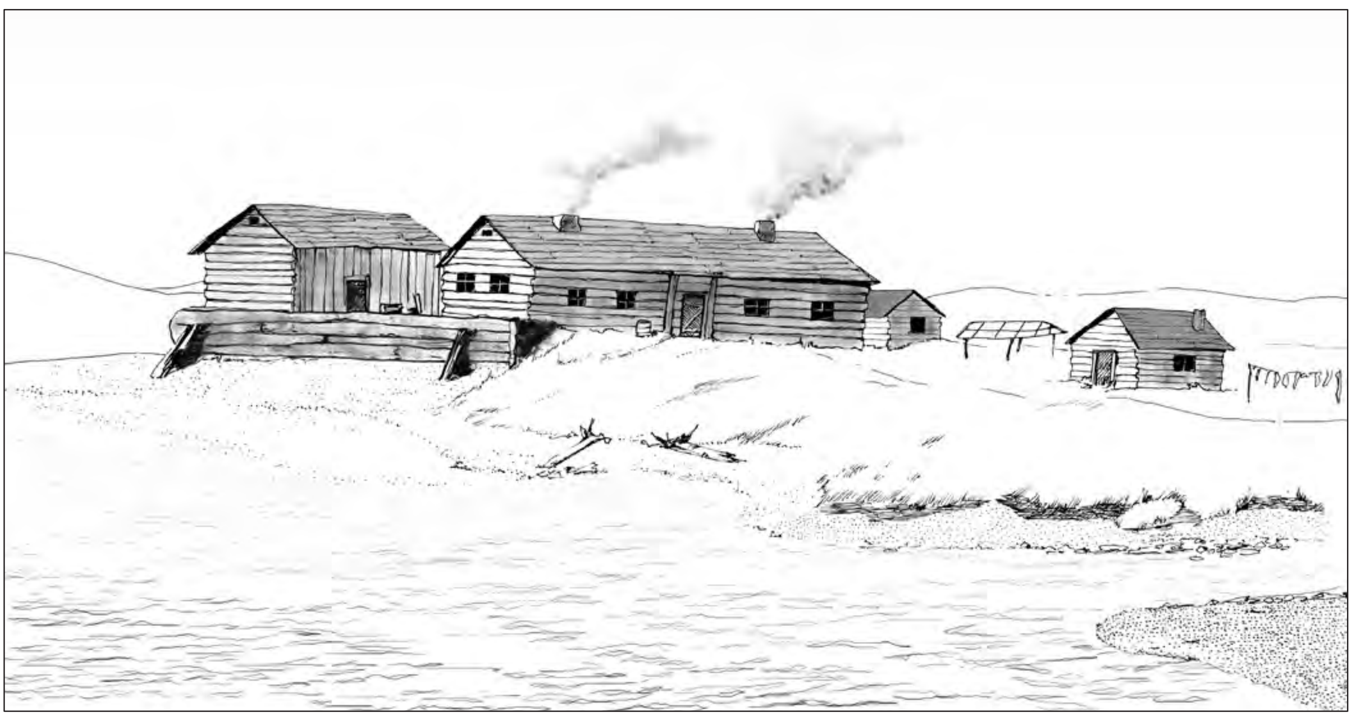

Figure 3: Andreevskaia odinochka as sketched in July 1867 (adapted by Mark Luttrell from Dall 1867b and 1870:230). The odinochka was "deserted…with the windows all nailed up" (Dall 1870:231) when the original sketch was made; hence, the chimney smoke and fish drying on racks reflect artistic license.

6. Dall (1870:231) provided a description of the odinochka in 1867, shortly before the Alaska Commercial Company assumed its operation (cf. VanStone 1979:81-82, 112-119). Later descriptions of the post were provided by Nelson (1878) in 1878 and Jacobsen (1977:93) in 1882.

To be blunt, characterizations of the Russian response by Dall and Schwatka are not believable. Dall's evident bias against the Russians and "notorious looseness with statements of a historical nature" (Arndt 1996:177; cf. Bancroft 1970:574*n*9; de Laguna 2000:34) make his account suspect, especially since it portrays the Russians in a negative light. But also:

> ...in the post-Baranov days the Russians would never have perpetrated retaliatory killings. Not only was it illegal under [Russian-American] company regulations, but there was the danger that such a practice would escalate to open warfare and the Russians were too thinly spread and too dependent on the natives' good will to risk such a thing. Of course, there was always a chance that a native would be killed if he were an immediate threat to the Russians' life and property, but that would occur in the course of self-defense, something far different than retaliatory killing (Arndt 2010; cf. VanStone 1979:79; Zagoskin 1967:236–237).

More compelling yet is the fact that RAC correspondence identified the home of Andreevskaia's attackers as the "so-called Robbers' village" (RAC 1856a; cf. Arndt 1996:117*n*57). the settlement in question was *Anqercaq* (e.g., Zagoskin 1967:278), a major Eskimo village about 47 km east of Andreevskaia odinochka. Zagoskin (1967:306) reported its population as 122 in 1844, and Edward Nelson (1899:247) described it as "the largest existing village of the Yukon Eskimo" in the late 1870s (Fig. 4). The notion that a contingent of *four or less* RAC employees massacred everyone in a settlement of this size is absurd (e.g., Zagoskin 1967:132). An active village throughout the Russian period, *Anqercaq* is also consistently documented in post-1867 accounts of the region (e.g., Dall 1870:229; Jacobsen 1977:95, 230, 242; Nelson 1899:Plates LXXXII and XCI, 365–379; Raymond 1871:30). There is no evidence in historical accounts—or Native oral history—of a massacre at this place. In all probability, the actual place being referenced in American accounts as the site of this reported massacre was *Sugtaq*—a village located on a small drainage just inside the *Negeqliq* mouth, about 8.5 km east-southeast of Andreevskaia odinochka. But there is no evidence such an event ever occurred there either.[7]

YUP'IK ESKIMO ORAL HISTORY ACCOUNTS

The Andreevskaia attack as related in official RAC records is largely supported by oral history interviews conducted with Yup'ik Eskimo elders 130 years after the fact. They collectively confirmed that: (a) the attack took place in late fall or early winter; (b) one worker escaped to *Taciq*/St. Michael; (c) the Russian group that tracked the criminals was led by Ivan Kozhevnikov; and (d) goods stolen from the odinochka were buried at a remote site, at which the criminals were eventually found and all but one was killed (Evan and Greene 1984; Polty 1985a, 1985b). But these accounts also introduce new discrepancies. The most glaring of these attributes the killings at Andreevskaia to a party of nine *Russians*—one of whom was married to a Native woman from *Sugtaq* (Polty 1985a, 1985b). The claim that "bad Russians" perpetrated the attack is almost certainly wrong, but it is not inconceivable that at least one such person may have been part of the attacking force.[8] But the most valuable contributions of these oral history accounts are the details they contain about the attackers' actions after leaving the odinochka. These are summarized next.

Figure 4:* Anqercaq *(the so-called "Robbers' Village") in January 1879 (originally published as Plate LXXXII in Nelson 1899 [Reprint courtesy Smithsonian Institution]).

7. However, according to local oral tradition (i.e., U.S. BIA Bethel Notes 1975), the men of *Sugtaq* were once unknowingly trapped inside the village men's house by a party of Yup'ik [*Magemiut*] warriors from the Askinuk Mountains area. About the time the attackers were poised to burn it to the ground an old man inside the men's house fell and landed head-first in a wooden honey bucket, causing all the *Sugtaq* men to roar with laughter. The attackers heard the laughter and interpreted it as a sign that they had not reached the village undetected, meaning that they themselves were in danger, so they immediately fled and *Sugtaq* was spared. This story likely explains the report by Zagoskin (1967:278) of a large village at this location that was "destroyed by the Magmyut" ca. 1814 (Pratt n.d.). It is plausible that Dall and/or Schwatka heard this story through interpreters, believed that a massacre had taken place at the village, and then compounded the error by ascribing responsibility for the presumed attack to the Russians.

After looting Andreevskaia odinochka the attackers traveled upstream on the Yukon to *Qissunaq* River, which they then followed to a place at or near the village of *Ikusek* (Evan and Greene 1984; Polty 1985b; see Fig. 2). This is where some of the stolen goods were buried and also where Kozhevnikov's party found the attackers—thanks to the assistance of other Natives. To explain, after departing Mikhailovskii Redoubt the Kozhevnikov party stopped at Native villages along the Yukon seeking information about the attackers. Upon reaching the settlement of *Kuigpalleq* (located at the confluence of the *Qissunaq* and Yukon rivers) the party learned the criminals had gone down the *Qissunaq* to hide at a site referred to as "*Kass'at Nuuqiit*" (Polty 1985b), which was said to describe a place beyond the reach of white men (Evan and Greene 1984).

The woman from *Sugtaq* was also at *Kass'at Nuuqiit* when the fight with Kozhevnikov's party began (Polty 1985b).[9] Pregnant and scared, she ran away, following the *Qissunaq* downstream until reaching *Manignalek* River (Polty 1985b).

> Since the woman was pregnant, while she was escaping she started her labor. She was walking along the *Manignalek* River when she came to a bear's den…She delivered her baby there in the bear's den (Polty 1985b).

It was this woman's husband who managed to escape the fighting at *Kass'at Nuuqiit*. He tracked his wife and found her in the bear's den; after a period of recuperation, he took her back to her family at *Sugtaq*.[10]

DISCUSSION AND CONCLUDING REMARKS

The preceding comments highlighted inconsistencies in Russian, American and Native oral history accounts about the attack on Andreevskaia odinochka (see Table 2), but they also revealed three major points on which those

Table 2: Summary of accounts about the attack on Andreevskaia Odinochka

Russian Accounts	American Accounts	Yup'ik Eskimo Accounts
Date of Attack: November 1855 (RAC 1856a)	**Date of Attack**: August 1855 (Dall 1870:231)	**Date of Attack**: 1848, "in the fall just before freeze-up" (Polty 1985b)
Attackers: "Six savages from the so-called Robbers' village" (RAC 1856a)	**Attackers**: (1) Natives from a village "about a mile" from "the fort" (Dall 1870:231–232); (2) a "band of Ingalik [Athabascans]" (US Census Office 1893:123)	**Attackers**: (1) Yup'ik Eskimos (Evan and Greene 1984); (2) a group of nine "bad Russians" (Polty 1985a, 1985b)
Killed in Attack: Alexsandr Shcherbakov and Ida Iakobson (RAC 1856a)	**Killed in Attack**: (1) Two Russians (Dall 1870:231); (2) the "few inmates" of the "station" (Schwatka 1900:357)	**Killed in Attack**: An unknown number of Russian men (Evan and Greene 1984; Polty 1985a, 1985b)
Escaped from Attackers: Lavrentii Kerianin (aided by *Pastuliq* man named "Aleksei" [RAC 1856a])	**Escaped from Attackers**: (1) "A Creole boy" (Dall 1870:231); (2) "a boy" (Schwatka 1900:357)	**Escaped from Attackers**: One Russian man, "the first Kozevnikoff" (Evan and Greene 1984)
RAC Pursuit Party: Ivan Kozhevnikov; Niuman; Ignat'ev; Mikiforov; and two other unnamed men (RAC 1856b)	**RAC Pursuit Party**: (1) "[Iván] Kogénikoff and Gregory Ivánhoff, with two Creoles (Dall 1870:231); (2) "the Russian kogenikoff…with one or two others" (Schwatka 1900:357)	**RAC Pursuit Party**: (1) The "man who escaped to *Taciq* [i.e., 'the first Kozevnikoff']" (Evan and Greene 1984); (2) an unknown number of "other Russians" (Polty 1985a, 1985b)
Fate of Attackers: (1) five killed by RAC pursuers; one escaped (RAC 1856a); (2) all surrendered to RAC pursuers (Tikhmenev 1978:351)	**Fate of Attackers:** killed, along with every other resident of their village, by Russians (Dall 1870:231–232; Schwatka 1900:357)	**Fate of Attackers**: (1) all killed by Russian pursuers (Evan and Greene 1984); (2) eight killed by other Russians; one escaped—he was married to a Yup'ik woman from *Sugtaq* (Polty 1985b)

8. Russian priest Iakov Netsvetov (1984:421) reported precisely this type of situation in the region in April of 1861.

9 The attackers presumably picked up the woman en route to their hiding place. By extension, this suggests *Sugtaq* was one of the settlements at which RAC personnel later recovered goods that had been plundered from Andreevskaia odinochka (RAC 1856a).

10. What little evidence there is suggests the RAC did not attempt to capture this man and bring him to justice at a later date; instead, the company was apparently satisfied that Andreevskaia's attackers had been duly punished (RAC 1856b).

accounts agree: i.e., one worker at the post survived the attack; Ivan Kozhevnikov had a central role in the pursuit and punishment of the attackers; and multiple Natives were killed by RAC personnel as a direct result of the attack. Another point of agreement not yet mentioned concerns how the attackers dealt with the odinochka's supply of flour. The RAC (1856a) reported the attackers "spilled flour" at the odinochka but suggested much of it was salvageable; in other words, the flour was not taken. Dall's (1870:231) account claimed "the Natives, not knowing how to use flour, had merely carried off the sacks." Yup'ik elders effectively concurred with the RAC and Dall accounts by stating that the attackers "took the flour sacks after they spilled the flour out" (Evan and Greene 1984). Details about the flour and flour sacks comprise a comparatively minor point in the story of Andreevskaia—for that very reason, however, their preservation in local oral tradition imbues Yup'ik accounts of the incident with added authority.

But, clearly, the most authoritative and important element of the oral history accounts is their geographical illumination of the event; they fix the story to the canvas of the local landscape, thereby making it richer and more alive. One geographical detail in these accounts that is technically problematic concerns whether "*Kass'at Nuuqiit*" was a formal place name or merely a generic term of reference for an area that was off the beaten path and therefore remote from non-Native activity. A reasonable argument can be made in support of either explanation. However, official RAC correspondence describing the pursuit and punishment of the attackers specifically reports that "the murderers were found hiding on the tundra in a barabara" (RAC 1856a); and the statement by Yup'ik elders that the attackers "settled there" (Evan and Greene 1984) further implies that *Kass'at Nuuqiit* was an actual site. The Native and Russian accounts seem consistent, and certainly a dwelling constitutes a 'site'; thus, the attackers must have chosen a pre-existing site for their hiding place—as opposed to a piece of empty ground at which a dwelling was then built. The author believes the memorable events that unfolded when the Russian pursuers caught up with the attackers caused local Yup'ik people to begin calling the site *Kass'at Nuuqiit*. In other words, the event's significance in local history gave rise to a new, unusual, and wholly legitimate Native place name. The name seems ironic given its reported meaning but, in fact, the Russians arguably would not have found the site without the assistance they received from other Natives. Regrettably, the precise locality to which the name *Kass'at Nuuqiit* applied is not certain; however, there is a good chance that it corresponded to part of the *Ikusek* site complex—specifically, Parcel D, which contained a single semisubterranean house (U.S. BIA 1989).

Also worth noting is that Aleksandr Shcherbakov, the Andreevskaia baidarshchik killed in the attack, was an RAC employee at Nulato when it was attacked four years earlier (see Arndt 1996:221). The Native groups involved in the two attacks were entirely different, but this coincidence may explain why Chief Manager Voevodskii specifically directed Andreianov to ascertain if *Shcherbakov* had done anything to anger the Natives who attacked Andreevskaia. Among other possibilities, Voevodskii's directive implies concern that Shcherbakov's experience at Nulato might have caused him to harbor bad feelings toward area Natives and, in turn, could have been a factor in the tragedy at Andreevskaia.

Obviously, Natives were also capable of holding grudges for real or perceived wrongs committed against them by others. The reported fate of Ivan Kozhevnikov is a case in point. According to Schwatka:

> [in 1882] a Russian was killed by an Indian living at Nulato, and the murderer still goes unpunished, though in constant fear of being killed or otherwise injured by the whites. This murder, though by no means justifiable, is nevertheless accompanied with circumstances more or less extenuating. The Russian, whose name was Ivan Kogenikoff, was held in great fear by all the Indians, not only on account of his naturally quarrelsome disposition, but on account of the very summary manner in which he had avenged a murder occurring farther down the river some years ago, and many of them would have been delighted at the prospect of disposing of him had they dared. One night he was being literally dragged home in a helpless state of intoxication by an Indian whose brother had been killed by a son of Kogenikoff. The Indian, seeing [Kozhevnikov] so utterly helpless and so completely in his power, struck him on the head with an ax, considering the deed justifiable in revenge for the death of his brother (Schwatka 1900:352).

While certain details of this account may be exaggerated it nevertheless suggests Kozhevnikov's role in punishing the attackers of Andreevskaia odinochka contributed to his murder. To some extent, this challenges American accounts that asserted the Russian response to the attack increased the safety of Euro-Americans in the region by reducing the threat of violence to them by resident Natives.

There is no real way to disprove the accuracy of those assertions, but they also should not be taken at face value as accurate. A critical evaluation of this topic would need to consider two facts. First, the claim that some Natives were "indignant with the criminals" responsible for the attack on Andreevskaia (RAC 1856a) is supported by oral history maintaining that Natives provided the information that led the Russians to the attackers' hiding place (Polty 1985b). This undermines any implication that the Russian response to the attack left the region's indigenous people seething with anger and hungry for revenge, but too terrified to act on such feelings. Second, incidents of hostilities between Euro-Americans and Natives were rare in this region—so citing the Andreevskaia incident as a watershed moment that dramatically altered local Native behavior toward Euro-Americans both overstates reality and reflects ignorance of the historical patterns of Russian-Native interactions.

In closing, an interesting point about the Andreevskaia attack is that no apparent motive for the action has been identified. This sets it apart from the attacks on Ikogmiut odinochka in 1839 and Nulato odinochka in 1851, both of which also resulted in the deaths of RAC employees. As previously mentioned, the Ikogmiut attack was carried out in retaliation for Native mortalities suffered in a smallpox epidemic. The Nulato attack is widely believed to have been based on longstanding trade rivalries between the involved Native groups (e.g., Arndt 1996:103–108; cf. Bockstoce 2009:244–247; de Laguna 2000:162–188; Wright 1995). Unfortunately, the period during which the Andreevskaia attack occurred coincides with a gap in the existing journals of Netsvetov (1984:362 [translator's note]; cf.), who served in the region from 1845 to 1863. Spanning the period from September 1853 through 20 July 1857 (Black 1984b:x), the missing journal entries probably contained information that would have improved our understanding of the event's context.

Most details about the 1855 attack on Andreevskaia odinochka are irretrievably lost to time. Thanks largely to the attack's documentation in Yup'ik Eskimo oral history, however, the data presented herein offer a more complete and geographically grounded account of this historical event than has previously been available.

AFTERWORD

After 1867, when the Russian America era came to an end, the Andreevskaia odinochka locality (Fig. 5) remained an important center of Euro-American trade activity in the lower Yukon River region (Table 3). Written accounts compiled after that date usually identify the site as "Andreafsky" or "Old Andreafsky," and trade operations there continued through the early 1900s. Thus, there is also an "American era" story yet to be told about this long-lived trade post; I hope the present paper encourages future research in that direction.

AKNOWLEDGEMENTS

I am indebted to Katherine Arndt for initially locating and then translating for my use two crucial pieces of Russian-American Company correspondence regarding the attack on Andreevskaia odinochka. I also gratefully thank Robert Drozda for his invaluable research assistance related to rediscovering the Yup'ik name for East Fork Andreafsky River.

Figure 5: **Carvanertuliar*,*** ***the site where Andreevskaia odinochka once stood; view to north, September 1985 (photo by author).***

Table 3: Significant dates in the history of Andreevskaia odinochka

1845: Established by the Russian-American Company (RAC).
1845–1846: Absorbed RAC business formerly conducted at Ikogmiut odinochka.
November 1855: Attacked by Yup'ik Eskimos.
1866: Closed by the RAC (Black 2004:282).
March 1867: Treaty of Cession signed (i.e., Russia sells 'Alaska' to the United States).
December 1867: Most of the RAC's North American assets are purchased by Hutchinson, Kohl and Company (Arndt 1996:178), which is soon renamed the Alaska Commercial Company (ACC) [and later, in 1901, the Northern Commercial Company].
August 1868: By this date, the ACC had presumably reopened the former odinochka for business; it operated under the name "Andreafsky."
1898–1899: Became known as "Old Andreafsky" after the village of Andreafsky (present day St. Marys) was established upstream on the Andreafsky River (Orth 1967:76, 719).

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AN ANALYSIS OF DENBIGH FLINT COMPLEX BURIN TECHNOLOGY FROM MATCHARAK LAKE, ALASKA

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ABSTRACT

This paper presents the results of an analysis of burins and burin spalls recovered from a 3,900-year-old frozen Denbigh Flint Complex midden discovered in Arctic Alaska. Use-wear patterns along with preserved organic remains suggest burins were used not only as gravers, but also as scrapers on bone, antler and wood. Additionally, some of the burins served as cores for producing spalls that were also used as engraving tools. Statistical tests suggest only larger spalls were selected for engraving tasks. An experimental study shows spalls must meet minimum thickness requirements to avoid fracture upon use. Experimental findings of burin spall use show they are suitable for performing the engraving tasks observed on decorated bone tools discovered at the Matcharak Lake Site (AMR-186).

KEYWORDS: Arctic Small Tool tradition, Denbigh Flint Complex, burin technology, stone tool function, use wear analysis, experimental archaeology

INTRODUCTION

This study presents a functional analysis of burin technology from a 3,900-year-old Denbigh Flint Complex site, Matcharak Lake site AMR-186, located in the central Brooks Range of Alaska (Fig. 1). The Denbigh Flint Complex is a distinctive regional tool classification of a northwestern variant of the widespread Arctic Small Tool tradition (ASTt) (Odess 2005). Burins, particularly the "mitten-shaped" or "stacked step" burins, are a highly diagnostic tool type found in Denbigh sites across the Arctic (Bandi 1963; Gal and Hall 1982:4–5) (Fig. 2). Excluding the pioneering work of Giddings (1956) and Bandi (1963), relatively little work has been done to explain the manufacturing techniques of these tools or their function in Denbigh culture. Generally, burins and burin spalls are interpreted as engraving implements used for the manufacture of organic tools (Bandi 1963; Giddings 1956; Sutherland 1996). Some have explicitly linked burins in arctic cultures to microblade technology, suggesting they were predominantly used to incise antler projectiles for inserting microblades (Anderson 1968). A lack of organic preservation at Denbigh sites precludes evidence of such activities (Bandi 1963; Odess 2005).

With no organic tools found associated with the Denbigh Flint Complex, interpretation of burin and burin spall function was based on analogy and speculation. However, Matcharak Lake (AMR-186) provides researchers with new organic evidence that allows us to test some of the assumptions and proposed uses made by Giddings and others. This study uses the recovered burins and burin spalls from Matcharak Lake to identify wear patterns showing how the tools were utilized, in addition to experimental observations which test the hypothesis that burins were used to make engravings and cuts observed on faunal remains recovered from AMR-186. This paper expands on our current understanding of burin technology and the burin blow technique in Denbigh culture by sup-

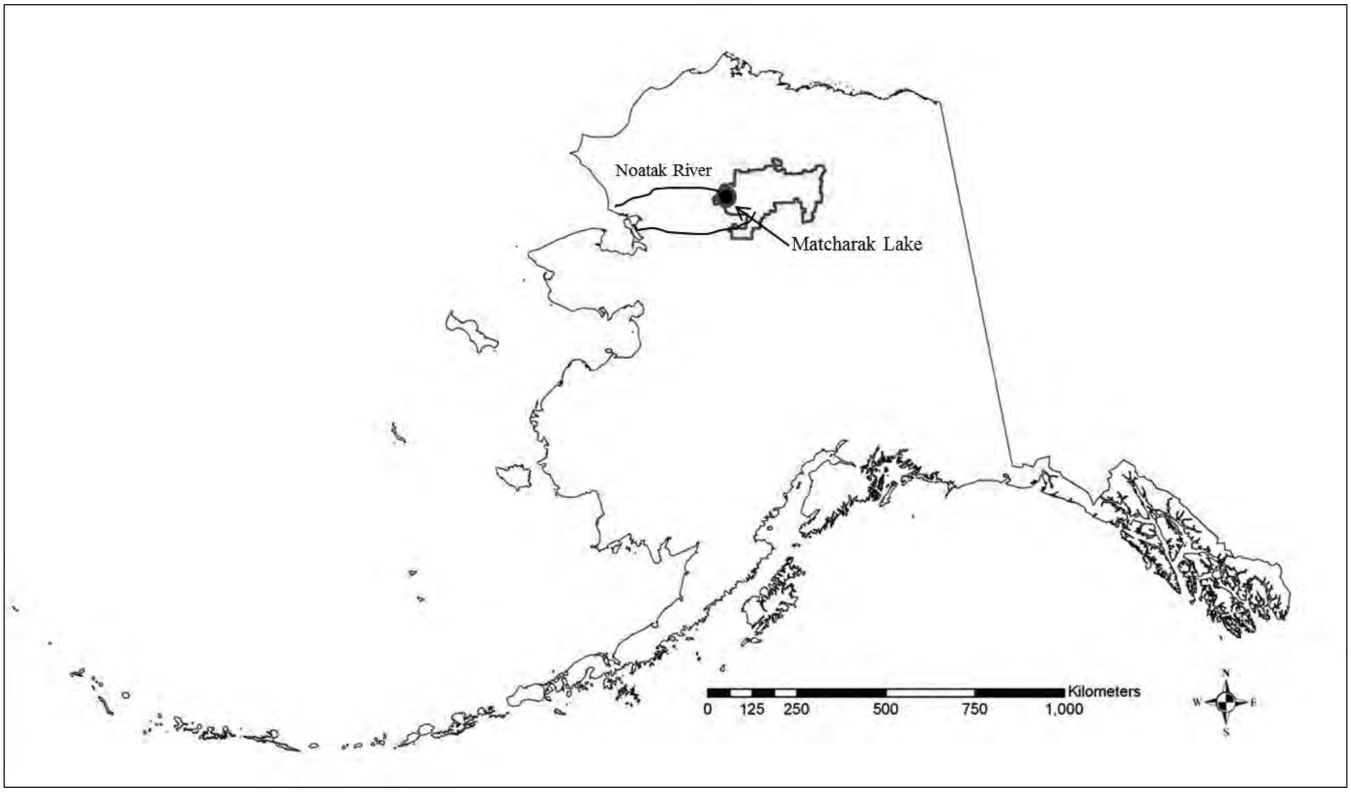

Figure 1. Gates of the Arctic National Park and Preserve and the area of study, the Upper Noatak River

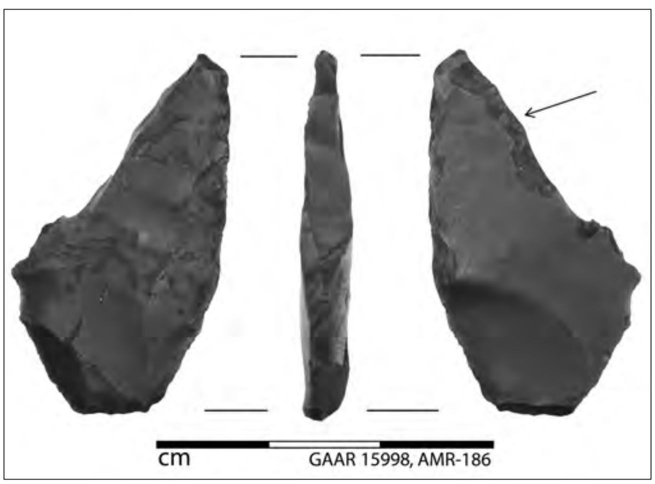

Figure 2. The diagnostic "mitten-shaped" burin of the Denbigh Flint Complex

porting long-held hypotheses about the function of these tools—for engraving and shaping organics and as cores for burin spalls; and by documenting previously unrecognized uses, such as scraping or whittling, and as hafting elements, serving as basal modification for fitting into an existing haft. These data are important for understanding the role that burins play in the technological organization of Denbigh tool kits. With an expanded functional role we should expect to find burins in a variety of camp types throughout all seasons of the year. While this study does not provide an intersite analysis this paper does present the information needed for such comparisons.

A BRIEF SUMMARY OF BURIN STUDIES

The study of burins has a long history in archaeological lithic analysis, from typological classification focused on morphology (Clay 1976; Noone 1934; Pradel 1971) to functional studies focused on manufacture and use (Barton et al. 1996; Kay and Solecki 2000; Stafford 1977; Tomaskova 2005; Vaughan 1985). The results of these studies show that burin technology is more complex and diverse than initially realized. Burins are defined by a specific flint-knapping technique for removing a linear spall of stone, known as the burin blow (Vaughan 1985). The removal of the spall from a biface or flake margin creates a sharp, nearly 90-degree beveled edge that ends with a chisel-like tip. Early interpretations of burin function suggested they were tools for engraving bone or antler (Barton et al. 1996; Giddings 1956). This interpretation was taken for granted as researchers focused predominantly on typological classifications of various burin forms (Noone 1934). However, archaeologists now understand burin technology to be much more variable and versatile. Barton et al. (1996) argue that burins and the burin blow spall removal technique were used for a number of purposes, including: engraving, as a scraper edge, to rejuvenate a scraping edge, for the shaping of haft elements and as a core for producing burin spalls, which may then be used as tools themselves. Other studies have focused on use-wear with the explicit goal of determining the material the burin was used on, as another means of deriving function and durability of burins made of different raw materials (Kay and Solecki 2000; Stafford 1977). Another study involved a burin refit analysis to understand burin production, and human behavior, as well as site formation and disturbance processes (Cahen et al. 1979). Each study has furthered our understanding of this enigmatic technology, yet many questions remain concerning idiosyncratic uses in different cultural traditions.

Burin technology of the Old World can be traced as far back as 28,000–33,000 years ago (Kay and Solecki 2000). Burins were present across Europe during the Upper Paleolithic (Tomaskova 2005) and in many of the oldest sites in Beringia (Irving 1955; West 1996). Whether or not this technology spread east from Europe or was independently invented is debatable. Outside of arctic North America, burin technology is not widespread in the New World (Epstein 1963; Gibson 1966). Compared to the Old World and the Arctic, burins are rare in prehistoric North America. Burin technology is commonly co-occurs with microblade technology, which implies a greater reliance on organic tools. These technologies are similar in that they produce long, narrow, uniformly shaped flakes that are removed by pressure or a controlled punch. In arctic microblade traditions, the burin is thought to be used to make incisions in bone and antler points, which are then inset with microblades (Anderson 1968). However, as argued for Old World examples, burins served more than one function: as engravers, scrapers, hafting elements, and cores (Barton et al. 1996).

SITE BACKGROUND

The Matcharak Lake Site (AMR-186) was discovered in 2007 and was test excavated in 2008 and 2009 by National Park Service archaeologists (Tremayne 2010). Excavation of 22 m^2 led to the discovery of dozens of diagnostic Denbigh artifacts including end blades, side blades, burins and microblades along with thousands of ecofacts and faunal specimens preserved in frozen soil. Ten radiocarbon dates from bone and charcoal recovered from Matcharak Lake average 3583 (±40) radiocarbon years BP, indicating one or two fairly discrete occupations occurred around 3730–3980 cal BP, contemporaneous with other "Classic Denbigh" sites in Alaska (Tremayne 2010). The Matcharak Lake Site (AMR-186) is a uniquely well preserved Denbigh camp which produced over eighty thousand faunal specimens, predominantly caribou. A faunal analysis identified Dall sheep, porcupine, arctic ground squirrel, Alaska marmot, snowshoe hare, willow ptarmigan, Anatidae, and four species of fish (Tremayne 2010). Based on juvenile caribou remains and migratory bird bones, the occupation(s) at Matcharak Lake occurred in the late summer, fall and in the spring (Tremayne 2010). There is no solid evidence for winter occupation, although it cannot be ruled out. Some of the only known Denbigh organic tools are included in the preserved remains. Four bone points or awls were recovered and one decorated bone foreshaft. A number of cut pieces of antler and bone waste products were recovered as well, preserving evidence of organic tool manufacturing processes. The foreshaft specimen exhibits three parallel incised grooves, apparently meant to be decoration (Fig. 8). These designs constitute the only known artwork by Denbigh people, with the Trail Creek cave finds as a notable, ambiguous exception (Larson 1968) In addition to the information on Denbigh diet, camp function and seasonality, the recovered faunal material allows researchers to link tool types to subsistence strategies that may vary between camp type or seasonal rounds. Use of specific tools may be found to correspond with certain activities. Lacking a local stone source, Denbigh people at Matcharak Lake were very conservative with raw material, which may have influenced use of other tool types, such as burin spalls.

DENBIGH BURINS

Denbigh Flint Complex burin technology is distinctive and varied. Giddings (1951) recorded a variety of burin types from the Denbigh type-site Iyatayet, located on Cape Denbigh. Giddings recognized the single faceted transverse and oblique burins ("mitten-shaped"), a beaked burin, the double faceted burin, separated and convergent burins, the double end burin and a burinated microblade (Giddings 1964). Gal and Hall (1982) introduce the term "stacked step" burin to replace the "mitten" or Denbigh burin, to set this tool apart from the other burins found in Denbigh tool kits; however the term "mitten-shaped" is still commonly used to refer to this diagnostic burin type. At Matcharak Lake we recovered fourteen total burins; ten "mitten-shaped" single-faceted burins and three single-faceted scraper burins (Fig. 3, #15988, 15677, and 16593). We also recovered one scraper burin, double faceted at the base and single faceted at the presumed tip (Fig. 3, catalog #16292). One mitten shaped burin may be an end blade with a burin blow on the base to produce a hafting element (Fig. 4, catalog #15998), discussed further below. The lack of diversity in burin types at Matcharak Lake compared to Iyatayet may reflect a simplification of the tool kit for terrestrial hunting as maritime hunting strategies require more complex technology (Collard et al. 2005:3).

Seven of the burins from Matcharak Lake are made of black chert, four from gray chert, one from green chert and two from obsidian. There seems to be no preference between black and gray chert for the type of burin made. The black chert tends to exhibit polish towards the tip that is not present on the gray pieces, although it may just be harder to detect with gray chert. The obsidian burins are unusual in that they do not have multiple spalls removed, nor do they exhibit any evidence of use. Some may consider these to be gravers rather than burins.

I focused my attention on the chert "mitten-shaped" burins for the following analysis. A low-powered 10–50x microscope was used to observe all burin edges, the burin tip and the burin facet edge for evidence of use-wear. Additionally, I noted any residue present on the tools. I recorded the number of spalls that were removed for each burin and whether it was complete or fractured. All of the burins have use-wear on the distal tip or the burin stem. Four of the ten "mitten-shaped" burins have evidence of use in the form of tiny retouch or edge damage along the margin of the burin stem (Figs. 2, 10). The mitten-shaped burin is made on a linear flake that was subsequently unifacially flaked along the dorsal side. The ventral side is unmodified or only lightly flaked along the margins. Once the unflaked ventral side of the burin is used it creates unmistakable use-wear in the form of polish and striations (Fig. 9). For the dorsal side, use may have occurred, but it is difficult to differentiate between use-wear and intentional or remnant flake scars. Rejuvenation of the edge by a burin blow as a reductive or "creator" technique (Vaughan 1985) occurred at least eight times, as use-wear was recorded at this position on eight of the seventy burin spalls examined. This indicates occasional use and reuse of the burin stem edge as a scraping or whittling tool. Exactly what material the burin edge was used to work is unclear, but preserved organics indicate bone and antler were shaped into pointed barbs or awls, and preserved wood shavings indicate that wood working occurred. Qeqertasussuk, a frozen ASTt site in Greenland, contemporaneous with the Matcharak Lake occupation, shows Saqqaq people heavily relied on wood in their toolkits (Grønnow 1996). Denbigh people likely did, as well.

This leads to a related research question: Were the burins from Matcharak Lake hafted? Considering the relationship between the ASTt people of Greenland to those in Alaska it seems reasonable to presume Denbigh people also shared some of the hafting techniques of the Saqqaq discovered at Qeqertasussuk (Grønnow 1996). A "mitten-shaped" burin was found at Qeqertasussuk still in its wooden, single slotted haft, bound with baleen (Grønnow 1996:21). While no wooden or bone hafts were recovered at Matcharak Lake, I did examine the basal edges of the "mitten-shaped" burins for edge grinding and notching. Microscopic analysis shows three of the burins were edge ground. There also appears to be intentional flaking to create a small step or tiny ridge present on all "mitten-shaped" burins, which may function as the top of the hafted base, similar to examples noted at other early ASTt sites in eastern Canada (Sutherland 1996:276). Furthermore, under the low-powered microscope, I observed fibers that may be remnant sinew and red ochre staining on three burins. Red ochre was commonly used as hafting adhesive in stone tool technologies around the world (Wadley 2005), and its presence here lends credence to the hypothesis that the "mitten-shaped" burin was a hafted tool in Denbigh toolkits.

Considering the recognition of the burin blow as a means for creating hafting elements in Paleolithic southwest Asia (Barton et al. 1996), we must also consider this as a possibility for two burins from the Matcharak

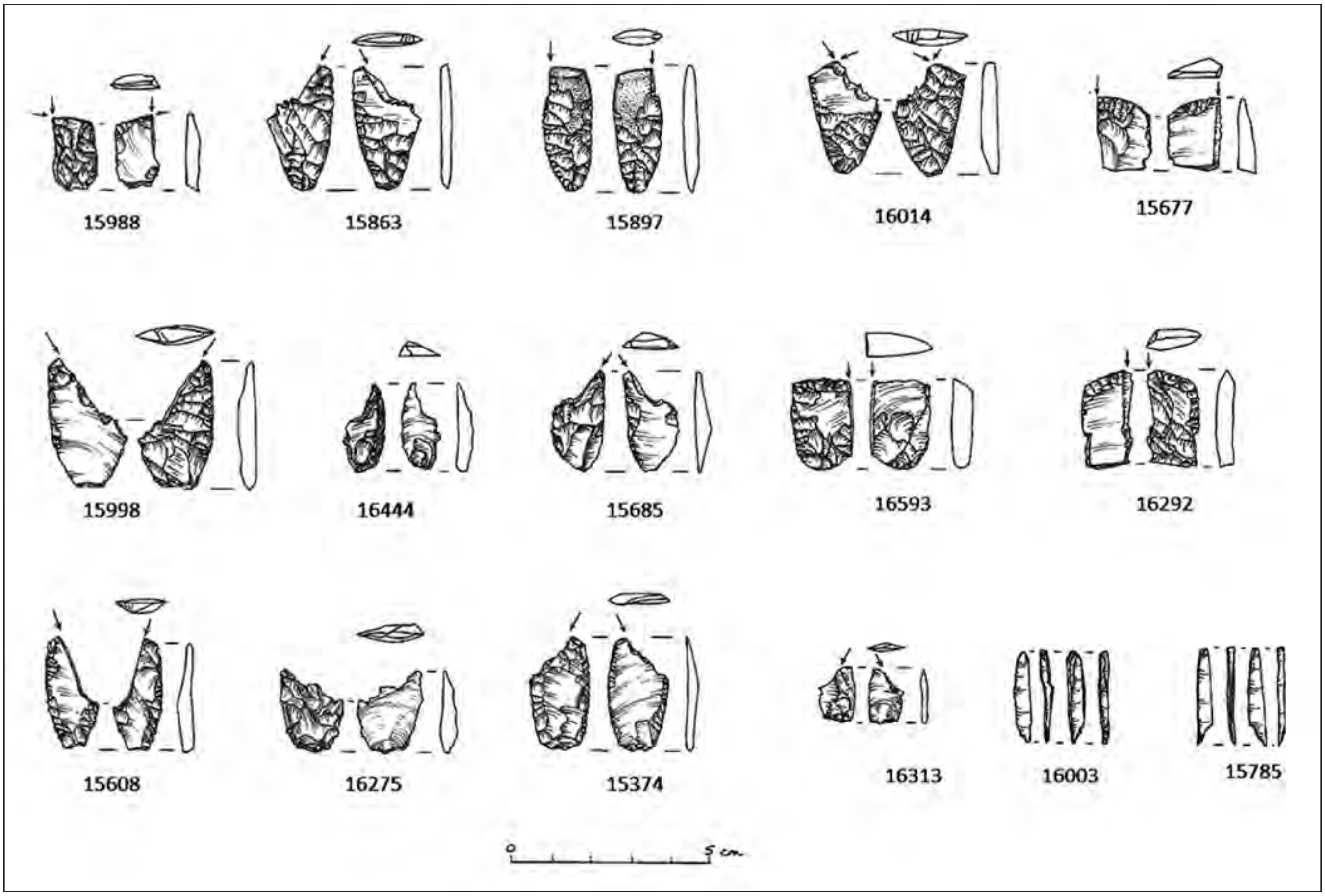

Figure 3. Illustrations of 14 burins and two representative burin spalls (lower right) collected from Matcharak Lake (AMR-186). Artifacts illustrated by Sarah Moore.

Figure 4. Burinated end blade or the start of a "mitten-shaped" burin.

assemblage (Fig. 3, catalog # GAAR 15897 and GAAR 16292). Burin 15897 could be viewed as a square based end blade or simply as a "mitten-shaped" burin with only one spall removed (Fig. 4). Grinding and polish along the margin implies that this is probably an early stage of burin production. Burins may have served as other tool types, such as flake tools, bifacial knives or end blades before burination occurred (Bandi 1963:24). Burin 16292 seems to have been burinated along the base to fit the tool to an existing haft or to repair damage.

In summary, the burins at Matcharak Lake are quite variable. They all have use-wear on the bit tip and 40% have wear along the stem margin suggesting scraping and whittling of organic material. The "mitten-shaped" burins were hafted tools that were resharpened with the spall removal technique numerous times. This tool type is generally argued to serve in the manufacturing of organic hunting implements (Sutherland 1996:278), a hypothesis supported here. The presence of burins at this camp suggests retooling and repair of organic tools occurred here.

While beyond the scope of this study, an intrasite spatial analysis is necessary to determine if burin presence or style varies with season or activity areas at Matcharak Lake.

BURIN SPALLS

A burin spall is a thin sliver of a flake produced from a burin blow (Fig. 5). Giddings (1964) describes the burin spall as an artifact similar to a microblade, except that it is square in cross-section, exhibiting four, nearly uniform sides (Fig. 3; catalog # 15785 and 16003). Some have argued that spalls are waste from rejuvenating a used edge on a burin (Vaughan 1985), while others argue that, in some cases, spalls are the desired product, burins serving as a core (Barton et al. 1996; Giddings 1956). Giddings (1956) established that the burin spalls produced by the Denbigh Flint Complex people were tools by identifying use-wear on the distal ends of the spalls. One should expect use-wear on the proximal end of a burin spall, as this is the bit of the burin, but not on the distal end, as this is still attached to the burin. Wear on the distal end of the spall can only occur after removal from the burin.

Burin spall use is a common attribute of Denbigh technology (Gidding 1964), but how and to what degree were they used at Matcharak Lake? What were they used on? Were they produced with specific attributes in mind, or are there a variety of spall sizes which can be used? To accomplish this analysis I created a spreadsheet in Statistical Package for the Social Sciences (SPSS) program to record and analyze a series of attributes relevant to the study. Recorded attributes include raw material type, completeness of the spall, length, width, thickness and weight. I used a low-powered microscope (10–50x) to identify evidence of use-wear and intentional retouch on the distal and ventral sides of the spall. I also recorded evidence of use-wear on the dorsal side of the spall as an indicator of use while still on the burin. I recorded any evidence of residues still present on the specimens and any possible evidence for the hafting of these tiny artifacts. Newcomer (1976) calls attention to the possibility of "spontaneous retouch" on the distal ends of the spalls. To differentiate between intentional use, retouch, and natural breakage, only spalls with multiple flake scars and polish on the tip were considered utilized. After confirming that some burin spalls were used, a series of statistical tests were employed to better understand selection of spalls for use.

The identification of use-wear on the distal end of the burin spall is not as straightforward as one might presume. Even under a microscope it can be difficult to distinguish between "spontaneous retouch" produced through removal of the flake (Newcomer 1976) and intentional retouch produced from use or resharpening of the tool. By looking at the jagged step fractures on the burin, it is apparent that some material is left behind, as the break is not clean (Giddings 1956:229) (see Fig. 2). On the distal end of the burin spall this "fracture" is often represented by a step, found on the dorsal side of the spall (Fig. 6a). This step creates a thin point which seems to be the preferred section of the spall to use, likely for engraving, as will be discussed below. To distinguish between natural and intentional breakage, I recorded whether or not the break was clean (Fig. 7a, b), if there were multiple flake scars

Figure 5. A representative sample of utilized burin spalls collected from AMR-186.

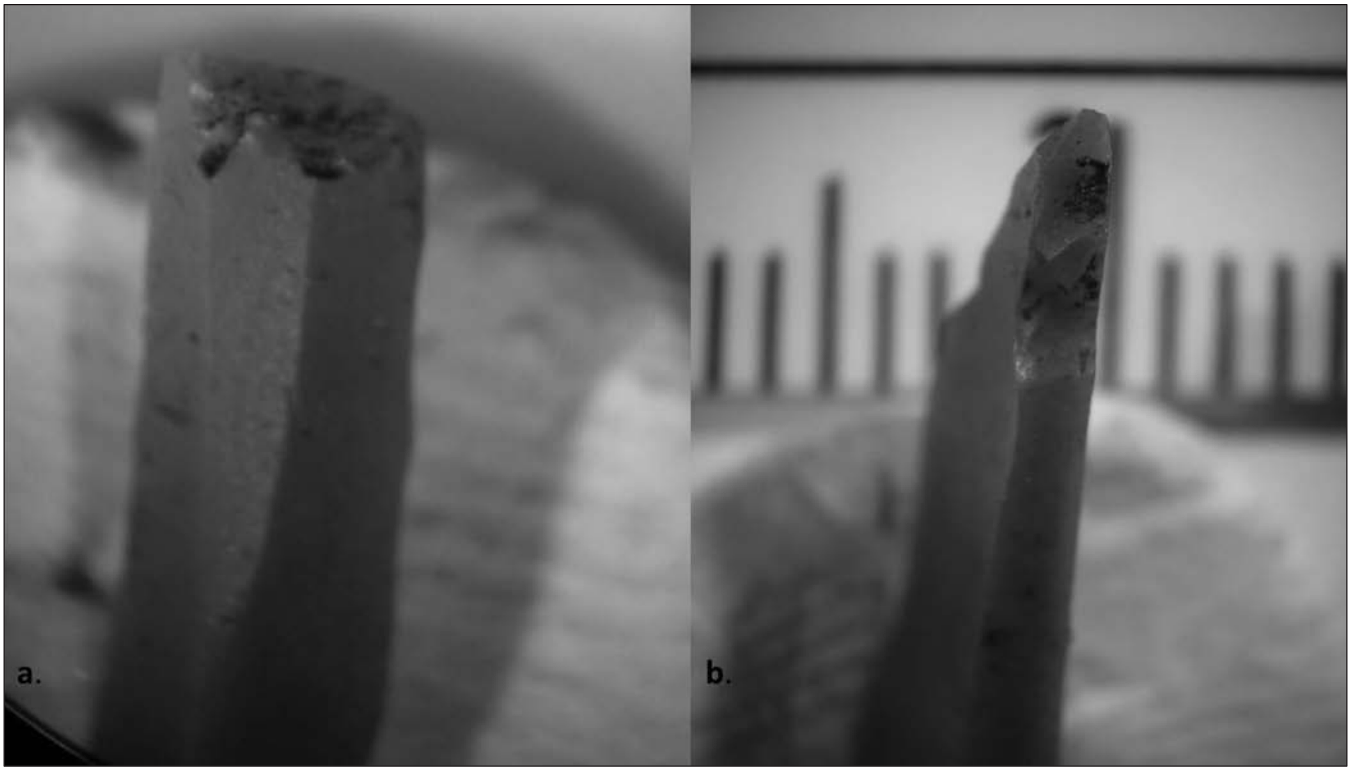

Figure 6. Two representative burin spalls exhibiting distal use-wear and retouch as seen under 10x magnification.

(Fig. 6a, b) and if there was damage to the dorsal and ventral sides. I recorded damage to the distal end of 77.1% (n = 54/70) of the spalls, but only 48.6% (n = 34/70) have definite use-wear. This means, by my estimation, 27.5% of the spalls have distal damage that should be attributed to spontaneous retouch.

Of the 70 recovered burin spalls from Matcharak Lake, 59 appeared unbroken. The average length of the 59 unbroken burin spalls is 15.5 mm, the average width is 3.52 mm, the average thickness 1.75 mm and the average weight is 0.13 grams. All of these values are statistically identical to the Iyatayet sample (Giddings 1964).

Giddings (1964) notes that 122 (55.7%) of the 219 spalls recovered from the Denbigh type-site, Iyatayet, exhibit use-wear on the distal end of the spall. Of the 70 burin spalls recovered from Matcharak Lake (AMR-186), 18 (25.7%) show definite retouch and 34 (48.6%) show evidence of use. An independent t-test of spalls with use-wear versus spalls with no use show there is a statistically significant difference between length and weight of spalls the Denbigh were selecting for use, although width and thickness are not significantly different (Table 1).

Eleven different raw materials were brought to Matcharak Lake and discarded as burin spalls (Table 2). Black and gray chert occur in the highest frequencies, making up 87.1% (n = 61/70) of the sample. This correlates well with the raw material represented by the burins themselves. Seven different raw materials represented by burin spalls indicate at least seven other burins passed through the site but were not recovered, meaning they are located in an unexcavated portion of the site or they were taken away as curated tools. Raw material type apparently played a minor role in how spalls were selected for use, as each raw material type has at least one representative spall with use-wear, except for the brown chert and obsidian, each represented by one spall. Attempted refits of spalls to the collected burins were unsuccessful, although two spalls did refit to each other.

To consider how the burin spall was used as a tool, I note that the dorsal side of the spall exhibits use 98.5% of the time. Use-wear is found on the ventral side only 10% of the time and generally this co-occurs with use-wear of the opposite side. When viewing the tip of the spall, distal end out, dorsal side up, the tip slants to the left 83.3% of the time for retouched burin spalls and 66% of the time for spalls exhibiting use-wear, a phenomenon noted by Giddings (1956:234), as well. This indicates the left corner of the distal end is preferentially used, by drawing the

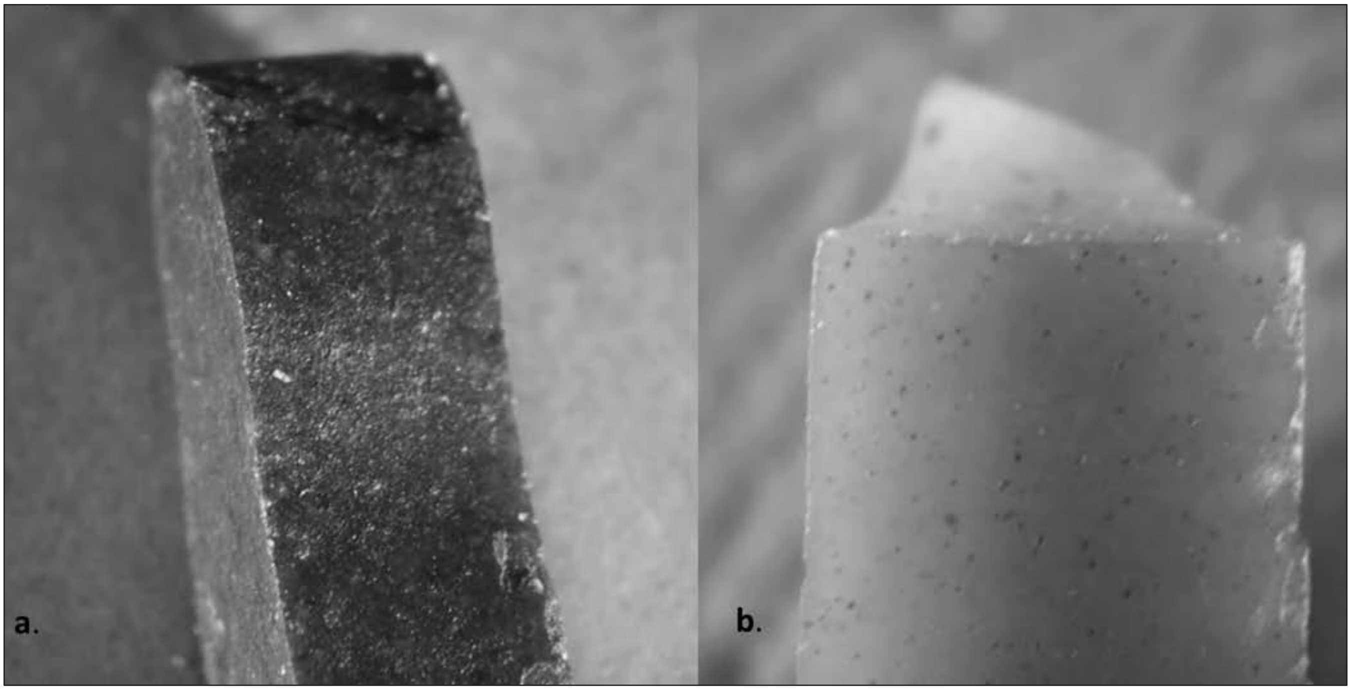

Figure 7. Two representative burin spalls exhibiting no retouch and natural breakage as seen under 10x magnification.

pointed corner towards the user. How the user held the tiny tool is uncertain, but there are implications for left- and right-handed spall users at Matcharak Lake (Giddings 1956:234).

Evidence for spall hafting is limited and ambiguous. Grønnow (1994:212) discovered a hafted microblade at Qeqertasussuk inset into a wood handle and lashed with baleen. Experimentation with a wooden haft left no identifiable wear patterns on my samples. Three of the 34 spalls that exhibit use-wear appear to have notches for hafting (see Fig. 5; fifth from left for an example). If the burin spall was hafted into a ball of mastic (Giddings 1964), I hypothesize one should see evidence of residue on the shaft of the spall. I recorded apparent residue on 27 of 70 spalls. Of these, 18 have retouch or use-wear present. However, of the 27 with residue, 9 lacked any evidence of use. If the residue is from hafting in mastic, all spalls exhibiting use-wear should have residue, so why do some exhibit residue with no evidence of use? Some spalls with use-wear may have been used expediently and were not hafted, or the residue might not have been preserved. Its presence on some spalls lacking use-wear might be because I have recovered only the proximal end of the spall. If the spall broke in half during use, the distal tip might be missing. Therefore, the presence of residue would indicate the spall was actually used. If the residue is a result of something in the soil adhering to it, it should be present on all of the artifacts. The fact that there is no residue on most spalls suggests that the residue is of cultural origin.

Not all of the burin spalls were used the same way. A small percentage (29.4%; n = 10/34) exhibit equal use

Table 1. Mean average length, width, thickness and weight for burin spalls exhibiting use-wear and no use-wear. An independent t-test ($p < 0.05$) with equal variances not assumed suggests there is a significant difference between the length and weight of the spalls chosen for use.

	Use-Wear	n	Mean	Std. Deviation	Std. Error Mean	Sig (2 tailed)
Length (mm)	Yes	34	15.872	5.053	0.867	p = 0.049
	No	36	13.577	4.494	0.749	
Width (mm)	Yes	34	3.595	0.667	0.114	p = 0.291
	No	36	3.415	0.747	0.125	
Thickness (mm)	Yes	34	1.705	0.440	0.075	p = 0.954
	No	36	1.711	0.437	0.073	
Weight (g)	Yes	34	0.142	0.079	0.014	p = 0.019
	No	36	0.102	0.058	0.010	

Table 2. Totals for burin spall raw material types divided by presence and absence of distal use-wear.

Raw Material	Use-Wear No	Use-Wear Yes	Total
Basalt	1	1	2
Black Chert	17	11	28
Brown Chert	1	0	1
Clear Gray Chert	0	2	2
Dark Gray Chert	4	4	8
Gray Chert	12	11	23
Gray/Red Chert	0	1	1
Green Chert	0	2	2
Orange Chert	0	1	1
Striped Gray Chert	0	1	1
Obsidian	1	0	1
Total	36	34	70

across the distal tip. These burin spalls were used like tiny end scrapers (Giddings 1956:234), perhaps for fine scraping of small pieces of hide, for delicately shaping wood, or for shaving down pieces of antler and bone. While beyond the scope of this study, a further line of evidence concerning burin spall use could come from residue analysis, as some used spalls appear to have microscopic traces of some unidentified resin on their tips.

In summary, burin spall use was a common occurrence at Matcharak Lake. Burin spalls are the most common tool recovered here and nearly half exhibit use-wear on the distal tip, similar to Giddings' (1956) findings at Iyatayet. Spalls may be used for intricate design work or for scoring antler to be cut and shaped into tools. Giddings (1956:232) showed the burin to be an effective engraving tool on bone, but no experiments with spalls have shown them to be capable of incising materials as hard as bone or antler. The following experiment tests the burin spalls strength and durability for engraving tasks and links this to groove and cut marks on organic remains from AMR-186.

EXPERIMENTAL DATA

It is clear from this analysis and from the evaluation of numerous Denbigh Flint Complex sites in Alaska that burin spall use was a common phenomenon (Giddings 1964). How these tiny tools were being used has been a source of speculation (Giddings 1956). Giddings (1956:235–236) suggests:

> If we are not too far afield in considering the burin spall tools to have been hafted engravers, another reasonable guess is that the Denbigh Flint people gave free rein to their artistic talents, quite possibly in the field of the elaborate art styles that prevailed in the western Eskimo area some 2,000 years ago. Thus far, however, we have no organic materials from the oldest layer at Cape Denbigh, and therefore no proof of engraving skill.

With no organic tools found associated with the Denbigh Flint Complex, interpretation of burin and burin spall function was based on analogy and speculation. However, Matcharak Lake (AMR-186) provides researchers with new organic evidence that allows us to test some of the assumptions and proposed uses made by Giddings and others (Fig. 8). Worked bone and antler provide the first clear evidence that the Denbigh people used mitten-shaped burins or burin spalls as engravers (Fig. 8). How effective of an engraving tool is the burin spall?

To quantify the durability of the burin spall, I produced a small sample of burin spalls from gray, green and black chert, collected from cobbles at Akmalik Creek in Alaska's Brooks Range. One spall of white chert from the Hartville Uplift in Wyoming was used for comparative purposes. In total, thirteen spalls of various sizes and thicknesses were produced. I recorded the length, width, thickness and weights of each experimental spall. I then used the spall by holding it between my thumb and forefinger while drawing it back and forth across bone and antler to create an incised line. To quantify spall performance, I marked off five centimeter sections of a sample of caribou antler and on a slightly weathered section of caribou rib. I created one groove by pulling the spall towards me with one hundred strokes. For each experimental groove, I measured the width and depth of the groove produced and the length and weight of the spall after use. I also recorded whether the spall snapped during use prior to completing the allotted one hundred strokes.

Results of an independent means t-test suggest that length, width and weight had little to do with whether the burin spall broke during use, but a statistically significant difference between thicknesses of the spalls was responsible for the fracture during use ($p = 0.002$ at the 0.05 level of significance) (Table 3). Each chert type performed equally well. Each raw material type had at least one fracture. The white Hartville Uplift chert did fracture, but the spall was long enough to continue using it for 100 strokes. Only three burin spalls became unusable after fracture, and thus did not complete the 100 strokes. The average width and depth of the 5 cm groove for the spalls that did not fracture was 1.3 mm wide and 0.60 mm deep, while the grooves for fractured spalls averaged 0.86 mm wide and 0.33 mm deep. The measured width and depth of the three grooves from artistically decorated bone from Matcharak Lake (see Fig. 9) are: groove (1) 1.13 x 0.50 mm; groove 2) 0.97 x 0.71 mm; and groove 3) 0.65 x 0.54 mm. Another independent t-test shows that at the 0.05 level, there is no statistically significant difference between the sizes of my experimental grooves and the sizes of the decorated bone tool's grooves ($p = 0.888$ and $p = 0.231$).

For the burin spalls that did not break an average loss of 0.730 mm and 0.005 grams of material was recorded for production of a 50 mm long groove. This means that to produce a 500 mm long groove in bone or antler, approximately 7.3 mm of the spall would be lost. The grooves on the archaeological faunal piece are about 750 mm long. This suggests that (not taking into account sharpening) the grooves on the bone tool recovered from Matcharak Lake could have been produced by as few as two good sized burin spalls of high-quality raw material.

Other factors come into play that are more difficult to account for. For example, how does the hafting of a burin spall affect its performance? My makeshift expedient wood haft certainly made the spall easier to handle. Even after a half hour of use the spall was still able to remove small amounts of bone from the grooves, but the tip did get dull and polished. With increased use it eventually created a sharp edge on the other side, so that if I rotated the spall I was able to get a good bite again. Variable raw material and inherent flaws in the chert are factors in the spall's durability as an engraving tool. Dulling of the edge and the degree of retouch to sharpen the bit would all factor in the use-life of the burin spall, as would how hard the user presses down when using the tool. Perhaps less force but more strokes could increase the use life, but without a machine to measure force, this will remain somewhat subjective. The relative freshness of the bone or antler could also play a factor in burin spall use life. Both the bone and antler used in this study were recovered from animals that had been dead for at least one year. Soaking the antler in water would make it more pliable and easier to score, increasing the use life of the tool.

CONCLUSION

Analysis of the burin technology from Matcharak Lake shows that burin use went beyond the graver and core for spalls, as it appears the Denbigh treated their burins as multifunctional tools analogous to pocket knives (Tomaskova 2005). The burin technology of the Denbigh Flint Complex occupation at Matcharak Lake is stylistically identical to portions of assemblages at other Denbigh sites in Alaska; a few burin types recognized from Iyatayet were not recovered from Matcharak Lake. This may be due to the sample size or because of a shift to a simplified toolkit in the interior. The proposed function of burins as incising tools for insetting microblades is not conclusively supported by this analysis, because no organic points with inset stone were recovered. It seems likely that burins create a groove that is too thick for a microblade to fit snugly into but additional work needs to be done to confirm this. However, decorated bone, a groove on antler waste and one tiny incision on a bone point have established that engraving indeed was performed on organic tools made by the Denbigh, and burins and burin spalls were used to do this. It is clear from use-wear damage on the tip of the "mitten-shaped" burins that they were used as engravers. Occasionally, the faceted burin edge on the

Figure 8. Engraved decorated bone artifact recovered from Matcharak Lake (AMR-186)

Table 3. Mean length, width, thickness and weight of the experimental burin spalls grouped by whether or not they fractured upon use. An independent t-test ($p < 0.05$) suggests thickness is the only significant difference between those spalls that fractured and those that did not.

	Fracture	n	Mean	Std. Deviation	Std. Error Mean	Sig (2 tailed)
Length (mm)	Yes	6	20.392	6.209	2.535	
	No	7	17.544	2.883	1.090	p = 0.337
Width (mm)	Yes	6	4.005	1.022	0.417	
	No	7	4.657	0.993	0.375	p = 0.271
Thickness (mm)	Yes	6	1.892	0.521	0.213	
	No	7	3.073	0.550	0.208	p = 0.002
Weight (g)	Yes	6	0.208	0.168	0.068	
	No	7	0.287	0.100	0.038	p = 0.343

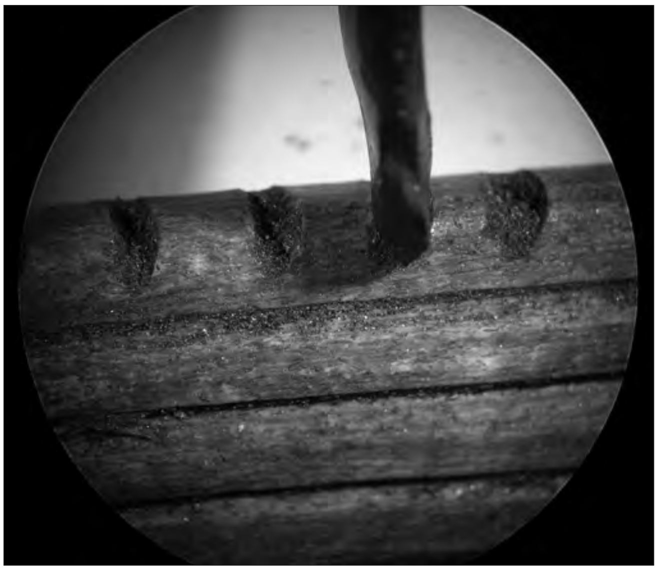

Figure 9. A magnified image of the engraved bone tool showing a correlation between notching widths and burin tip width.

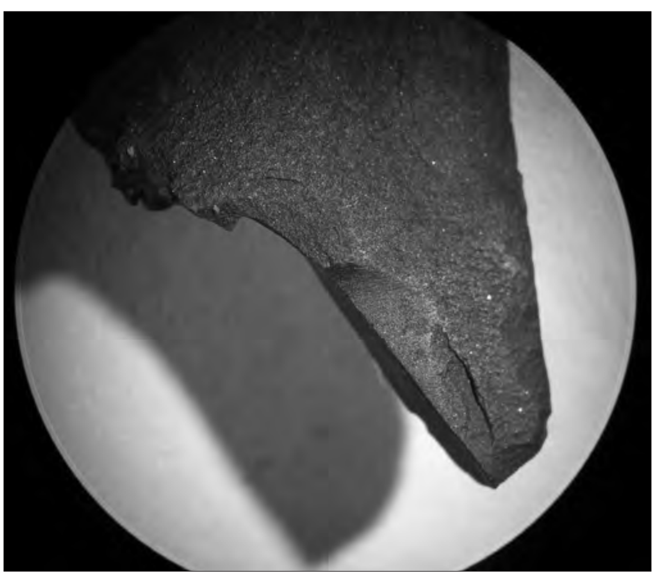

Figure 10. Evidence of use-wear on the stem of the burin indicating use as a scraper; stained with red ochre.

stem was used as a scraper or whittling tool for working some fairly hard material. This burin edge was also rejuvenated by removing a spall that contained the dulled edge. Evidence for the burin being a hafted tool is recognized by edge grinding, slight notching and red ochre, which likely served as an adhesive. There is some evidence the burin blow technique was performed on end blades and scrapers for shaping a haft element. Burins also served as cores for producing spalls, which in turn were used as engraving tools. These four functions of the burin and burin blow technique are also recognized in Old World assemblages (Barton et al. 1996).

Burin spalls were a desired product which the Denbigh used as tiny engravers and scrapers. Use-wear on the distal ends indicates the larger spalls were often used, most likely in an expedient fashion. There is some microscopic residual evidence on the burin spall shafts that supports the hypothesis that spalls were hafted in a ball of mastic. ASTt people in the eastern Arctic had hafting techniques for microblades (Grønnow 1994:212). We should predict the same for ASTt groups in Alaska. My experimental results indicate burin spalls, if thick enough, are durable engraving tools capable of replicating the engraved artwork represented by the decorated bone from Matcharak Lake.

The people of the Arctic Small Tool tradition were obviously very conservative with their raw material. I am aware of no high-quality raw material sources near Matcharak Lake that could have provided their tool stone. No cores were recovered and most of the debitage is so small it was likely the result of pressure flaking. Future studies should compare burin spall use from sites with a local tool stone source versus ones farther afield. Furthermore, comparisons between different site types and from earlier or later occupations may show changes in the frequency of use for these tools.

AFTERWORD

Continued excavation at AMR-186 in 2009 led to the recovery of one additional "mitten-shaped" burin and four burin spalls which were not used in this study.

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THE RUSSIAN-AMERICAN PERIMORTEM TAPHONOMY PROJECT IN SIBERIA: A TRIBUTE TO NICOLAI DMITRIEVICH OVODOV, PIONEERING SIBERIAN VERTEBRATE PALEONTOLOGIST AND CAVE ARCHAEOLOGIST

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ABSTRACT

This account describes ten years of data collecting, travel, personal experiences, analyses, and report writing (a list follows the text) on the subject of "perimortem" (at or around the time of death) bone damage in Ice Age Siberia. In the telling, emphasis is given to Nicolai D. Ovodov's role in this long-term project, and his earlier contributions to Siberian cave and open-site archaeology. This is more a personal story than a scientific report. Observations made on the bone assemblage from 30,000-year-old Varvarina Gora, an open-air site east of Lake Baikal that Ovodov helped excavate in the 1970s, illustrate our research.

KEYWORDS: taphonomy, Late Pleistocene Siberia, cave hyenas

INTRODUCTION

Former Alaska Governor Sarah Palin has reportedly said that Russia is just outside her back door in Wasilla. I don't know which way that door actually faces, but she has a point. Russia is close to Alaska geographically, historically, prehistorically and in other ways. Alaska scholars should know as much about Russia as my Southwest U.S. colleagues have to know about Mexico.

The scholar I will talk about here is almost totally unknown outside Russia. His name is Nicolai D. Ovodov. Let me set the stage for this story. Experimental replication is generally not possible in archaeology, but statistical procedures and analogy can be used for scientific inference, and they often approximate experimentation. This methodological restriction should prompt more contextual information, which patently means some accounting about the analyst(s) involved. That is what I will try to do here. After all, knowing the backgrounds of scientists is often useful in evaluating the conclusions they reach from their studies. Credibility is linked with reputation.

The reason for our taphonomy study is simple. We wanted to see first-hand the damage to bone caused by human butchering compared with chewing by nonhuman animals, particularly that of large carnivores, especially cave hyenas, *Crocuta spelaea* (Fig. 1). Remains of these creatures show that they roamed in Siberia as far as 55° N, almost the same latitude as Ketchikan. This research was a natural next step in my interests in cannibalism (Turner and Turner 1999), the peopling of the New World, and the idea that something more than cold was involved in the very late human crossing of Beringia, especially in light of the fact that most of the Old World, and even Australia, was colonized by anatomically modern humans at least 40,000 years ago. Our study explores the possibility that packs of perhaps one hundred huge night-hunting hyenas might have served as a barrier to Beringia due to their predation on humans or human food resources in a patchy environment (Fig. 2). Such predation may have inhibited human population growth in small groups, and

Figure 1. Hyena mandible fragments from Okladnikov Cave, shown against background of a data sheet. Hyenas were cannibalistic. The pencil points to a tooth notch. Lower piece is 10.5 cm long (CGT neg. 8-3-00: color 6).[1]

natural expansion into a rich but environmentally harsh and challenging Siberian Ice Age (i.e., quote by Hans Kruuk to follow).

A different "animal barrier" model was proposed by Valerius Geist (1989). He suggested that very large Alaskan predators, such as the giant short-faced bear, kept Siberians out of Alaska until the carnivores went extinct. Carnivore extinction is an important component to both models, as are the large predators themselves. Both models imply that cold alone was not responsible for the late colonization of the New World compared with the much earlier occupation of the Old World. The hyena model is more parsimonious because Ice Age Siberian archaeological sites often contain hyena remains, which shows that humans and hyenas dwelled in the same territory, whereas there is no such record that I know of for Late Pleistocene Alaska. Recently, Geist and his Russian co-authors, L. Baskin, I. Okhlopkov, and I. Spilenok, reviewed possible antipredator mechanisms (Geist et al. n.d.). Our project has not given much consideration to this matter except for our thoughts on the importance of dogs for a variety of purposes: sentinels, defense, transportation, hunting, and even serving as food in crisis situations. However, we may have only one Late Pleistocene dog, should future morphological reanalysis and DNA study show that the remains found many years ago in Afontova Gora II are those of a small wolf, not a dog (Astaknov 1999).

It took the skills of three very differently trained individuals to carry out this project. First, a vertebrate paleontologist and pioneering cave archaeologist, who incidentally speaks only Russian. This researcher is Nicolai D. Ovodov. I think of Nicolai as being a "bioarchaeologist"

1. ID notation applies to photographs in this article. CGT neg. 8-3-00: color 6 refers to Christy G. Turner negative, August 3, 2000: frame # color 6.

Figure 2. Photo set-up to illustrate size and power of hyena jaws. Top piece is a rhinoceros humerus, cracked open by a hyena. Middle is a late prehistoric humerus from a human female from a Neolithic Altai foothills cemetary. Bottom is a young hyena mandible fragment, 10.0 cm in length. The potential hazard to humans by hyenas is easy to envision here. The rhinoceros piece came from Proskuryakova Cave, squares 15–16, 0–30 cm deep. The hyena mandible is from excavations at Razboinich'ya Cave in 1989, small trench 8. Both caves are in the Altai Mountains of Siberia (CGT neg. 8-11-99: color 2).

in the usage of the term by my colleagues at Arizona State University (Turner 2007). There, on the one hand, it refers to archaeology and faunal correlates, as exemplified by the work of Katherine Spielmann. This approach fits Nicolai's research. On the other hand, bioarchaeology refers to concerns about human skeletal remains and archaeology, a combination that I have dealt with long before the term was coined. This orientation is best exemplified in Alaska by the work of the late William S. Laughlin. Secondly, we needed a Russian-English translator familiar with scientific terms who was also field savvy. This person is Olga V. Pavlova. Lastly, we needed someone experienced in perimortem bone damage, i.e., me.

I first met in person the other team members of this project, Nicolai and Olga, in Siberia, January, 1984, although I had unknowingly photographed Olga as she was simutaneously translating for Robert Ackerman (English to Russian) and Ruslan Vasilevsky (Russian to English) at an international Pacific Science Conference held in Khabarovsk in late summer, 1979. Five years later, accompanied by my youngest and anthropologically trained daughter, Korri Dee, we had traveled to Novosibirsk to examine prehistoric human dental remains in the collections of the Institute of Archaeology and Ethnography (formerly, IHPP), Academgorodok, Novosibirsk. These dental studies, permitted by the institute director, academician Anatoly P. Derevianko, were part of my long-term study on the ancestral origins of Native Americans and peoples of Oceania (Turner 1992, 1998). Our first meeting occurred in Nicolai's top floor osteology lab, which was located down the unheated dark hallway from the cold lab space we had been provided for our dental examinations. Nicolai was a very interesting person. Born in 1939, he never talked about his youth. Still, he was friendly, hospitable, gentle, with greying hair and a rather typical Slavonic appearance: blue eyes, weather-beaten masculine face. Nicolai was no stranger to cheap cardboard-tubed Russian cigarettes and all grades of vodka. He was very knowledgeable about mammalian osteology and Pleistocene fauna; piles of excavated bones reached to the ceiling of his cluttered little dusty lab. In the lab, near the ceiling on the highest shelf, sat a shiny silver samovar and a time-stained rhinoceros skull—symbols of where part of my future lay. Despite the clutter, most of the faunal remains collected during forty years of archaeological and paleontological research were kept in a multitude of boxes shelved in a large unheated attic storeroom (Fig. 3). A weathered handmade wooden bird feeder was outside one window of his lab, on which Nicolai placed bits of old bread, slices of tiny withered apples, and fatty sausage for small winter birds. As I was to learn in the future, Nicolai cared deeply for animals large and small (Fig. 4). He cared also for people. After we began our joint research project in 1998 and were working in his lab, all sorts of people would pop in to see him. All this daily traffic suggested that he was one of the most popular members of the institute, possibly even more than the charming women translators and editors in room 318. As Nicolai and I were both interested in old bones and teeth, we immediately struck up a friendship that has lasted to the present day.

Figure 3. Nicolai Ovodov and Olga Pavlova in the IAE attic osteology storeroom. Hundreds of boxes filled with bone fragments and teeth are kept in this room (cgt neg. 7-30-99:15 A).

Olga Pavlova is a petite woman, on occasion somewhat remote. Her knowledge of Russian and English literature is staggering. Her accent is pure magic. She has a Russian saying for all sorts of occasions, which always starts out as: "Vee Russians have a sayying. . . ." Olga had been assigned to help Korri and me with written and verbal translations, and she was also a wonderful hostess, bringing us snacks for lunch, inviting Korri and I for dinner at her home, and other kindnesses. Friendship with Olga eventually led to our 2004 marriage in Novosibirsk, eight years after my first wife, Jacqueline, died of cancer. Our wedding dinner party at "Zhili-Byli" ("once upon a time") was honored with Alexander Konopatski, also bilingual, serving as master of ceremonies. Two of the room 318 editor-translators, Elena Pankeyeva and Olga Volkova, helped Olga select a beautiful evening dress. These comments all mean, of course, that our team was greater than the sum of its parts. Ours was not a 9 to 5 operation.

At that first meeting in 1984, Nicolai had laid out on a table the skull bases of several Late Pleistocene saiga antelopes whose gnawed occiputs and horn cores were all that remained. The uniformity of the damage was striking, so much in fact that it undermined my belief that patterned damage to bones was evidence of human manipulation. Nicolai explained that the damage was most likely done by young wolves. Nicolai's work and his faunal collections would eventually shatter many of my beliefs about human prehistory, including my concern that some Siberian archaeology was questionable because workers had not taken into account the stratigraphic disturbances, behavior, and presence of large carnivores that we soon recognized on the basis of our perimortem taphonomic research. For example, we determined that Okladnikov Cave in the Altai Mountains was used as much by hyenas as by Late Pleistocene humans. Human occupation of the cave had to have been discontinuous. More stark was the archaeological find by Alexander Postnov in Ust-Kan Cave that Upper Paleolithic blade tools were deeper in the statigraphic profile than the Mousterian-like artifacts. We proposed a simple bioturbation explanation rather than less parsimonious cultural scenarios (Turner, Ovodov, and Pavlova 2001). Hyena presence was abundant in Ust-Kan (Fig. 5). The reversed statigraphy had to have been the result of hyena disturbances. Discontinuity of occupation is a safe inference. Living with hyenas at Ust-Kan or anywhere else would have been dangerous. Consider accounts of humans and hyenas today in Africa. Hans Kruuk (2002:64) writes:

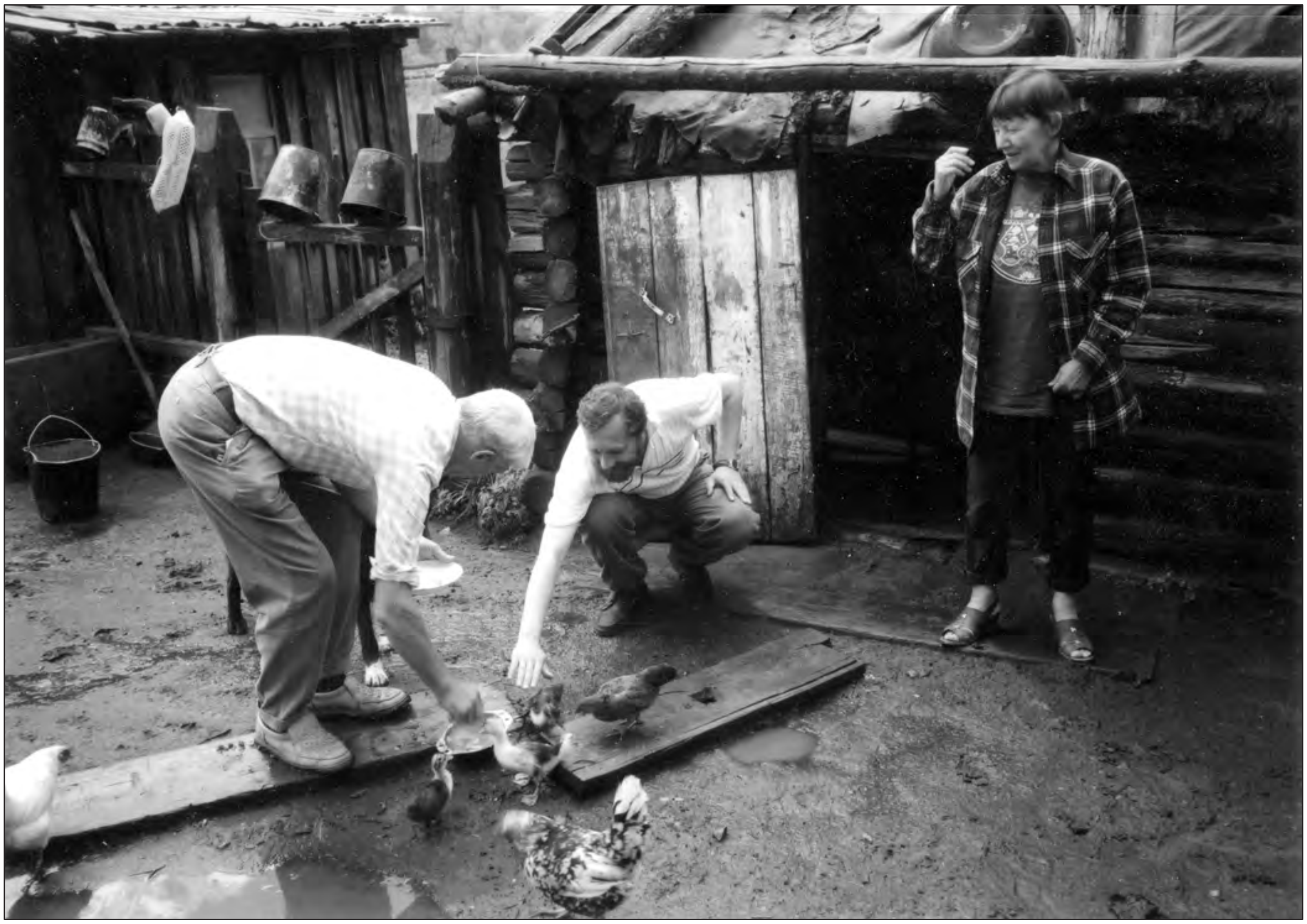

Figure 4. L to R, Nicolai Ovodov (IAE archaeologist), Sergei Markin, and Olga Pavlova at the pre-Russian style of residence belonging to Karakol villager Galina Urosova. The men are giving young chickens and the mother hen bread crumbs following a torrential afternoon rain storm in the Altai Mountains. The doorway behind Olga leads into a large circular cribbed-roof hogan-like log structure (cgt neg. 7-10-99:19).

> The spotted hyena is, despite its [scavenger] reputation, a large, wolf-like predator, often hunting the African plains and even the forests in packs . . . they have a considerable crime record . . . hyenas are also killers of people. . . . In Malawi . . . they killed and ate 27 people over 5 years. Many . . . of the victims were children.

In addition, the Okladnikov Cave people were more likely to have been Neandertals than anatomically modern humans. This inference was first proposed on the basis of my examination of the few ancient teeth found in Okladnidov and Denisova caves (Turner 1990). This inference would be confirmed seventeen years later by DNA analysis of human bone fragments from these caves (Krause et al. 2007). Elsewhere (Turner 2008), I have commented on the issue of Neandertals and possibly even earlier hominids in Siberia.

We would eventually determine that most excavated Siberian Pleistocene archaeological cave and open-air sites we studied were also used or scavenged by cave hyenas (statistical inference).

These seemingly pristine sites unquestionably had their statigraphic levels disturbed or blurred, leading to inferences that there had been cultural continuity from Middle to Upper Paleolithic traditions rather than external cultural replacement. This finding of human and hyena site use leads to fascinating questions about how humans and hyenas got along together. Not well, Ovodov (1987) imagines. I agree. The miniscule amount of human skeletal remains in Late Pleistocene Siberia demands explanation. I suspect that much of the explanation, whenever it is proposed, will involve hyena behavior as much as mortuary practices. There are grounds for this speculation. For example, Alan Mann (pers. comm., September

Figure 5. Faunal remains from Ust-Kan Cave, Altai Mountains. Top two pieces have breakage but no other damage. All other pieces have been digested to some degree, including the hyena tooth (middle left). The tooth also has tooth dints, indicating that it had been chewed as well as swallowed and partly digested. The large cranial fragment (lower right) is also partly digested. The cave in which these pieces were found by Alexander Postnov and his field crew is located in a limestone butte high above the surrounding sagebrush-covered valley floor. Scale in cm (cgt neg. 9-20-00:33).

13, 2007) found in his excavations at Les Pradelles, a Middle Paleolithic Mousterian site in the Charente, France, a number of Neandertal teeth "that were clearly eaten by hyenas and then regurgitated." Les Pradelles also produced numerous hyena bones, teeth, and their distinctive round, white scats.

In 1987 I returned to Novosibirsk, this time with my late wife, Jacqueline, to continue the human dental examinations. With the recommendation and support of Anatoly Derevianko, Jacqueline and I were offered the opportunity to visit the ongoing Institute of Archaeology and Ethnography (IAE) excavations in the Late Pleistocene Altai cave sites. A permanent field camp had been established near one site, Denisova Cave, and Nicolai was there studying newly excavated faunal remains on our arrival in early June 1987. Olga Pavlova accompanied us to be our translator and hostess. Through her excellent language skills, we learned a great deal about past and ongoing excavations and scientific research in this region from IAE archaeologists Sergei Markin, Vyacheslav Molodin, Yuri Grichan, and others. Also, we learned that it was Nicolai, with his scientific interest in caves, who had explored and first tested the now famous Denisova and Kaminnaya archaeological cave sites (Okladnikov and Ovodov 1972).

Nicolai's excavations in another Altai cave, locally called Razboinich'ya (Deserter's Cave), turned up no evidence that humans had ever occupied the cave, although Ovodov found evidence suggestive of a ritual involving a dog's head had been performed deep in the cave at least 14,000 years ago, and possibly 30,000 BP (Ovodov and Kuzmin 2006). Nicolai's identification of this complete skull as being that of a dog means it is among the oldest, if not the oldest, dogs known in Siberia, and perhaps in the entire world.

The huge faunal assemblage from Razboinich'ya would be the foundation for our project's identification of a carnivore perimortem bone damage signature. I was aware of numerous studies that had identified carnivore bone damage, including that of hyenas in Africa and Israel. But, remember, we wanted to see this damage first hand, and for statistical reasons, lots of it. Moreover, the Razboinich'ya and other cave hyena assemblages provide a solid basis for inferences about hyena life, including their cannibalistic behavior (Ovodov and Martynovich 2005).

Nicolai's cave discoveries of Altai Pleistocene fauna and associated stone artifacts ignited a major program by the IAE archaeologists and other specialists, who have published scores of articles and books following his Altai discoveries. Few of these acknowledge Nicolai's pioneering work, and none has recognized the vastly important comparative value of the Razboinich'ya Cave faunal assemblage that accumulated with remarkable preservation for at least 40,000 years because the limestone cave was alkaline, dry, cold, dark, geologically stable, and remote.

During that 1987 field trip, Nicolai urged us to visit Razboinich'ya in the forested mountains above Kaminnaya Cave and 3 km away. Several seasons of excavations by Nicolai and his associates, including avian paleontologist Nicolai Martynovich, showed that the major large inhabitants were cave hyenas (Ovodov and Martynovich 2005). This interpretation was based on the many hyena bones and the hundreds of distinctive round white coprolites, many containing incompletely digested bone and tooth fragments. Although we tried, the weather turned too bad to reach Razboinich'ya Cave. Despite this disappointment, it was immediately apparent that here was an excellent opportunity to differentiate bone damage caused by carnivores and humans in archaeological cave deposits and to help recognize bones that might have been introduced into archaeological sites by hyena occupants. We began to doubt the general assumption that all bone found in an ancient archaeological site was the result of human foraging.

Given the mixed human and hyena use of the Siberian archaeological sites we had studied, I wondered about the sourcing of site contents at an international field conference held at Nicolai Drozdov's Kurtak camp on the Yenisei River reservoir. One thought that might help to infer what Late Pleistocene Siberian humans were actually hunting or scavenging would be to count as "human-procured" only those bones that had all or most of the human damage signature. Derevianko, who briefly attended the conference, was unimpressed with this suggestion as our team was sorting the thousands of small bird and rodent bones and teeth recovered from screening sediments from our premeeting excavation far to the south at Dvuglazka Cave. I thought that distinguishing carnivore versus human perimortem damage to bone would allow a better assessment of how much the archaeological caves had been used by carnivores. Knowing this would allow us to estimate continuity of human occupation. Discontinuity would, it seems to me, allow for the unimpeded entry of Upper Paleolithic modern humans from Europe and East Asia, as cultural remains and human teeth suggest actually happened. For example, blade tools, busty and full-hipped female figurines, and European-like teeth from the site called Mal'ta suggests to me a Cro-Magnon presence near Lake Baikal at least 22,000 years ago. In a cave near the Sea of Japan, called Geographic Society Cave, excavated by Ovodov, chopping and flake tools like those found in China were unearthed (Fig. 6) (Okladnikov and Kirillov 1980; Okladnikov, Vereschagin and Ovodov 1968; Ovodov 1977). He also found hyena remains, which means that cave hyenas once hunted and scavenged across Eurasia, from the Atlantic to the Pacific oceans in Late Pleistocene times. Their numbers must have varied from region to region depending on food resources and other factors, including competition from humans. Yes, there were packs of other social predators (wolves) throughout the same territory, but humans domesticated wolves, not hyenas. A daytime attack by a huge but solitary cave bear or cave lion might have been repulsed, but it is hard to imagine how a small group of Paleolithic Siberians could have saved themselves against a many-jawed stalking pack of fifty to one hundred nocturnal predators.

The rarity of hyena images in the remarkably realistic European Upper Paleolithic rock and mobile art (Guthrie 2005), when compared with numerous images of other carnivores such as bears and lions, was not due to their scarcity, because hyena remains are common in European cave sites. Instead, perhaps like in parts of Africa today, hyenas were viewed as evil spirits. Kruuk (2002:187) wrote:

> The animal involved in witchcraft more than any other is the spotted hyena, a species which generally is utterly loathed throughout the [African] continent.... This loathing goes beyond feelings based on mere ecological competition.... Aren't the animal's weird laughing noises and its slinking nocturnal movements around one's house (often followed by some disaster to the occupants) almost proof that in some devilish way it is under control of supernatural powers?

Despite this loathing, a few hyena images appear in African cave art (Kruuk 2002:196).

These lines of reasoning and inference became the basis of our long-term perimortem taphonomy project, though it shifted slightly from a technical emphasis on bone damage and cannibalism to curiosity about the relationship between hyenas and human migration to the New World (e.g., Turner, Ovodov and Pavlova 2005). We never gave up on the cannibalism focus, because we had a few bits of human bone with damage that suggested cannibalism might have occurred. I have to say "might" because carnivore damage in most of our human remains is so prevalent. One site where human cannibalism might have occurred is a cave that Nicolai helped excavate, and which he named Yelenev Cave. It is located in a high limestone cliff overlooking the Yenisei River a few km upriver from Krasnoyarsk. Five Mesolithic-Neolithic (10,500–8,500 BP) individuals could be identified with certainty based on sixty-five pieces of bone and teeth. Bone damage included perimortem breakage, cut marks, burning, anvil abrasions, end-polishing, and many missing vertebrae—the six key features of cannibalism based on prehistoric Mexican and Southwest U.S. assemblages. The Yelenev Cave human assemblage is the best case of possible cannibalism in prehistoric Siberia (Turner, Ovodov and Pavlova 2003). The dental morphpology of these individuals suggests a mix of Asian and European characteristics. While other cases of possible cannibalism exist, provenience information is inadequate, making it impossible to determine whether cannibalism occurred in Late Pleistocene Siberia.

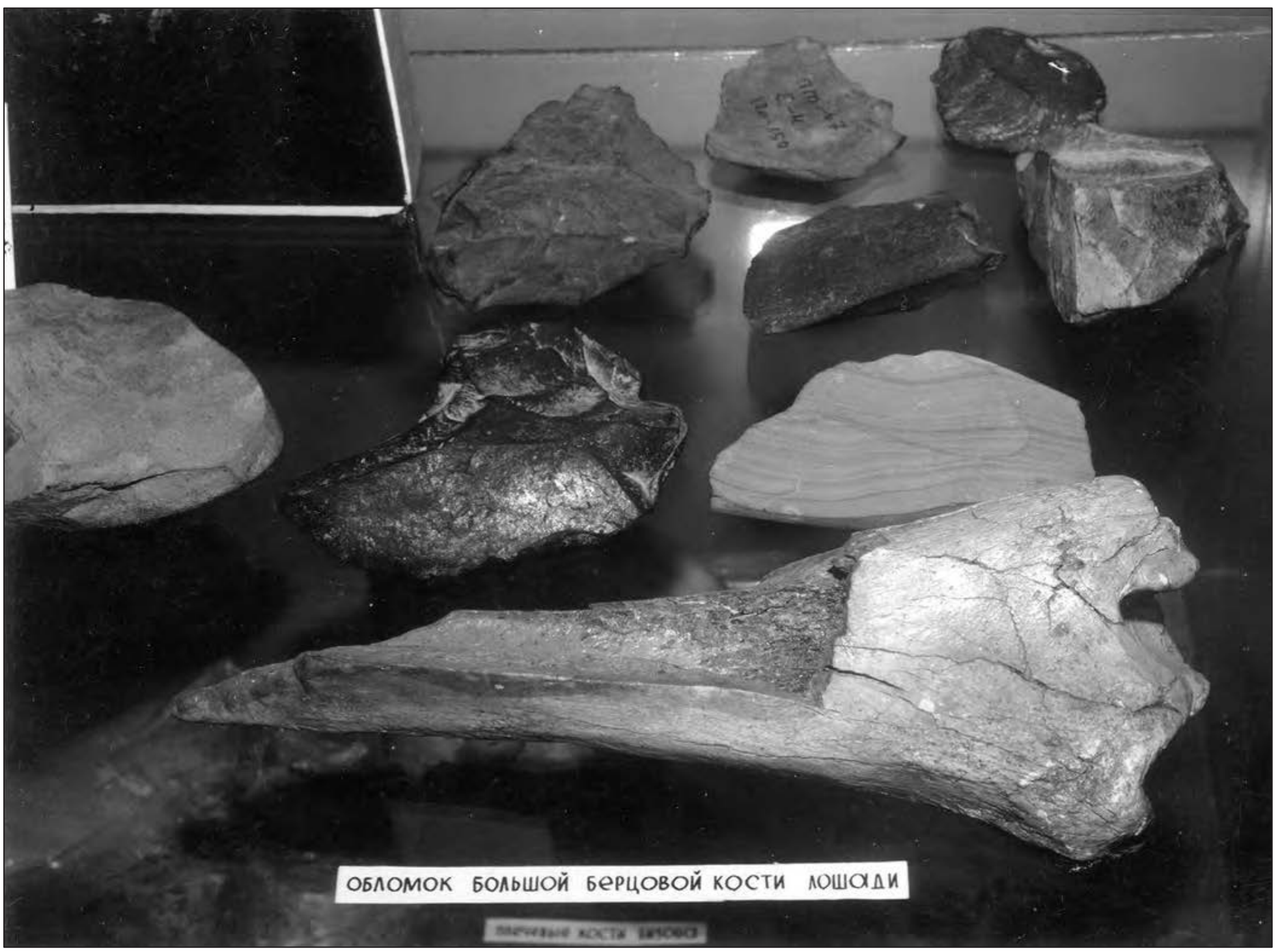

Figure 6. Examples of Geographic Society Cave bone and stone artifacts excavated by Nicolai Ovodov, 1966–67. Horse tibia has polishing at pointed end. Locked cabinet in old IAE museum, hence no scale. Cave hyena remains were also found here. The cave is near Nakhodka, a port on the Sea of Japan (cgt neg. 6-8-87:29).

Since 1998 Nicolai, Olga, and I have made taphonomic damage observations on thirty bone assemblages collected in open and cave archaeological and paleontological settings (e.g., Turner, Ovodov, and Pavlova n.d.). We sorted through at least one million pieces of bone and did a detailed study on more than 9,000 pieces (each taking 20 minutes or more to record) until our final year of data collecting in 2006 when, at the invitation and with much help from archaeologist Nicolai Drozdov and his associate, Eugene Artemiev, we examined newly excavated faunal remains from Afontova Gora, a famous site complex located on the left bank of the Yenisei River (Astakhov 1999) near the center of Krasnoyarsk.

Throughout the project Nicolai did most of the faunal identifications. Olga did all the translating and made the travel and lodging arrangements. (She once insisted in a huge eight-story run-down student dorm we were staying in that my mattress was no good and demanded a better one from the manager. I got the mattress, and we even were given two little bars of soap and a nearly empty roll of toilet paper). I made the taphonomic observations, often double-checking with Nicolai to see if he agreed with me on one point or another, and I did the macro-photography. Our selection criteria were (1) a bone piece had to be at least 2.5 cm in maximum diameter, and (2) it had to exhibit minimal root damage. We generally did not study loose teeth. We came to realize that whole bones rarely had any perimortem damage, so we only sampled these in each assemblage. This selectivity means that our measurement data are biased towards smaller mean size, although not significantly since we excluded from study the very small pieces of bone. Our examinations were carried out in museum and field settings and, wherever possible, with standardized lighting. For the former we studied collections in archaeological and paleontological institutions in Moscow, Novosibirsk, Tomsk, Krasnoyarsk, Irkutsk, Vladivostok, and Kiev. We visited several sites in the Altai Mountains and along the Yenisei River and in its vast catchment basin. We visited work in progress on the southern forested shore of Lake Baikal, and to the east near the dry steppic Ulan-Ude. Our lodging ranged from short-term furnished apartment or hotel rentals to mosquito-stricken tents. Meals included dishes in institutional cafeterias, small restaurants, and food we cooked in apartments, to starchy and pasty dishes prepared in field camps. Always, regardless of the situation, vodka was at hand.

Our three-person team got along together remarkably well. Of course, there were moments of discontent, just as there are in any long-term relationships. Our relations with other archaeologists, geologists, biologists, and related specialists were cordial. Everyone knew Nicolai. We had few setbacks. Only once were we denied access to a museum collection and only once did we have an accident. That occurred when I slipped and fell while descending a high boulder-covered Bronze Age burial mound. One year when I was passing through customs and security at an airport for a flight back to Moscow, I was stopped by a soldier checking documents and passports. He noticed that I had failed to register with the militia in this city and therefore I could not board the aircraft with my faulty credentials. We argued for quite a while until he telephoned his superior who told the guard to let me pass. The soldier muttered in simple English that I would never get back into Russia again. That threat never materialized, although after that incident I made certain to register with the local militia wherever we traveled. Few Siberian banks would exchange rubles for traveler's checks or dollars. I once wrote the wrong date on ten $100 traveler's checks. The bank clerk refused to accept them. With this loss of a month's funding, our travel expenses were tightened considerably. Still, we had enough money to travel for the project that summer. Anyone considering travel in Siberia can count on some banks having ATM service, but the exchange rate is costly. On the whole, I found it best to travel with half the summer's money in traveler's checks and half in new $100 bills.

Travel in Siberia is difficult. Seasoned world travelers can figure things out, but without some Russian language ability one is lost. With the exception of the southern Lake Baikal region (backpacking trekkers) and Vladivostok (Chinese), Siberia has almost no foreign tourists. There is little danger of bumping into a gaggle of loud New Yorkers. Nevertheless, Siberians love to travel, and there are numerous inexpensive tour and express bus companies that operate out of every city. Along their routes there are highway pull-outs and rest stops that are filled with umbrella-protected, out-of-doors vendors and small cafes and stalls selling all sorts of beverages, cigarettes, candy, baked goods, and fast foods. The best are *shashliks*—bite-size chunks of juicy meat, usually beef, on skewers seared over hot wood coals in smoky half-barrel-shaped waist-high steel BBQ grills, and served with spicy tomato and garlic sauce that varies in flavor from vendor to vendor. When several buses and tourist cars pull into one of these roadside rest stops at the same time there is a frantic and festive air. Cigarettes are lit, photos are snapped, and snacks are purchased. At these stops, Nicolai would have his cigarette and whatever I had ordered to eat. This was usually a flavorless mushy gray hot dog and cheeseless macaroni (all the kitchen had left by noon), and a beer. Olga would order hot tea with lots of sugar and a small tort. She detested paper cups, and always sought out a vendor who sold tea in glasses or pottery cups. She had a very strong attitude about purchases: If it cost more, it must be better. This classy aristocratic behavior worked, and low class vendors always went out of their way to fulfill her requests. I never ceased to be amazed at how such a small woman could get so much respect from the huge apron- and scarf-wearing babushkas.

Travel by bus was fun and, like today's airlines, one paid a small fee for baggage if the driver thought he could extract it from a passenger. Train travel is even more exciting. The express trains have scheduled stops of about 20 minutes at the larger stations. Most passengers get off the train to purchase food and beverages from a score or more of enterprising elderly women vendors waiting on the station platform. The neatly uniformed female conductors stand at the steps of their cars to guard them from unticketed persons. I got the impression that not only did many Siberian scientists know Nicolai, but so did a number of the pretty conductors serving on the vast Trans-Siberian railroad system. At these stops it is like a circus with fabulous photo ops. There are sad moments also. I once watched a tiny old woman offering homemade pickles for sale that no one was buying. While queuing is not a Russian national practice, everywhere we traveled the crippled, blind, or very old were given special attention. Respect for those less fortunate is part of the national character. Olga rarely passed a sidewalk beggar without giving a few coins. (A five ruble coin, about 15 cents, would buy a half loaf of bread.)

Nicolai was an excellent field worker as well as being a well-read scholar. His knowledge of the history of Siberian natural science, the workers, sites, theories, and a warehouse of anecdotal information is astounding. He worked closely with Academician A. P. Okladnikov at sites such as the famous Geographic Society Cave, near Nakhodka, and Varvarina Gora, several km from Ulan-Ude and east of Lake Baikal. Okladnikov captured Nicolai's personality perfectly by calling him "the cat that walks alone." This remarkable cat has walked many, many kilometers, and many years with Olga and me. At this writing we are putting the finishing touches on a lengthy book that describes the findings and interpretations that have come out of our Siberian bioarchaeology. Alone, none of us could have generated this book, but together our team has added significantly to the field of Siberian taphonomy, the term coined by the Russian paleontologist I. A. Yefremov for the study of postmortem events and their causes.

To some degree our work is paralleled by that of a graduate student named Patrick Wrinn, whose University of Arizona dissertation supervisor is Regents' Professor John W. Olsen, a famous archaeologist specializing in the Paleolithic of East Asia. However, we and Wrinn differ in our objectives. We are focused on synchronic bone damage in several assemblages aimed at statistical inference. Patrick is more concerned about diachronic faunal change in fewer sites, changes that might have occurred during the Middle to Upper Paleolithic transition. We gave up on all but the grossest stratigraphic provenience after it became blindingly obvious that hyena disturbances were blurring the borders of stratigraphic horizons. On a site visit to Kara-Bom, even Denisova field supervisor Michael Shunkov admitted that this open site had been heavily disturbed. Our earlier taphonomy study of the Kara-Bom faunal remains supported this.

To give readers a sense of our work, I present our findings for Varvarina Gora, one of the thirty studied assemblages. I chose this particular assemblage because of Nicolai's involvement in its initial excavation with Okladnikov and Konopatski, and his subsequent impeccable identifications of the faunal remains (Ovodov 1987). The point I want to get across is that Nicolai was one of the twentieth-century pioneers in Siberian Paleolithic bioarchaeology, cave archaeology, and ecology. He is hardly known outside Russia due to the language barrier. He is one of the Russians that Alaska zooarchaeologists and others should be aware of.

For the following text, definitions for the twenty-six characteristics listed in the "findings" are provided in Turner et al. (2001).

THE VARVARINA GORA SITE

BACKGROUND

Varvarina Gora (Barbara's Hill) is east of Lake Baikal, on the border between dry steppe and hillside conifer forests at 51°38' N and 108°10' E (Lbova 2002:153; Lbova et al. 2003; Vasil'ev et al. 2002:528). It is upriver from another open Paleolithic site, referred to as Kamenka (Stone) by its excavator, Ludmila Lbova (1994, 1996; Lbova et al. 2003), who has described and illustrated both sites in great detail. We studied the Kamenka faunal assemblage stored in Ulan-Ude and the Varvarina Gora assemblage housed in Novosibirsk. Varvarina Gora contained the accumulation of artifacts and faunal refuse left about 30,000 years ago by Levallois technique tool-makers and later by blade-making Upper Paleolithic hunters and their families who camped several times at the site, probably for many generations judging from the amount of refuse. One reaches Varvarina Gora by turning off a dusty dirt road connecting a remote and strangely out-of-place rusty factory town called Zaigraevo with a distant village by the name of Sara Bryan. At the turn off, a lightly used track winds uphill around burnt tree stumps and new-growth forest, soon reaching Varvarina Gora. The site is located on the lower southern slope of a conifer-covered hill overlooking the distant left bank of the northward-flowing Bryanka River. Stone artifacts had been discovered by workmen constructing a power line in 1961; the holes for some poles had been dug into the ancient site. News of the discovery of stone artifacts and bones was sent by E. A. Khamzina and D. D. Bazarov to A. P. Okladnikov, who began a multiyear excavation program at Varvarina Gora in 1973 that lasted until 1977 (Lbova 2002; Okladnidov and Kirillov 1980). During our site visit on July 8, 2003, guided by Lbova, the forest was plagued by swarms of large biting black flies that attacked our faces and eyes. Were these dreadful insects present when ancient Varvarina Gora was occupied? Nicolai recalls that they were such a severe problem when he and Alexander Konopatski helped Okladnikov conduct the original excavations that smoky fires had to be kept burning every day.

Ludmila Lbova (2002, and elsewhere; Lbova et al. 2003) discusses Okladnikov's finds, as well as her own subsequent additional excavation. She illustrates the more recent level (Layer 1) and typically Upper Paleolithic artifacts recovered from the approximately 110 m^3 of the total volume excavated at Varvarina Gora, as judged from her site maps (Lbova et al. 2003). Stratigraphic and archaeological evidence initially indicated a single major component (Okladnikov and Kirillov 1980; all cited in Ovodov 1987), but Lbova's re-excavations in 1986, 1992, and 1993 showed that there was also a later (Layer 1) 17,000 BP occupation by people who produced microblades and wedge-shaped cores. This later occupation overlay the earlier occupation dated 28,000 to 34,000 BP (Lbova, pers. comm., July 8, 2003). Vasil'ev et al. (2002:528) list all the published dates for Varvarina Gora, which I have simplified to 30,000 BP for ease of recall. Ovodov (1987) identified the species and estimated minimum number of individuals (MNI) in the faunal assemblage from the Okladnikov excavations at Varvarina Gora. He identified fox, wolf, bear, horse, rhinoceros, reindeer, bison, gazelle, and goat—mainly a steppe assemblage. Note these identifications were made from the larger pieces of bone, whereas our study focused on the smaller and largely unidentifiable pieces. Due to a lack of time and cash (we could find only one bank in Ulan-Ude that would exchange rubles for traveler's checks, and then only one check per day), we did not examine the more recent faunal remains recovered by Lbova. Following will be some comparisons with the Kamenka site, where dates range from 25,000 to 30,000 BP, maybe some centuries after Varvarina Gora Layer 2. Most of the dates from both sites are based on bone. Readers who are literate in Russian and are interested in these two sites should see Lbova et al. (2003). Artifacts are well illustrated by line drawings for anyone wanting to infer culture-historical reconstructions for these and other Cis-Baikal sites.

FINDINGS

1. Provenience: All of the specimens we examined were curated in the Institute of Archaeology and Ethnology, Novosibirsk. These are from Level 2, excavated in the 1970s. While some small pieces had no provenience labels, they were always bagged with whole or mainly whole pieces that were labeled for year of excavation and section number. The dates include 1973, 1974, 1976, and 1977. The specimens had been sorted into bags of identifiable species and unidentifiable pieces. In addition to section numbers, some pieces also were numbered for Ovodov's paleozoology catalogs. Hence, our observations are based on the excavations led by Okladnikov and do not include the later work directed by Lbova. We examined 864 pieces, disregarding most unmodified loose teeth and foot bones. Our total was at least one quarter of the collection. The excavations in the 1970s did not find the microblade horizon, so there was no reason not to pool our observations. They essentially all came from the same level.

2. Species: (Latin names are in the appendices of this article and our book in progress) All 864 pieces were assessed for species determination (precise or general, i.e., specific name or big or small mammal, etc.). "Indeterminable" pieces made up 18.6% of the total, a value not too dissimilar from that of the Kamenka site (21.9%, 552 pieces).

Gazelle (32.3% pieces) was the most commonly represented identifiable species, followed by horse (17.1%). Rhinoceros (6.0%), goat-sheep (4.4%), wolf (1.6%), bison (0.2%), hare (0.1%), and mammoth (0.1%) are also represented. The relatively large percentage for rhinoceros is due to a single animal at Varvarina Gora. It had cut and chop marks indicating butchering. This creature was very large and would have been difficult to move from the place of killing to a camp elsewhere. Hence, we suspect that the rhinoceros carcass itself was what determined why the Varvarina Gora people camped where they did. On the other hand, as Alaska campers well know, it is unwise to bed down with one's grub nearby, which might attract bears. In 1987 Ovodov also identified marmot, red fox, corsak or steppe fox, bear (a single tooth), yak, screw-horned antelope (three pieces of horn), and found a few pieces of bird bone that he did not identify. He remarked that the mammoth reported by Okladnikov was represented by ivory objects only. Ovodov felt that the mammoth presence at Varvarina Gora was not the result of human hunting.

3. Skeletal elements: Our element sample size was 864 pieces. Nonspecific long bone pieces were the most common (12.4%), followed by rib pieces (11.6%). These values are nearly identical to those at Kamenka (12.7% and 11.4%, respectively), although there are not quite as many cranial pieces at Varvarina Gora (8.3%) as we identified at Kamenka (12.5% **out of a total of 552 pieces at Kamenka**). Still, these similarities are enhanced by the presence of penis bones in both sites and almost nowhere else in our other assemblages.

4. Age: Our sample size for age assessment was 864 pieces. Adults were about five times more common than subadults. This age ratio is nearly identical to that found at Kamenka, so all the comparative comments here apply there as well.

5. Completeness: We had 863 observable pieces. Complete pieces (3.4%) were similar in number but fewer than at Kamenka (8.7%); however, considering that we may have excluded from study proportionally more Varvarina Gora complete bones. Certainly the ratio of one-ended to no-ended pieces in the two sites is similar, although there is a slightly significant statistical difference (χ^2 = 5.4, 1 d.f., $0.01 < p < 0.05$). Varvarina Gora does not stand out for completeness when compared with our other assemblages.

6. Maximum size: The average size for 847 observable pieces is 9.0 cm. This is larger than the mean for Kamenka (6.5 cm), which is entirely attributable to the several very large pieces of the rhinoceros found at Varvarina Gora. Removing those pieces reduces the Varvarina Gora mean considerably. However, with the rhinoceros pieces included, Varvarina Gora has a mean maximum diameter that is in the upper half of the size range for all our assemblages.

7. Damage shape: We evaluated this variable on the basis of 862 pieces. Most frequent were long bone fragments (30.3%) and long bone flakes (13.8%). The number of long bone splinters was significantly less (χ^2 = 98.8, 1 d.f., $p < 0.001$) at Varvarina Gora (3.4%) than at Kamenka (11.4%). The suggestion by Germonpré and Lbova (1996:44) that the Kamenka splinters "could be the by-products of bone tool manufacturing" is reasonable but would have been strengthened had Varvarina Gora had a similar proportion of splinters, given many other taphonomic similarities in the two assemblages. Another consideration is that splinters were a stage in the production of tailoring needles, which were a well-established item in the Upper Paleolithic tool kit, much more so than in the Middle Paleolithic. Evidence for these fine needles (eyed or knobbed) is largely lacking for earlier time periods, but Varvarina Gora Layer 2 is about the same age as Kamenka, so bone splinters in the two sites could represent seasonality, dating errors, or other differences. We are inclined to view the splinter differences as due to temporal or cultural differences.

8. Color: Color was assessed in 862 pieces. Almost all of the pieces were ivory-colored (99.2%). Pieces that were burned or possibly burned (brown or black) made up only 0.7% of the total. One was a partly burned, mostly horse vertebra. This vertebra is the only piece that suggests roasting, although it more likely represents accidental burning. The occurrence of ivory-colored pieces in Varvarina Gora and Kamenka (98.9%) is identical. Compared with our other assemblages, Varvarina Gora is at the very upper end of the ivory-colored range.

9. Preservation: Quality could be evaluated in 863 pieces. While the majority of pieces were ivory hard (65.3%), there were many pieces of chalky and intermediate quality. There is a highly significant quality difference between Varvarina Gora and Kamenka (χ^2 = 1,270.3, 1 d.f., $p < 0.0001$). The preservation difference is due to Varvarina

Gora's coarser-grained sediments, southern exposure, and hillside slope, conditions the combination of which must have led to more humic acid percolation, more and deeper ground freezing and thawing, and a longer period of surface weathering before final burial. In addition, the many highly weathered rhinoceros bones indicate that they had been exposed to surface weathering for a relatively long period of time. Preservation at Varvarina Gora is much like that of other open sites. Kamenka, however, has unusually good preservation for an open site.

10. Perimortem breakage: We were able to assess 862 pieces for perimortem damage. Like nearly all of our faunal assemblages, Varvarina Gora has a very high frequency of perimortem breakage (97.0%). This amount of breakage is only slightly more than that found at Kamenka (94.7%). The difference is just barely statistically significant ($\chi^2 = 4.95$, 1 d.f., $0.01 < p < 0.05$). Given the previous discussion of the very significant bone quality differences (i.e., arising from environmental and depositional history) between Varvarina Gora and Kamenka, we feel that the manner in which these ancient humans extracted nutrients from game animals and their use of bone for tools was effectively the same in both sites. This view is backed up by the lack of color difference in these two assemblages, i.e., little or no evidence for roasting that would scorch or blacken bone.

Compared with our other assemblages, Varvarina Gora is not unusual with respect to perimortem damage.

11. Postmortem breakage: We evaluated 862 pieces for postmortem damage. Of these, 9.6% showed postmortem breakage. Much of this happened in the excavation of the adult rhinoceros, most of whose skeleton was crumbly and chalky due to weathering and poor subsurface preservation. Even so, there is much more postmortem breakage at Varvarina Gora than at Kamenka (1.1%). The difference is so large that there is no need for a formal statistical comparison.

12. End-hollowing: Due to the large number of pieces without anatomical ends, we could assess only 418 pieces for end-hollowing. End-hollowing occurs in 1.2% of the Varvarina Gora sample, a value not significantly different from that of Kamenka (0.8%) ($\chi^2 = 0.19$, 1 d.f., $0.5 < p$). Hence, discussion of Kamenka regarding our objective of developing multiple criteria for defining carnivore damage applies here also. By itself, end-hollowing does not suggest much carnivore activity at these two sites.

Compared with our other assemblages, especially those where there had been an unquestionable presence of hyenas, Varvarina Gora end-hollowing is decidedly at the very low end of the range of occurrence. Wolf bone was present at Varvarina Gora; however, wolves may not have caused end-hollowing. Ovodov (1987) suggested that the type of wolf elements and their breakage implies that these animals may have been hunted for their fur and for food. On the other hand, carnivores that caused the end-hollowing are likely not represented in the Varvarina Gora assemblage, so scavenging wolves and foxes could still have produced the small amount of end-hollowing.

13. Notching: Our sample for notching consisted of 856 pieces. Of these, 5.7% had one or more notches. The most frequent number of notches per piece was one (4.2%). Occurrence and intensity of notching is less than at Kamenka (9.8% occurrence). Although the difference is statistically significant ($\chi^2 = 8.3$, 1 d.f., $0.001 < p < 0.01$), we do not believe that it signals any special cultural or taphonomic importance because chalky pieces with crumbly edges would not be scored as notched in the face of uncertainty caused by possible postmortem damage.

Compared with our other assemblages, notching at Varvarina Gora is unexceptional for an open site. It clearly had less notching than the amount associated with hyenas and other carnivores.

14. Tooth scratches: We were able to assess the occurrence of tooth scratches in 703 pieces. Only 1.9% had one or more scratches. The most frequent number of scratches per piece was five (0.4%), but two pieces had more than seven scratches. Occurrence and intensity of tooth scratches is slightly less than at Kamenka (2.8% occurrence), but the difference is not statistically significant ($\chi^2 = 1.1$, 1. d.f., $0.2 < p < 0.5$). As far as tooth scratches alone indicate carnivore activity, bone refuse at the two sites was processed similarly by scavengers.

Compared with our other assemblages, Varvarina Gora tooth scratching is unexceptional for an open site and has much less than the carnivore cave sites.

15. Tooth dints: A total of 682 pieces could be evaluated for tooth dints. Only 1.9% had one or more dints. The most frequent number of dints per piece was three (0.6%), and only one piece had more than seven dints. Occurrence and intensity of tooth dints is less than at Kamenka (3.3%), but the difference is not statistically significant ($\chi^2 = 2.4$, 1 d.f., $0.05 < p < 0.2$). Our comments for tooth scratching apply equally to tooth dinting; namely, there is only a small amount of carnivore damage that can be inferred for Varvarina Gora.

16. Pseudo cuts: We could identify no examples of pseudo cuts in 689 usable pieces. This again reflects minimal carnivore processing of Varvarina Gora bone refuse.

17. Abrasions: In 686 pieces, only 0.4% had one or more abrasion grooves per piece. This is practically the same as seen at Kamenka (0.2%). We earlier proposed bone breakage for marrow extraction was accomplished using nonabrasive hammers and anvils such as bone, antler, or wood instead of gritty abrasion-producing hammer stones and anvil stones. Stone could have been used for bone breakage, but it would have had to have been fine-grained so as not to leave abrasion grooves. A low frequency of abraded pieces is characteristic of all the assemblages in our study. Given the generally coarse- to medium-grained stone sources that we have noticed in all the site localities visited, there seems to be a reasonable basis for proposing that stone was not the preferred material in the perimortem breakage that also characterizes all of our assemblages.

18. Polishing: A total of 834 pieces could be assessed for polishing. Polishing was very common in Varvarina Gora (96.0%). At Kamenka there was less (90.0%), the difference of which is statistically significant ($\chi^2 = 20.19$, 1 d.f., $p < 0.001$). The difference is attributable to slope, where some polishing was possibly caused by bone movement downhill, since the amount of slope at the time of deposition seems to have been a few degrees greater at Varvarina Gora than at Kamenka. Also, because the proportion of chalky pieces is greater at Varvarina Gora than at Kamenka, bone refuse at Kamenka was better protected from weathering, which implies less time passed before burial, and once buried the perimortem and postmortem polishing processes were less energetic. Compared with our other assemblages, Varvarina Gora is decidedly at the upper end of the range for polishing. This range does not break down as neatly for open versus cave sites as do some other variables.

19. Embedded fragments in bone: We were able to assess embedding in 858 pieces. There were very few pieces that had embedded fragments (0.9%). Of these, having two embedded fragments was most common (0.3%). There were no pieces with more than four embedded fragments. Kamenka had a similarly low occurrence of pieces with embedded fragments (1.5%). Compared with our other assemblages, Varvarina Gora is at the low end of the range for embedded pieces. In all assemblages, embedded fragments are most frequently found in tooth dints. Together, they suggest minimal carnivore scavenging at Varvarina Gora.

20. Tooth wear: We evaluated tooth wear on thirty-six maxilla and mandible fragments. Individuals we considered to be young made up 13.9% of this total. Kamenka had almost half this amount, but both assemblages are too small for meaningful chi-square comparisons. Compared with our other samples, Varvarina Gora would appear to be at the low end of the range for the presence of (dentally) young individuals.

21. Acid erosion: We assessed 864 pieces for acid or enzymatic digestive erosion. Only 0.5% of this total had acid erosion. Of the four eroded pieces, three were highly rounded like water-worn pebbles. The fourth was highly eroded but felt gritty rather than greasy. None is exhibit digestive damage like that seen in the hyena cave assemblages. In addition, there were two other pieces that were corroded on one surface as if they had been in the process of dissolving by some agent other than stomach acid. These two were not considered to have digestive damage. The 0.5% acid-eroded pieces are somewhat less than what occurred at Kamenka (1.3%), but not significantly so ($\chi^2 = 2.85$, 1 d.f., $p > 0.08$). Compared with our other assemblages Varvarina Gora is at the low end of the range for acid erosion. This suggests that there was very little, if any, hyena presence. We noticed no caves or rock shelters in the vicinity, which could have limited the number of hyenas in the region.

22–24. Rodent gnawing, insect damage, and human bone: Varvarina Gora had no examples of these three variables.

25. Cut marks: We assessed 714 pieces for cut marks. Fully 8.8% of all pieces had one or more cut marks. The number of cuts per cut piece range from one to more than seven.

The largest number of cut marks on a given Varvarina Gora piece is fifteen. There is one 15.8-cm-long piece of a distal end of an adult horse humerus with five ultra-fine cut marks varying from 2.0 to 5.0 cm in length. The piece is extraordinarily well preserved, equal to that found in cave sites, suggesting that other very fine cut marks may have been erased from less well-preserved pieces. This in turn suggests that we have to some degree underestimated cutting at Varvarina Gora and perhaps at other open sites where preservation is not as good. Kamenka has a slightly higher frequency of cut marks (9.5%), but the difference is not significant ($\chi^2 = 0.18$, 1 d.f., $p > 0.3$). As discussed above, Kamenka bone was excellently preserved, so if we had undercounted cut marks it does not show up in these two neighboring sites with notable preservation differences. Compared with our other assemblages, Varvarina Gora is more or less in the middle of the range for cut mark frequency.

26. Chop marks: There were 747 pieces that could be evaluated for chop marks. Of these, 13.8% of all pieces had one or more chop marks. Of chopped pieces, the majority (8.6%) had only one chop mark. Two chop marks were less common (2.9%) and only a few pieces had three to six. The occurrence of chop marks at Kamenka was less (8.6%), and most of these were pieces with only one chop mark. The frequency difference in the occurrence of chop marks at Varvarina Gora and Kamenka is significant ($\chi^2 = 8.94$, 1 d.f., $p < 0.005$). We suggest that this difference is due to Varvarina Gora having proportionally more pieces of large mammals (horse, rhinoceros, and large unidentifiable species, i.e., larger than a wolf) than Kamenka. Certainly the large mammal pieces at Varvarina Gora have more chop marks than do pieces of smaller mammals. Moreover, Varvarina Gora shows a large number of pieces with associated chop marks and notching. It would seem that gaining access to the marrow cavity of large mammals such as horse and rhinoceros was more commonly accomplished by the use of large heavy sharp-edged stone artifacts like the Varvarina Gora and Kamenka cores illustrated by Lbova (2002:65–66) than by hammering with a piece of bone, horn, or wood. Conceivably, the choice of material illustrates ancient awareness of the "stiletto heel effect"—where a great deal of kinetic energy can be focused on a small area causing great damage that might not occur when the impacting surface has more area. Compared with our other assemblages, Varvarina Gora is in the upper part of the range for chop mark frequency.

DISCUSSION

Varvarina Gora is in the same river valley and of about the same time period as Kamenka. Both sites are located on the lower slopes of low hills adjacent to the valley. Both were repeatedly used, open steppe sites. The use of Varvarina Gora took place around 30,000 years ago, a time relative warmth during the Late Pleistocene. Later, both show similar Upper Paleolithic tool types that the occupants used to hunt and process the same sorts of game animals. These were mainly gazelles and horses. The natural- and human-caused perimortem bone damage of both sites is remarkably similar, with the exception of Varvarina Gora having gone through less favorable conditions for bone preservation than the exceptionally well-preserved assemblage Lbova recovered from Kamenka. The occurrence of chopping at Varvarina Gora is greater than at Kamenka, which reflects the larger proportion of big animal bone pieces at Varvarina Gora. The perimortem taphonomic characteristics of Varvarina Gora are broadly like those of our other open sites. Carnivore damage was slight, and there is no evidence of hyenas. There are no known caves near Varvarina Gora or Kamenka, which may explain the absence of hyenas.

One possible cause of human damage to bone relates to cooking. If meat had been cooked, it must have been mainly by stone boiling because the evidence for roasting is weak to nonexistent. As elsewhere in this project, perimortem processing was intensive; that is, most bones were broken, and broken into many small pieces with an average maximum diameter of only 9.0 cm, a value that would be smaller had our protocol not excluded from study pieces smaller than 2.5 cm in diameter. Still, small average piece size, coupled with frequent polishing, points to meat having been cooked. Preparing soups, stews, and rendering for fat could have involved the use of leather bags, wooden bowls, or tightly woven baskets into which were placed water, heated stones, and pieces of smashed bone with adhering ligament, muscle tissue, and fat. Carved stone bowls (like those used by historic Inuit women) are another possibility, although neither stone cooking pots nor stone lamps have been found. Low heat cooking would melt fat in muscle tissue and marrow in bone. Low heat cooking would not have destroyed vitamins as would have roasting, nor would melted fat dripping into a fire have been wasted. The considerable amount of perimortem bone breakage probably means that roasting pits were not used for cooking in all of our Late Pleistocene assemblages. Stone-boiling seems to be the most likely means of cooking. Flavor-enhancing plants like wild onion could have been added. This suggestion has to remain as speculation because plant residues have not been identified in any of our assemblages. Moreover, the amount of charcoal found with these assemblages is small, making even the argument for cooking somewhat tentative were it not for the small average piece size and the considerable surface polishing.

In our book in process (Turner, Ovodov, and Pavlova n.d. [see list of project reports that precedes the bibliography]) we spend considerable time on the subject of Siberian hyenas. There, we show that the Late Pleistocene distribution of cave hyenas extended all the way from western Europe (many cave sites) to the Sea of Japan (Geographical Society Cave), with examples in between and as far as 55° N latitude. The evidence is abundant for hyenas having once lived in Siberia and having frequented archaeological sites. Their absence in Varvarina Gora (also Kamenka) is based on 864 pieces used for species identification at Varvarina Gora, none of which was with any degree of certainty hyena. Perhaps, as mentioned above, a lack of suitable denning shelter was the cause. Although some hyena remains have been found to the east in the Yenisei River basin they appear to have been less common there than elsewhere in southern Siberia. If hyena packs did constitute a kind of barrier to Beringia, then that barrier might have been weakest in the region east of Lake Baikal. Interspecies competition between humans and hyenas and the killing of humans for food would have limited human population size and human expansion northward where there would have been no competition for resources from other humans, as there would have been in the south (e.g., Turner n.d.; Turner, Ovodov and Pavlova 2005).

In our book in progress we also consider the rarity of Late Pleistocene human remains in Siberia, which is markedly in contrast to the abundant and well-preserved faunal remains. Not until Mesolithic-Neolithic times, after hyenas had gone extinct, do human remains become relatively common. We propose that hyenas were partly to blame for the rarity of human remains. Whatever the reason(s), Alaska seems not to have been reached by humans until after hyenas had disappeared from the Siberian landscape.

In sum, our ten-year taphonomic study of faunal remains in Late Pleistocene Siberia has added a new dimension to the use of perimortem bone damage for archaeological interpretation, among them stratigraphic disturbance, food preparation, human-hyena competition, discontinuity of site occupation, carnivore introduction of faunal remains into archaeological sites, and the late arrival of humans to Beringia. Bone exhibiting cut and chop marks, burning, and other forms of human damage differ so much from carnivore damage that very interesting site-specific and regional stories can be suggested using our damage criteria along with whatever can be inferred from stone, bone artifacts, and other cultural remains.

Lastly, it is my hope that Alaskan researchers will search out the published research of Nicolai Ovodov. It was his immense personal knowledge of Late Pleistocene Siberian vertebrate paleontology, cave archaeology, and natural history that made this project possible. *Spasibo*, Nicolai. Acquiring this literature will not be easy. The IAE library still uses a file card cataloging system without subject cross-referencing. I have tried to Google various topics and authors, but only rarely does a Siberian researcher show up on any of my searches. In my view, if you want to know something about Siberian anthropology, you need a contact who can help you visit Siberia. My initial contact was Serg Arutiunov, who in 1979 helped me get a foot in the door of the gigantic closet of Russian scientific knowledge.

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APPENDIX

Common and Latin names of animals mentioned in text.

Bear. *Ursus* sp.
Bison. *Bison priscus*
Red Fox. *Vulpes vulpes*
Corsak or Steppe Fox (Corsak). *Vulpes corsac*
Gazelle. *Procapra gatturosa*
Goat. *Capra* sp.
Hare. *Lepus* sp.
Horse. *Equus* sp.
Marmot. *Marmota bailbacina*
Reindeer. *Rangifer tarandus*
Rhinoceros. *Coelodonta antiquitalis*
Wolf. *Canus lupus*
Yak. *Poephagus bikalensis*

PREHISTORIC UPLAND TOOL PRODUCTION IN THE CENTRAL ALASKA RANGE

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ABSTRACT

The Bull River II site represents an important alpine tool production site in the central Alaska Range south of Broad Pass. Initial test excavations produced a sizable lithic assemblage and charcoal dated to the Younger Dryas. A lithic analysis comparing Bull River II and the undated Costello Creek assemblages reveals biface production was the primary activity at both locations. Discovered at relatively high elevations (>1000 m.a.s.l.), the sites reflect an underrepresented Eastern Beringian site type related to upland resource procurement and offer a basis for testing seasonal land-use models.

KEYWORDS: central Alaska, Younger Dryas, lithic analysis, upland hunting

INTRODUCTION

Strategically positioned south of Broad Pass, the Bull River II site contains evidence of hunter-gatherer tool production and technological preparation for upland hunting. Initial AMS radiocarbon results date the occupation to the Younger Dryas and comparisons of artifact attributes with the nearby but undated Costello Creek site indicate a remarkable consistency in flint-knapping behaviors. The sites represent high elevation (>1000 m.a.s.l.) prehistoric assemblages relevant to wider interpretations of early prehistoric land use and subsistence strategies.

In Eastern Beringia, the Pleistocene-Holocene boundary is arguably the most thoroughly documented archaeological period (Goebel and Buvit in press; Hamilton and Goebel 1999; Holmes 2001; West 1996; Wygal 2003; Yesner 1996). However, archaeological interpretation remains limited because a preponderance of existing evidence is derived from a narrowly defined site type and, to a lesser extent, setting (i.e., south-facing overlooks in the Tanana and Nenana river valleys). Subsistence and land-use models for central Alaska would benefit from a wider range of sites from multiple topographic settings.

UPLAND HUNTING

The central Alaska Range has yielded few prehistoric alpine sites with the exception of the Tangle Lakes Archaeological District where the Alaska Office of History and Archaeology (OHA) has been monitoring melting ice patches in the Amphitheater Mountains east of Cantwell (VanderHoek et al. 2007a, 2007b). While ice patch discoveries offer fascinating contextual data on upland kill sites in central Alaska, none of the Tangle Lakes ice patch finds predate 1100 cal BP (VanderHoek et al. 2007a). An incised antler projectile point dated to 7310±40 BP (8110±50 cal BP) from a southern Yukon ice patch suggests that early Holocene upland hunting occurred in some parts of Eastern Beringia (Helwig et al. 2008). Denali National Park and Preserve developed survey strategies aimed at locating logistical support sites such as toolstone procurement or weapon production and repair occupations in alpine zones near ice patch settings (Wygal and Krasinski 2010).

STUDY AREA

The Bull River II and Costello Creek sites are located in southeastern Denali National Park and Preserve, 27 km southwest of Cantwell and 8 km northeast of the West Fork Chulitna River where a complex network of small upland ponds and tributaries drain the mountains buttressing Easy Pass (Fig. 1). This region has both precipitous peaks and gentle ridges that reach in excess of 1400 m.a.s.l. with a seasonal abundance of resources including upland game, berries, and toolstone. Winter months are harsh with deep snow, high winds, and frigid temperatures. Soil formation is generally consistent with 40 to 60 cm of silt and clay capping basal layers.

While, the specific glacial history of Bull River and Costello Creek remains undocumented the Carlo glacial advance dates between 19,000 and 17,200 years ago based on terrestrial cosmogenic nuclides and optically stimulated luminescence on glacial erratics in the nearby Nenana Valley (Dortch 2006). Glaciers retreated from the summit of the Reindeer Hills east of Cantwell between 16,600 and 15,500 years ago and from the valley floor between 19,000 and 17,200 years ago (Briner and Kaufman 2008; Dortch 2006). Less extensive glacial readvances in Broad Pass during the Younger Dryas (Dortch 2006) probably did not hinder human migration between the north and south slopes of the Alaska Range.

Present vegetation cover is a blend of low shrub alpine tundra consisting of berries, lichens, and flowers. Dense patches of dwarf birch thrive at lower elevations along major drainages and south-facing slopes. Faunal communities include caribou (*Rangifer tarandus*), grizzly bear (*Ursus arctos*) and the occasional black bear (*U. americanus*). Dall sheep (*Ovis dalli*), beaver (*Castor canadensis*), red fox (*Vulpes vulpes*), wolf (*Canis lupus*), hare (*Lepus* sp.), ground squirrel (*Spermophilus parryii*), and ptarmigan (*Lagopus*

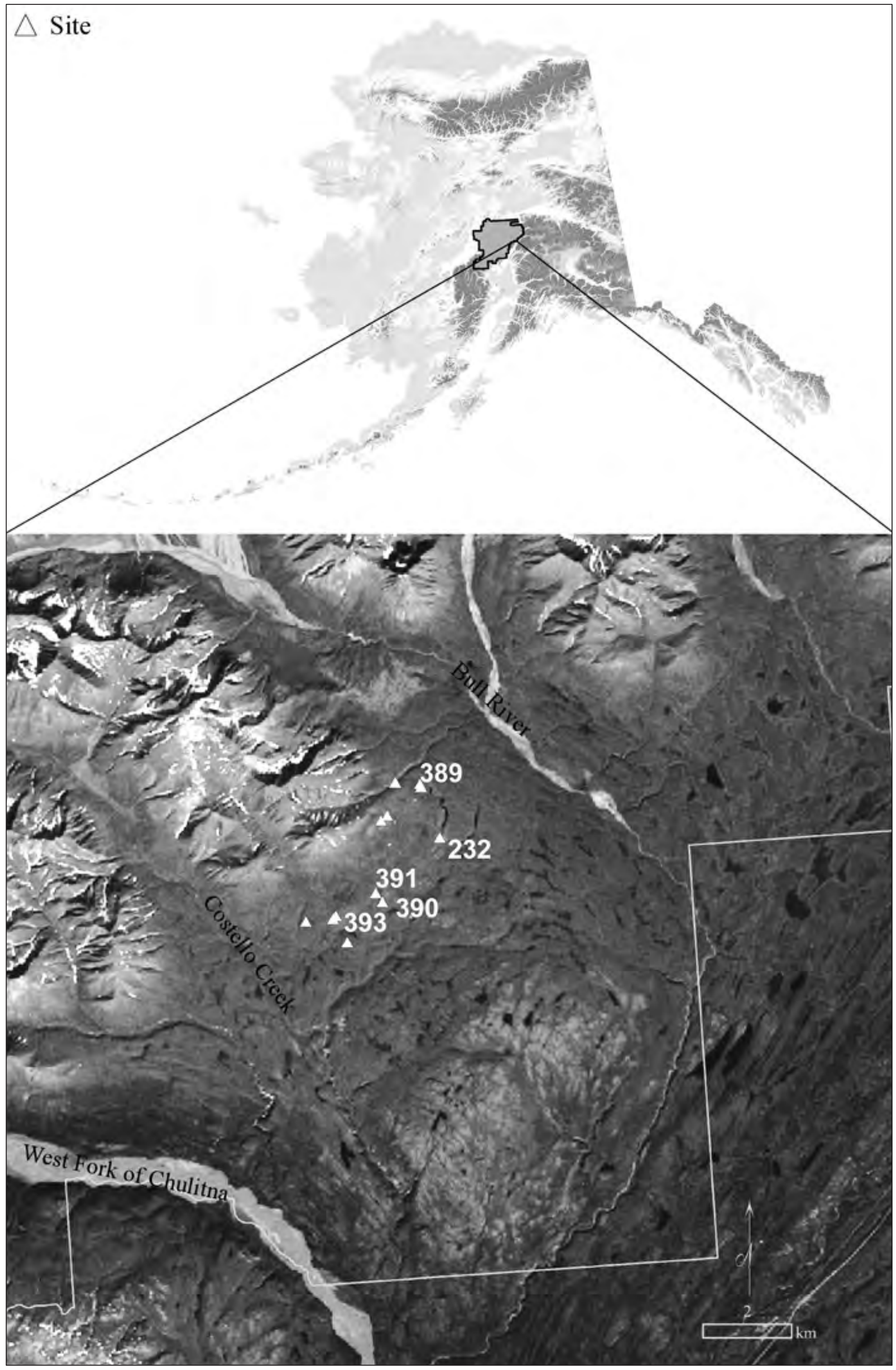

Figure 1. Location of Denali National Park and Preserve (top) and sites mentioned in text labeled by the last three digits of the Alaska Heritage Resources Survey (AHRS) numbering system (bottom). The National Park boundary is in white. Note extensive upland snow and ice patches at higher elevations.

sp.) are common, while moose (*Alces alces*) frequent the brushy river bottoms. No known fish species live in the small streams or ponds of the study area.

Situated on a north-south trending bench at an elevation of 1031 m.a.s.l., Bull River II and at least two additional sites overlook a small beaver-dammed tributary of Camp Creek. Less than 100 m north of the site, a western tributary of the Bull River is fed by melting snowfields above. Prehistoric hunters may have been attracted to the area because it offers a commanding view of the lowlands with easy access to fresh water, toolstone, and upland resources. With no single ideal camp location along the 2 km bench, deposition of palimpsest assemblages was probably limited.

The Costello Creek site is located halfway between the headwaters of Camp Creek and Costello Creek, 2.5 km southwest of Bull River II. At 1039 m.a.s.l., the Costello Creek site occupies a small, undistinguished knoll at the base of a larger hill.

RESEARCH HISTORY

In 1988, Lynch (1996) conducted aerial and pedestrian survey in the foothills north of Dunkle Mine and west of the Bull River as one facet of a larger park-wide investigation primarily aimed at documenting historic sites. During this survey, three waste flakes and a small possible microblade core were documented at HEA-232 on the same ridge containing Bull River II. Black chert, dark gray chert, white chalcedony, and obsidian were recorded among the small artifact assemblage. Surface finds were not collected and a test pit excavated nearby yielded no subsurface artifacts (Griffin 1990:245; Lynch 1996; Saleeby 2000:420).

In 2007, Denali National Park and Preserve and the University of Nevada, Reno initiated an intensive archaeological survey of the region surrounding HEA-232 (Wygal and Krasinski 2010). The work yielded eleven new prehistoric sites ranging from small surface scatters to extensive buried deposits. No evidence of microblade technology was found. Biface and bifacial flake fragments were recovered from the majority of these sites. Bull River II and Costello Creek were considered most substantial of the newly recorded sites and underwent careful evaluative test excavations. At both sites, artifacts were piece-plotted in three dimensions using metric tape measures and a line level from a central datum. Excavation was undertaken in 5-cm arbitrary levels with meticulous documentation of stratigraphic transitions and artifact provenience. Sediments were screened through one-eighth-inch wire mesh.

STRATIGRAPHY AND DATING

This initial stratigraphic assessment from Bull River II and Costello Creek represents the sites' depositional history derived from common soil and texturing charts (Midwest Geosciences Group n.d.a, n.d.b). Initial observations suggest stratigraphic similarities between the sites; however, full sedimentological and geomorphological studies have yet to be completed.

BULL RIVER II

Bull River II contains five broadly defined stratigraphic layers (Fig. 2) consisting of aeolian deposits overlying the basal stratum. The uppermost layer, stratum 5, is comprised of a thin vegetation root mat from 0–3 cm below the ground surface. The organic horizon (stratum 4) is particularly dark with a high concentration of gray silt deposits at 10–15 cm below the surface. Tentatively identified as heavily weathered tephra, these silts contain a small percentage of angular glass shards observed in the field through a 10x hand lens. Although further research is necessary, the silt in stratum 4 may represent the nearby Cantwell ash identified at the Carlo Creek site (Bowers 1979) and later incorporated into the widespread Hayes

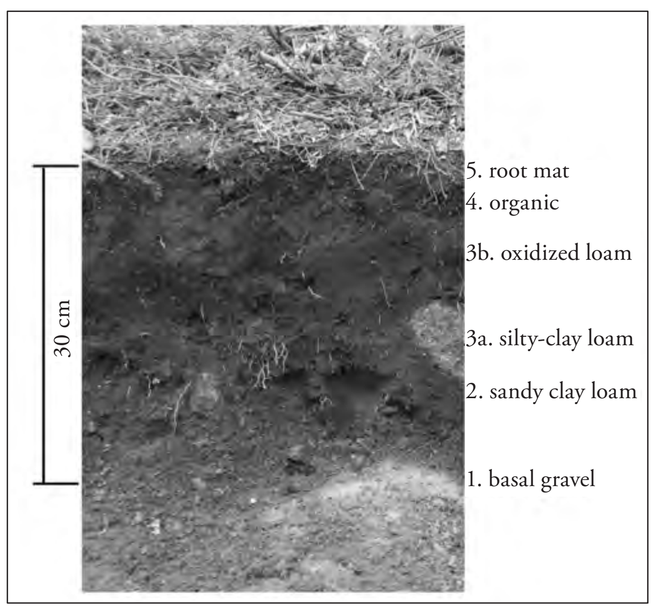

Figure 2. Stratigraphic profile at Bull River II.

tephra (Riehle et al. 1990). The Hayes tephra is the most extensive tephra deposit across southcentral and central Alaska, and was deposited in a series of eruptions between 4,300 and 3,800 cal BP (Begét et al. 1991; Riehle et al. 1990). Recently, the Hayes tephra has been found in cores from Wonder Lake and Sneaker Pond north of the Alaska Range in Denali National Park where Child et al. (1998) obtained a maximum bracketing age of 4250±100 cal BP (3830±60 BP).

Stratum 3b is a heavily oxidized red-brown silty clay loam deposit forming a distinct crusted barrier that seals the cultural components below. The cultural zone at Bull River II is contained within stratum 3a, a compact, organic-rich, black and brown mottled remnant O-horizon. The majority of artifacts (73%) were recovered near the base of stratum 3a at a depth of 22–27 cm below the surface (28–34 cm below datum). Stratum 2 consists of a thin sandy clay loam and the basal layer (stratum 1) is nonuniform unsorted colluvium with round boulders, angular shatter, and fractured schist mixed in a sandy loam matrix.

Although no faunal remains were recovered, portions of the original occupation surface at Bull River II have remained relatively well preserved. Artifact frequency increased with depth below surface while artifact pitch (vertical orientation) decreased. Based on current evidence, windblown sediments slowly buried artifacts deposited onto the stratum 3a surface. Vertically oriented artifacts were transported upward in the profile into stratum 3b through cryoturbation.

Documented near the base of stratum 3a were two small charcoal clusters in association with discolored soil, organic staining and concentrations of *in situ* artifacts (Fig. 3). Specimens of the charred wood fragments have been submitted for genus and species identification. Samples of the organic stains were wrapped in aluminum foil and sealed in Ziploc bags. Once out of the field, the

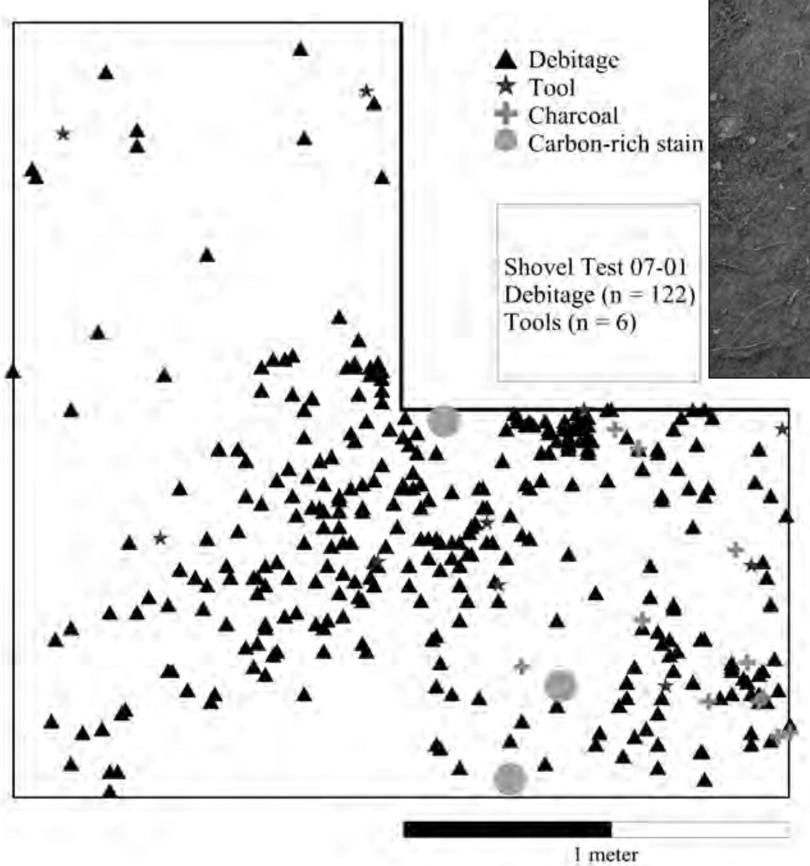

Figure 3. Point-provenienced artifacts and charcoal samples from Bull River II. Photo inset (top right) depicts the cultural horizon with* in situ *artifacts and associated charcoal.

samples were air dried for seventy-two hours and repackaged in fresh foil and dry bags. John McCormack of the Department of Geological Sciences and Engineering at the University of Nevada, Reno characterized the elemental composition of the samples using a scanning electron microscope (SEM) equipped with an energy-dispersive detector. Elemental analysis of individual particles indicated a composition of aluminum (Al), silicon (Si), oxygen (O) and an unusually high level of carbon (C). While the Al signature originated from foil used to collect the samples, Si and O occurred in amounts consistent with standard kaolin-type clay soils. The unusually high levels of carbon were abnormal for natural soil formation (McCormack, pers. comm. 2008).

The charcoal and carbon-rich staining identified at Bull River II was the only evidence of charred material observed in greater than one thousand subsurface tests from this survey region. Several of the charcoal fragments were in excess of 2 cm in diameter, but most of the wood fragments measured between 1 and 2 cm. The charcoal clustered within the culture zone and in close proximity to *in situ* artifacts and organic-rich resinous features. While natural processes such as lightning strike or tundra fire may have deposited the charred wood remains, the parsimonious explanation attributes the charcoal to a small remnant hearth because there is no obvious evidence of regional tundra fires. Four individual fragments were dated between 12,500 and 12,200 cal BP (Table 1), coincident with the Younger Dryas and Dry Creek component II (Powers and Hoffecker 1989), making Bull River II one of the earliest known human occupations in an Alaska alpine setting and south of the Alaska Range divide.

Table 1. Radiocarbon data from the Bull River II site.

Lab Number	^{14}C BP	δ^{13}C	Cal BP*
BETA234748	10,310±50	–26.7	12,180±150
BETA234749	10,350±50	–24.6	12,260±150
BETA234746	10,460±50	–25.4	12,410±150
BETA234747	10,490±50	–26.7	12,460±140

Note: Calibrated using CalPal05 and the Intcal04 curve at one sigma (Weninger and Jöris 2004). All dates are AMS on single charcoal fragments.

COSTELLO CREEK

The excavation at Costello Creek revealed a similar but deeper stratigraphic profile than Bull River II (Fig. 4). Stratum 5 is a relatively thin root mat that terminates near the ground surface. Gray silts (potential tephra) within the organic horizon (stratum 4) are more prominent at Bull River II than Costello Creek. Stratum 3 is comprised of a brown silty clay loam deposit; the heavy oxidation prevalent at other sites in the region was not as pronounced at the Costello Creek site. The majority of artifacts occurred in the lower levels of stratum 3 near its contact with the underlying stratum 2. Stratum 2 is a sandy clay loam horizon and is thicker than at Bull River II. The basal layer (stratum 1) is comprised of a sandy loam colluvium with unsorted pebbles and boulders. The assemblage remains undated although further investigations are planned.

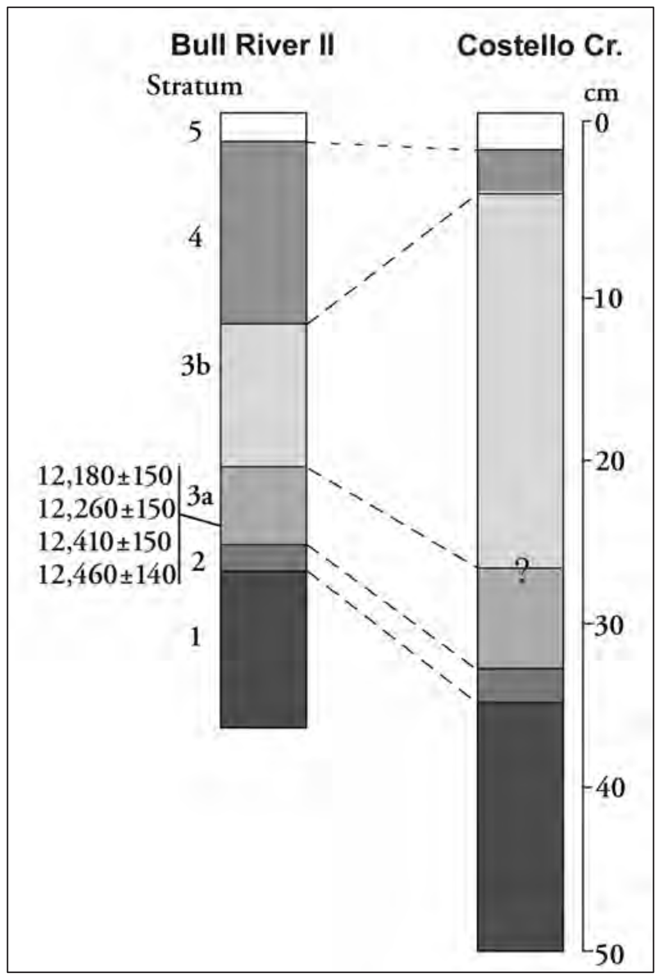

Figure 4. Schematic stratigraphic comparison of the Bull River II and Costello Creek sites with calibrated radiocarbon data.

As at Bull River II, the Costello Creek assemblage was deposited within stratum 3 with upward displacement of artifacts oriented vertically through cryoturbation. An artifact-filled krotovina began in stratum 4 and extended through stratum 3. Fig. 5 depicts a three-dimensional representation of a 1 x 1 m excavation unit and point provenienced artifacts. The krotovina is visible in the profile on the right and the corresponding displaced artifacts found within the unit matrix are depicted in the block diagram at the left. Despite these disturbances, careful documentation of the sediments and post-depositional disturbances distinguished displaced artifacts from those found *in situ*. Although the age of the Costello Creek site is currently unknown, the attributes and stratigraphic position of its lithic assemblages are comparable to those at Bull River II.

ARTIFACT ASSEMBLAGES

A lithic analysis was designed to detect and compare flint-knapping behaviors between the Bull River II and Costello Creek assemblages based on frequencies of raw material type, amount of dorsal cortex, platform preparation, and metric data (Wygal 2009). Tools are distinguished from flaked debris (except for those associated with primary reduction, i.e., cores and core fragments). Additional traits recorded on tools include edge angle, condition, and the following retouch characteristics: form, degree of invasiveness, location, and number of retouched margins. No blades, microblades, burins, or associated technology were found in the Bull River II or Costello Creek assemblages.

BULL RIVER II

Flaked debris (n = 566) and tools (n = 13) were recovered from Bull River II. Raw material frequencies consist of blue-gray siltstone (88.9%), sandstone (6.6%), chert (2.8%), basalt (0.7%), claystone (0.7%), and chalcedony (0.3%). All tools in the assemblage are on siltstone. Raw material frequencies among flaked debris mirror the overall assemblage with siltstone as the principal type (88.7%) followed by lesser sandstone (6.7%), chert (2.8%), claystone (0.7%), basalt (0.7%), and chalcedony (0.4%).

All formal tools at Bull River II are biface fragments (N = 5) in various stages of production (stages 1, 2 to 4). Each biface possesses scalar retouch except a stage 2 biface, which is stepped. Biface retouch invasiveness ranges from 16.8 to 32.57 mm and edge angles vary between 25° to 38°. Nearly one in three tools has retouch on one edge (30.8%), but most (46.2%) have two worked edges. Late-stage bifaces are worked on three (15.5%) or four (7.7%) edges.

Informal tools (n = 8) include unretouched utilized flakes (23.1%), a *tci-tho* scraper (7.7%) and a notched flake (7.7%). The *tci-tho* cortical spall has stepped retouch on two lateral margins. Retouched flakes tend to be unifacially worked with marginal and scalar retouch forms. The notch measures 11.35 mm on the right lateral margin of a distal flake fragment that bears no other retouch. No hammer or anvil stones were recovered.

Tools and flake debris show a range of cortex preservation. The *tci-tho* scraper is the only tool with >90% dorsal cortex; an unhafted biface (stage 2) has 51–90% cortex and the remaining tools (84.6%) lack cortex (Fig.

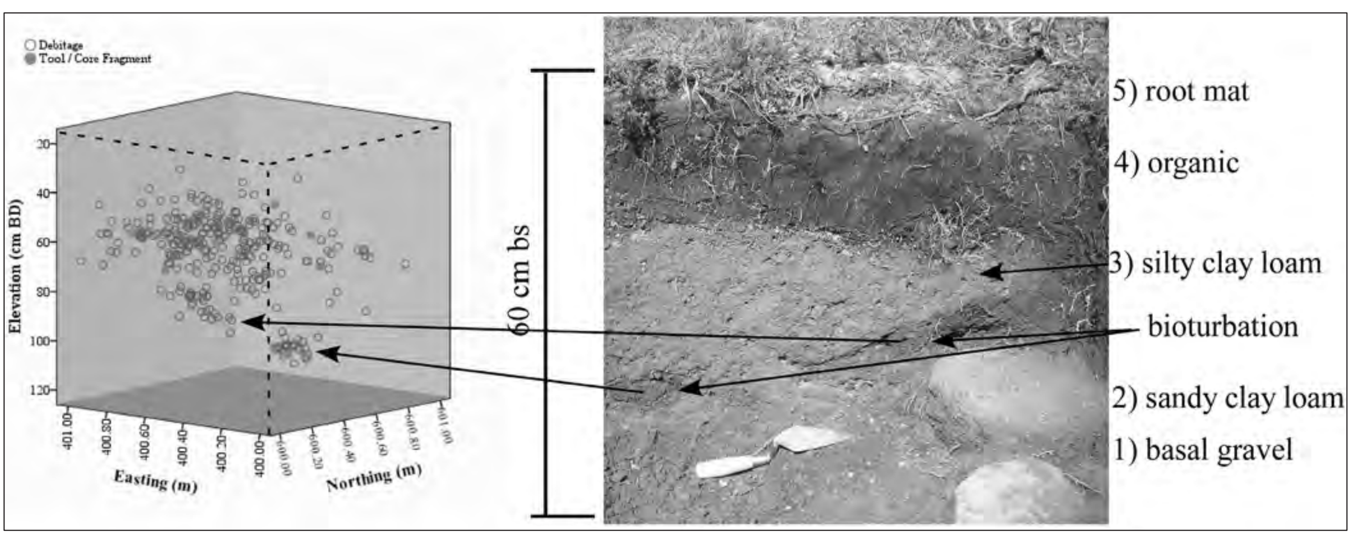

Figure 5. Stratigraphic profile and block diagram from Costello Creek, highlighting artifacts displaced through upward through cryoturbation and downward through bioturbation.

6). Among flaked debris, 75.8% lack cortex while 17.3% have greater than 90% cortex. The majority of tools from Bull River II are between 5 and 7 cm in size (92.3%) and one is 7 to 9 cm. Flaked debris ranges in size from >1 cm (3%), 1 to 3 cm (57.1%), 3 to 5 cm (28.3%), 5 to 7 cm (9.2%), 7 to 9 cm (1.6%), and 9 to 11 cm (0.9%).

Most tools are broken (61.5%) and lack an identifiable platform (53.8%). When platforms are present, most are simple (38.5%) followed by cortical platforms (7.7%). None of the platforms on tools are complex or crushed. On flaked debris, platform preparation includes simple (36.9%), complex (14.5%), cortical (7.1%), and unidentifiable (41.5%) varieties. Debitage type classifications include complete (29.2%) and fragmented flakes (35.5%) produced primarily from siltstone cobbles. Primary core reduction is represented by angular shatter (4.2%), primary and secondary cortical spalls (21%), and fragmented multidirectional flake cores (0.9%). When complete flakes are counted (n = 165), flaked debris associated with core reduction equals more than 55% of the debitage assemblage. Biface thinning flakes (7.4%) and retouch chips (1.1%) indicate biface production was common but more refined retouching activities were less frequent.

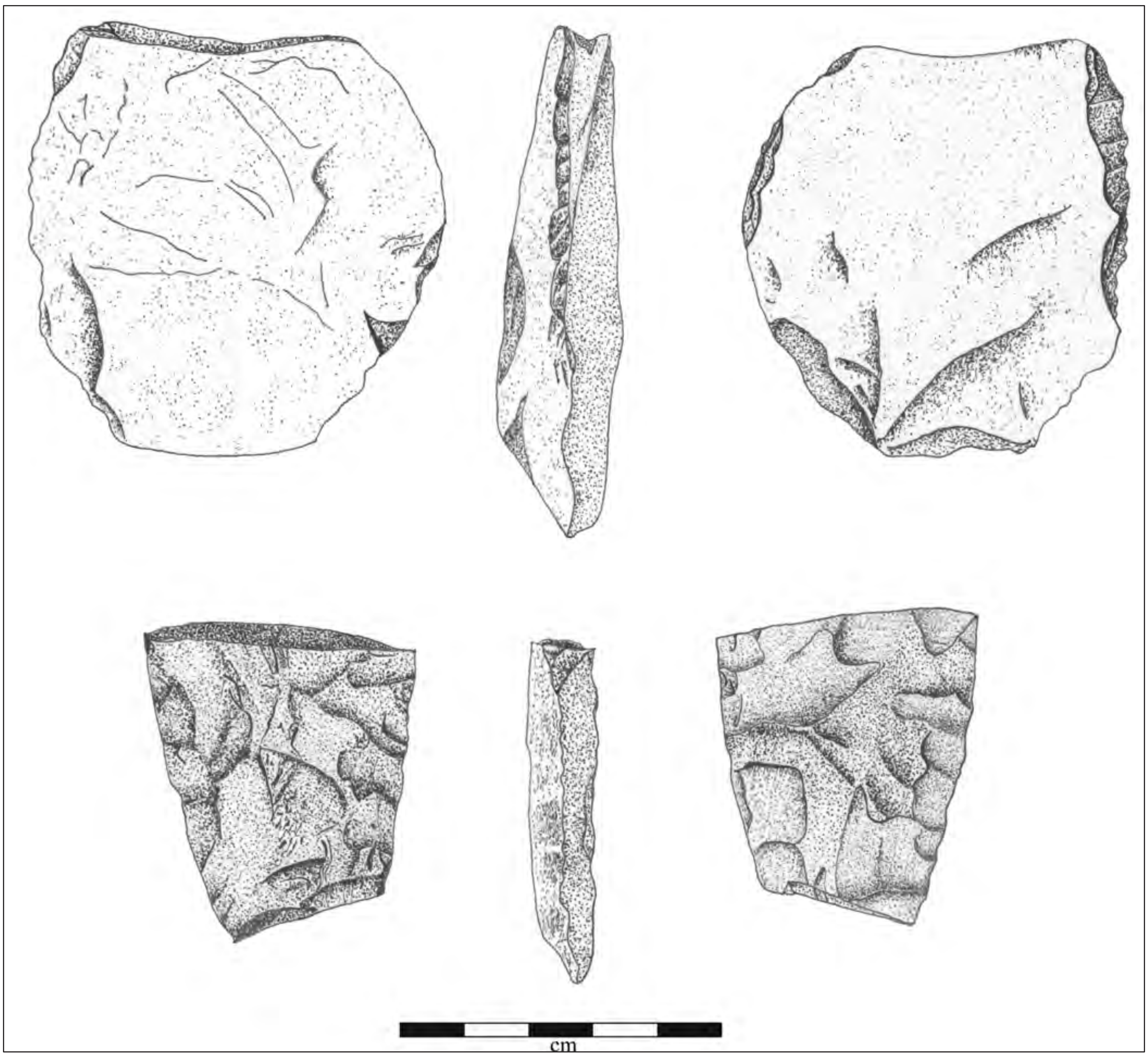

Figure 6. *Tci-tho* ***and biface fragment from Bull River II. Drawing by Evan Pellegrini.***

COSTELLO CREEK

The Costello Creek lithic assemblage contains 422 pieces of flaked debris and 4 tools. The assemblage is dominated by siltstone (91.8%), primarily a brown to tan variety, with lesser amounts of sandstone (5.2%), basalt (2.3%), and chert (0.7%). Because there are only four tools in the assemblage, raw material frequencies of flaked debris closely mirror the assemblage as a whole (Table 3): siltstone (92.2%), sandstone (5.2%), basalt (2.1%), and chert (0.5%).

The tool assemblage consists of a side scraper on brown siltstone with stepped retouch on the lateral margins, a retouched flake, also on brown siltstone, with marginal retouch, a notched flake on tan chert (notch size = 20.38 mm) with an edge angle of 44°, and an unretouched utilized flake on basalt. No hammer or anvil stones were recovered at Costello Creek. All tools were manufactured on flakes and only the notched flake was a complete specimen. These tools are considered informal because they were expediently manufactured and discarded in a single setting.

The only tool in the Costello Creek assemblage with dorsal cortex is the retouched flake with 51–90% surface coverage. Among flaked debris, 84.1% lack cortex and 11.6% posses greater than 90% dorsal cortex. Two tools are between 1 and 3 cm, and one is 3 to 5 cm, another is 5 to 7 cm. Flaked debris size classes range from <1 cm (1.7%), 1 to 3 cm (64.2%), 3 to 5 cm (25.1%), 5 to 7 cm (6.2%), 7 to 9 cm (2.1%), 9 to 11 cm (0.5%), and 11 to 13 cm (0.2%).

Simple platforms are preserved on two of the tools at Costello Creek and no platforms are preserved on the remaining tools. Platform preparation on flaked debris includes simple (34.2%), complex (15.4%), cortical (9.3%), and unidentifiable (32.5%) varieties. Debitage types include complete flakes (33.7%), fragmented flakes (33.3%), biface thinning flakes (13.3%), retouch chips, chip fragments (<1%), and a blade-like flake (0.5%). Detritus from primary reduction activities includes primary (10.9%) and secondary (3.1%) cortical spalls and angular shatter (4.2%). The frequency of debitage types suggests biface production was common at the site and more than half (51.9%) of flaked debris is consistent with core reduction activities.

DISCUSSION

In both assemblages, raw material types are skewed in favor of siltstone (Table 2) and tools were recovered in frequencies too low for meaningful statistical analyses (Table 3).

Table 2. Raw material frequencies at Bull River II and Costello Creek.

	Bull River II						Costello Creek					
	Debitage		Tools		Total		Debitage		Tools		Total	
Raw Material	N	%	N	%	N	%	N	%	N	%	N	%
Basalt	4	0.7	—	—	4	0.7	9	2.1	1	25	10	2.3
Chalcedony	2	0.4	—	—	2	0.3	—	—	—	—	—	—
Chert	16	2.8	—	—	16	2.8	2	0.5	1	25	3	0.7
Sandstone	38	6.7	—	—	38	6.6	22	5.2	—	—	22	5.2
Siltstone	502	88.7	13	100	515	88.9	389	92.2	2	50	391	91.8
Claystone	4	0.7	—	—	4	0.7	—	—	—	—	—	—
Total	566	100	13	100	579	100	422	100	4	100	426	100

Table 3. Tool class frequencies at Bull River II and Costello Creek.

	Bull River II		Costello Creek		Total	
Tool Type	N	%	N	%	N	%
Biface unhafted	5	38.5	—	—	5	29.4
Flake tool	3	23.1	1	25	4	23.5
Retouched flake	3	23.1	1	25	4	23.5
Side Scraper	—	—	1	25	1	5.9
Tci-tho	1	7.7	—	—	1	5.9
Notch	1	7.7	1	25	2	11.8
Total	13	100	4	100	17	100

Tools in common between the Bull River II and Costello Creek assemblages include expedient notched flakes and flake tools. While late-stage biface fragments dominate the Bull River II assemblage, no bifacial fragments were recovered at Costello Creek. However, the percentage of biface thinning flakes comprised more than 13% of that assemblage. These sites lack microblade technology and do not fit traditional Denali or Nenana complex designations (Goebel et al. 1991; Powers and Hoffecker 1989; West 1996).

Survey of the Camp Creek tributary directly between Bull River II and Costello Creek revealed an abundant supply of sedimentary rocks including siltstone, sandstone, and claystone. Blue-gray banded and brown to tan siltstone varieties comprise the bulk of raw material types in both site assemblages. Smaller amounts of chert, basalt, and chalcedony also occur among the flaked debris, are probably nonlocal in origin because these lithic types lack cortex, and were not observed in local tributaries. Chalcedony flakes recovered from Bull River II are similar in color and texture to artifacts from the Trapper Creek Overlook site in the Susitna River lowlands (Wygal 2009). While the source of this material is currently unknown, Coffman (2006) recovered a similar chalcedony cobble from natural deposits in Hurricane Gulch, an eastern tributary of the middle Chulitna River about 30 km south of Bull River II.

Obsidian artifacts were recovered at two nearby locations, HEA-232 and Camp Creek II (HEA-391), near the Bull River II site. Archaeologists at the Smithsonian Institution used X-ray fluorescence (XRF) to compare the chemical composition of the specimens to an extensive database of Alaska obsidian. The results were a "solid match" with Cook's (1995:97) group K obsidian, which has also been recovered from Dry Creek component II (R. J. Speakman pers. comm. 2007), suggesting the prehistoric occupants of Dry Creek component II procured obsidian from the same source as people in the Bull River valley.

Tools and degree of dorsal cortex are indicators of the relative distance an artifact has traveled from the procurement source. More dorsal cortex is expected for artifacts found nearer the source than those found farther away (Feder 1980; Newman 1994). This measure is amplified in high latitudes since procurement of lithic material is more difficult during winter months (Wygal 2009:88, 112). Tools at Bull River II range from 3 and 7 cm in maximum size and two tools possess more than 50% dorsal cortex. While Costello Creek produced few tools, most are between 3 and 5 cm with a slightly higher percentage of cortex than at Bull River II (Table 4). Given the size and degree of cortex on the tools from both sites, it is reasonable to assume the toolstone was procured nearby. This interpretation is also supported by the presence of locally available raw material in the assemblages.

Amount of dorsal cortex and measurements on flaked debris are also indicative of core reduction activities. A relatively high percentage of the debitage from Bull River II and Costello Creek (15% of the combined total of debitage from both sites) possessed more than 90% dorsal cortex (BR = 17.3%; CC = 11.6%). The percentage of flakes measuring 1 to 3 cm was also consistent between the two sites (BR = 51.7%; CC = 64.2%). Flakes between 3 and 5 cm are also prevalent (BR = 28.3%; CC = 25.1%) but debitage pieces less than 1 cm in size are relatively rare (BR = 3%; CC = 1.7%). These percentages are another good indication that raw material was worked near its procurement source.

Debitage type frequencies are remarkably similar between the sites with relatively high numbers of complete flakes and cortical spalls and low numbers of retouch chips

Table 4. Artifact size class frequencies at Bull River II and Costello Creek.

	Bull River II						Costello Creek					
	Debitage		Tools		Total		Debitage		Tools		Total	
Size (cm)	N	%	N	%	N	%	N	%	N	%	N	%
< 1	17	3.0	—	—	17	2.9	7	1.7	—	—	7	1.6
1–3	323	57.1	—	—	323	55.8	271	64.2	2	50	273	64.1
3–5	160	28.3	—	—	160	27.6	106	25.1	1	25	107	25.1
5–7	52	9.2	12	92.3	64	11.1	26	6.2	1	25	27	6.3
7–9	9	1.6	1	7.7	10	1.7	9	2.1	—	—	9	2.1
9–11	5	0.9	—	—	5	0.9	2	0.5	—	—	2	0.5
11–13	—	—	—	—	—	—	1	0.2	—	—	1	0.2
Total	566	100	13	100	579	100	422	100	4	100	426	100

and chip fragments (Table 5). Three or more flake scars, with the largest scars ranging from 23 to 68 mm, characterize multidirectional core fragments from both sites. Worked margins on cores varied from a single retouched margin to all margins with flake scars.

Among flaked debris, platform preparation is uniform between the assemblages, with simple platforms dominating. The relatively common occurrence of cortical platforms in both assemblages (BR = 7.1%; CC = 9.3%) is an indication of primary core reduction. Complex platforms, which typically occur on bifacial thinning flakes, are also common (BR = 14.5%; CC = 15.4%).

To better assess flaking behavior between the assemblages, I applied a series of intersite tests on a variety of lithic attributes. To compare reduction intensity, the Mann-Whitney statistic was used to determine if the mean ranks of flake size class frequencies were different between the Bull River II and Costello Creek assemblages. The results indicate that flake size classes are statistically equivalent between the assemblages (u = 113330.50, a = –1.573, p = 0.116, two-tailed). Reduction stage and intensity were examined further by categorizing each assemblage based on debitage weights. The weights of individual debitage pieces are an exact measure of flake mass and thus an indication of reduction stage because smaller mean weights of flaked debris represent smaller flake sizes (Odell 2004:126; Shott 1994:80). Statistical tests indicate that the mean weights of flaked debris at Bull River II and Costello Creek are statistically equivalent, suggesting that similar flake reduction behaviors occurred.

Table 5. Flaked debris frequencies at Bull River II and Costello Creek.

Debitage Class	Bull River II N	Bull River II %	Costello Creek N	Costello Creek %	Total N	Total %
Flake fragment	201	35.5	140	33.2	341	34.5
Complete flake	165	29.2	141	33.4	306	31.0
Blade-like-flake	2	0.4	2	0.5	4	0.4
Prim. cortical spall	94	16.6	46	10.9	140	14.2
Sec. cortical spall	25	4.4	13	3.1	38	3.8
Retouch chip fragment	2	0.4	1	0.2	3	0.3
Retouch chip	6	1.1	3	0.7	9	0.9
Bifacial thinning flake	42	7.4	56	13.3	98	9.9
Angular shatter	24	4.2	16	3.8	40	4.0
Worked chert cobble	—	—	1	0.2	1	0.1
Core fragment	5	0.9	3	0.7	8	0.8
Total	566	100	422	100	988	100

Because platform types are indicative of patterns in lithic reduction (e.g., percussion versus pressure flaking techniques), distinctions in flaking behaviors can be assessed by differences between platform type frequencies (Andrefsky 1998; Odell 2004). No significant differences in platform preparation between Bull River II and Costello Creek were detected using chi-square analysis.

The density of deposits and attribute analysis support the hypothesis that lithic reduction and biface production of locally available siltstone were the primary activities undertaken at the Bull River II and Costello Creek sites. Statistical tests indicate that stone knapping behaviors were similar between the two sites. If multiple palimpsest assemblages were deposited at these sites, then the activities undertaken during each occupation event were remarkably similar. Moreover, site locations are not particularly distinct, i.e., there are no unique topographical features on the landform. This is particularly evident along the 2-km ridge containing Bull River I, Bull River II, and the HEA-232 sites, where any single location is as ideal as the next, thereby limiting the probability of mixed assemblages.

The assemblages presented here were recovered from relatively small-scale test excavations, a 1-m^2 unit at Costello Creek and 3 m^2 at Bull River II. Some researchers have argued that sample sizes account for significant analytical problems (Rhode 1988). However, others (Mason et al. 2001:531) maintain that increasing an excavated area, even substantially, would not necessarily resolve sampling issues in assemblage variability.

SEASONAL LAND USE AND TECHNOLOGICAL ORGANIZATION

The alpine setting of Bull River II and Costello Creek is in close proximity to ice patches and other upland resources. Assuming this region was unoccupied during harsh winter months leads to hypotheses *vis-à-vis* seasonal rounds and technological organization in the central Alaska Range between 12,500 and 8,000 cal BP. Many Late Pleistocene/early Holocene sites in the Nenana and Tanana River valleys occupy bluff-top overlook positions which Guthrie (1983) argued were logistical spike camps. However, the Healy Lake site diverges from this common pattern because it reportedly contained artifacts reminiscent of more than one lithic industry and multiple activities. Thus, Healy Lake was originally considered a substantial base camp rather than a hunting outpost (Cook 1996; Yesner 2001:319). Early to middle Holocene assemblages at

Whitmore Ridge and Butte Lake in southcentral Alaska are reminiscent of Healy Lake in that they contained both bifaces and extensive microblade production facilities and are represented by relatively high artifact frequencies near large lakes (Betts 1987; West et al. 1996). Dry Creek component II arguably fits this mold; although not along a lakeshore, it is near Eight Mile Lake and adjacent to an excellent raw material source in the Dry Creek riverbed. Dry Creek component II contained evidence of butchering, microblade core preparation, and bifacial projectile points within the assemblage (Hoffecker et al. 1996; Powers and Hoffecker 1989; Powers et al. 1983).

These site types may represent late fall to early winter occupations where remnants of fall hunting toolkits merge with activities associated with winter gear-up. Late fall to early winter would have been a rich season when hunter-gatherers could congregate, trade and visit prior to the lean late winter and early spring times when groups may have dispersed into smaller family units and hunted river lowlands to survive. A similar pattern has been observed among traditional Athapaskan groups in central and southcentral Alaska (Kari and Fall 2003). Although Athapaskan economies relied heavily on the seasonal abundance of salmon (a resource that likely did not materialize until the middle Holocene) and less on big game hunting from overlook positions, it is reasonable to assume hunter-gatherers practiced similar seasonal rounds during the Late Pleistocene and early Holocene (Wygal 2009). If they did, assemblage variability in conjunction with site setting could be a powerful indicator of technological organization. Future research at Bull River II and Costello Creek will be modeled to test this hypothesis.

CONCLUSIONS

Survey and test excavations of Bull River II and Costello Creek in the mountains south of Broad Pass, Denali National Park and Preserve, revealed new evidence on the prehistoric occupation of upland areas in the central Alaska Range. These sites are significant because they provide evidence for the early prehistoric use of alpine resources, evidence that is currently underrepresented in the Alaska archaeological record. Although limited testing has been undertaken thus far, the relatively dense deposits have yielded sizable lithic assemblages. Lithic analyses indicate similarities between raw material selection and flaked debris, suggesting lithic reduction and biface production were the primary activities at both locations. Evidence of core reduction and biface manufacture was recovered, but evidence of microblade technologies was not found in any of the sites documented in this survey; the assemblages do not readily fit currently defined techno-complexes. An intact cultural horizon at Bull River II yielded carbon-rich stains associated with artifacts and clusters of charcoal. AMS radiocarbon dates on four fragments of charred plant remains date the occupation to between 12,500 and 12,300 cal BP. Because prehistoric foragers were likely highly mobile, these sites may represent a wider economic system based on the seasonal organization of technology and landuse.

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RETHINKING SUBSISTENCE IN SOUTHEAST ALASKA: THE POTENTIAL OF ZOOARCHAEOLOGY

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ABSTRACT

Subsistence use of fish and game in Alaska is tangled in a web of contradictory and complex state and federal legislation and regulation. The institutional structures that have metastasized with subsistence regulation illustrate how technologies of government have restructured people's lives and livelihoods. I argue that zooarchaeological research can help Alaska Natives assert their rights to continue to use resources as they have for thousands of years in an increasingly bureaucratic world. Use of fish and wildlife is central to Alaska Natives' ongoing struggles to retain their cultures and identities. Subsistence is very much about race and the struggle of Alaska Natives to maintain their cultures in the face of global homogenization. This article points to ways archaeologists, especially zooarchaeologists, can re-evaluate our social roles and contribute to the decolonization of subsistence.

KEYWORDS: Tlingit, historical ecology, resource management, subsistence

INTRODUCTION

The term "subsistence" is routinely used by archaeologists to refer to how a group of people obtain basic food and shelter. In North America, the focus of most subsistence studies has been on how people acquire food, whereas studies of "shelter," focusing on dwellings, houses, other domestic architecture, village layout, etc., fall within the realm of spatial, household, or community archaeology. In zooarchaeological and paleoethnobotanical studies, the term "subsistence" is frequently used; "subsistence" is also commonly used as an adjective, as in "subsistence strategies," "subsistence pattern," "subsistence economy," or "subsistence-settlement system." Reitz and Wing (1999:28) state that "[s]ubsistence research requires study of both the biological needs that diets meet and the strategies by which humans procure dietary components." They also state that "[s]ubsistence strategies are the target of most current zooarchaeological research" (Reitz and Wing 1999:28), although in 2008, they qualified this to say that "[s]ubsistence strategies are the target of *much* research" (Reitz and Wing 2008:28; emphasis mine).

To speakers of English, "subsistence" is understood as the means of making a living. Despite its superficial simplicity, the term actually has multiple meanings in different contexts. For example, "subsistence" is often assumed to mean the bare minimum necessary to survive economically. For example, a subsistence economy is defined as one:

> in which a group attempts to produce no more output per period than they must consume in that period in order to survive, but do not attempt to accumulate wealth or to transfer productivity from one period to the next. In such a system, a concept of wealth may not exist, and there is a reliance on renewal and reproduction within the natural environment. For this reason subsistence economies are often lauded by environmentalists who consider investment economies to be too much of a strain on the environment (Wikipedia 2009).

While the minimalism or marginality of subsistence is recognized as difficult and challenging, at the same time it can be valorized, as in the above quote in which a subsistence economy is praised for its low impact on the environment. Anything beyond the bare minimum is not really "subsistence" by these definitions. In this paper, I suggest that the precontact Tlingit and Haida economies—and perhaps those of other Northwest Coast groups—were not merely "subsistence" economies. Members of these societies worked hard to acquire wealth, above and beyond what was necessary to merely survive. This is just one of many complications in debates over the varied meanings of "subsistence" and how the term is used today.

The term "subsistence" has an interesting history in anthropology and an even more convoluted history in Alaska. Today, it is a term embraced by some Alaska Natives as denoting a lifestyle worthy of legal protection. It is a term rejected by other Alaska Natives because of pejorative connotations, some of which can be traced back to its nineteenth-century usage by social scientists. Some people believe that subsistence is under threat in Alaska; others believe that fish and wildlife are under threat by subsistence uses. The specific threats to subsistence, or to fish and wildlife, are perceived differently in different communities.

In this paper, I deconstruct the term "subsistence" for the ultimate purpose of showing how received knowledge and conventional ways of thinking limit the impact archaeology can have in the modern world. I start by discussing the origins of the term "subsistence" in anthropology to show how the term is burdened with cultural evolutionary, ethnocentric, and racist connotations that remain with us today. I then focus on subsistence in Alaska, where the term occurs in both federal and state laws. "Subsistence" in Alaska has been a site of considerable political struggle, between state and federal governments, between rural and urban communities, and between Alaska Natives and non-Native Alaskans. The laws, and the regulations that have been developed to institutionalize them, have evolved over the last thirty-plus years into a complex maze that Alaska Natives are forced to navigate. Many cultural anthropologists are now employed by state and federal governments, and they play key roles in the documentation, legitimization, and bureaucratization of subsistence. Although cultural anthropologists have contributed to knowledge and management of subsistence, the work of archaeologists—and for the purposes of this paper, the work of zooarchaeologists—has heretofore not made a significant impact. Contemporary struggles over "subsistence" reflect both the colonialist history of the term and how anthropologists have mediated between Native and government interests. I then illustrate some of the diverse perspectives on subsistence in Alaska Native communities and how archaeological perspectives on "subsistence" are too narrowly conceived to make much of a difference in contemporary struggles. "Rethinking subsistence" involves evaluating the results of our work in ways that can help bridge the gaps between Native and non-Native perspectives and between fishers, hunters, collectors, and regulators.

SUBSISTENCE AS AN ANTHROPOLOGICAL CONCEPT

Even before anthropology developed as a discipline, European thinkers used subsistence to classify "others." Stages of social evolution based on subsistence date at least to the mid-eighteenth century. As Pluciennik (2001:741–742) has shown, "philosophies of history, concepts of property and the idea of improvement" underlay the idea that humans progressed from savage hunters to barbarian pastoralists to civilized farmers, and ultimately, to the age of commerce. Agriculture was viewed as the main source of wealth, and colonial conflicts were largely about seizing land and converting it to property. Making productive use of land through agriculture was thought both rational and moral, hence appropriation of lands in the Americas and elsewhere became moral imperatives. Without colonial invasions, the "fertility and abundance" of the Americas could not reach its God-given potential, since the indigenous people would continue to leave it "unmanaged and unimproved" (Pluciennik 2001:742). From Thomas Jefferson onward, the introduction of farming was meant to "civilize the Indians."

In Lewis Henry Morgan's (1877) treatise *Ancient Society*, he identified seven "ethnical stages" including lower, middle, and upper stages of savagery, lower, middle, and upper stages of barbarism, and civilization. Morgan also specified seven "constants" of society: Subsistence, Government, Language, Family, Religion, House Life and Architecture, and Property. Morgan dedicated an entire chapter to the "successive arts" of subsistence; these were "Natural Subsistence," "Fish Subsistence," "Farinaceous Subsistence" (cultivation of cereals), "Meat and Milk Subsistence," and "Unlimited Subsistence through Field Agriculture." In such a scheme, hunters were fully dependent on nature, while farmers had cultural means—technical, social, mental, and moral—that placed them in a superior position to nature. Morgan's thinking was highly influential during the nineteenth century and beyond—it was required reading for all staff of the Bureau of American Ethnology (Pluciennik 2001:747). Such thinking was embedded in the archaeology of the day by Worsae, de Mortillet, and Childe, who tried to correlate technological ages, such as the Paleolithic, Mesolithic, and Neolithic, to subsistence stages (Pluciennik 2001:747–748). These notions of subsistence informed the development of the concept of mode of production developed by Engels in *The Origins of the Family, Private Property and the State* and all that followed in Marxism. Peake (1927) went on to use subsistence to distinguish "producers" from "exploiters" (Pluciennik 2001:749). While producers raised crops or domestic animals, exploiters hunted game and birds and collected shellfish, nuts, and berries. Peake (1927:21–22) wrote that producers "had started on the road to civilization," while the exploiters are "clearly uncivilized, even if we hesitate to call them barbarous or savage."

Although Boas and his students turned away from such unilinear schemes of social evolution in the early twentieth century, subsistence remained important as a trait to be compared cross-culturally, within and between culture areas. The importance of subsistence was reinvigorated in the work of neoevolutionists Leslie White and Julian Steward by the mid-twentieth century. Steward (1955:37) saw subsistence activities as the center of the cultural core of societies. Attention to subsistence and its ecological context were used to rehabilitate social evolution.

The word subsistence thus carries a great deal of social evolutionary baggage. Even today, anthropologists and archaeologists devote considerable energy to comparing and contrasting types of people: we study hunter-gatherers and compare them to farmers; for some, the term "forager" has replaced hunter-gatherer. Archaeologists talk about the subsistence base of an economy, the subsistence pattern people use to obtain food and other necessities, or the subsistence-settlement systems people develop to use land and resources. Many archaeologists obsess about the origins of agriculture and domestication and the transition from foraging to farming. Unfortunately, we are not always aware of the cultural evolutionary, ethnocentric and, some would claim, racist origins of these anthropological constructions. This is essential background for understanding part of the context underlying the term subsistence as used by social scientists. But subsistence has additional meanings in Alaska.

SUBSISTENCE REGULATION IN ALASKA[1]

With regard to resource management in the United States, both the federal government and the governments of each of the 50 states have their own authorities and jurisdictions. In Alaska, subsistence is regulated by both federal and state laws, depending on land status and the resource in question. Over time, federal and state responsibilities have shifted with political struggles played out in Washington, D.C. and in Juneau. Between 1959 and 1978, all fish and game were open to all Alaska residents on a "first come, first served" basis. As populations grew, subsistence-dependent Native villages struggled. In 1971, to facilitate construction of the Trans-Alaska Oil Pipeline, Congress passed the Alaska Native Claims Settlement Act (ANCSA). ANCSA extinguished "any hunting or fishing rights that may exist" for almost $1 billion and forty-four million acres of land in compensation. Although it didn't explicitly protect Native subsistence, a conference report that accompanied the law stated that subsistence resources on state and federal lands would be protected. Native communities made many right-of-way and other concessions that allowed the pipeline to be built. They did so in return for promises of subsistence protections. In 1978, the State of Alaska enacted its first subsistence law that required boards of fish and game to give preference to subsistence uses over commercial and sports uses.

In 1980, the U.S. Congress passed the Alaska National Interest Lands Conservation Act (ANILCA) which created new national wildlife refuges and public recreation lands. ANILCA mandated that the state maintain a subsistence hunting and fishing preference for rural residents and allow them customary and traditional use of federal lands or forfeit its management of subsistence uses there. Even though ANILCA does not provide for subsistence preferences based on ethnicity, it acknowledges a difference between Native and non-Native subsistence. ANILCA states that subsistence is "essential to Native

1. This section was compiled largely from Alaska Federation of Natives (1998), Case and Voluck (2002), and United Fishermen of Alaska (2008). The Alaska Federation of Natives is the largest statewide Native organization and includes 178 villages (both federally recognized tribes and village corporations), 13 regional Native corporations and 12 regional nonprofit and tribal consortia. The United Fishermen of Alaska is a statewide organization composed of 32 commercial fishing organizations, as well as individual and business members.

physical, economic, traditional and cultural existence, but only to non-Native physical, economic, traditional and social existence" (Wheeler and Thornton 2005:70). This is a fairly subtle distinction, with the words "cultural existence" reserved for Alaska Natives.

Between 1981 and 1989, the state struggled to comply with ANILCA, and some non-Native Alaskans became vehemently "antisubsistence." In 1986, the Alaska legislature amended state law to limit subsistence uses to residents of rural areas, but in 1989, the state supreme court found that the rural preference violated the Alaska constitution. At that point, the state was clearly not in compliance with the federal law, ANILCA. After special legislative sessions and other failed attempts, the federal government seized authority for subsistence on federal land in 1990. In 1995, the U.S. Ninth Circuit Court of Appeals ruled that the ANILCA subsistence priority extended to rivers, streams, lakes, and other freshwater bodies within and adjacent to federal lands. Between 1997 and 2001 various efforts to try to bring state fisheries law into compliance with ANILCA failed, and the federal government took over subsistence fishery management.

Federal management of subsistence is administered by the Office of Subsistence Management (a branch of the U.S. Fish and Wildlife Service) in Anchorage and regulated by the six-member Federal Subsistence Board. The chairman of the board is appointed by the U.S. secretary of interior; the other board members are the regional directors of the federal agencies that manage ~60% of Alaska land: U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs and U.S. Forest Service. The federal regulatory process begins with an annual call for proposals from the public. Proposals are reviewed by ten regional advisory councils around the state that consider proposed changes. Regional advisory council members are local residents appointed by the secretaries of interior and agriculture. A proposal recommended by a regional council can be rejected by the Federal Subsistence Board only if it is not supported by substantial evidence, violates principles of wildlife conservation, or would harm subsistence. The regional councils meet twice a year: once in the fall, to recommend subsistence fish proposals and again in the winter, to recommend wildlife proposals. Proposals are forwarded to the Federal Subsistence Board, which meets in a public venue twice a year. Other legal mandates regulating subsistence are the Marine Mammal Protection Act and the Migratory Bird Act. Subsistence fishing for halibut is further regulated by the North Pacific Fisheries Management Council. Besides considering proposals to change regulations, making "customary and traditional" determinations, and deciding rural and nonrural designations, the board is authorized to close federal lands to nonsubsistence uses and take actions necessary to provide for subsistence outside of the proposal process. The multimillion-dollar Fisheries Resource Monitoring Program was initiated in 2000, in response to the federal takeover of subsistence fisheries (Wheeler and Craver 2005:15).

While the federal government manages subsistence on federal lands, the state government has a separate program for managing subsistence on state lands, encompassing about 40% of Alaska, including most marine waters. The two programs differ in who is eligible for subsistence, where subsistence is allowed, how uses are defined and how decisions are made. The state does not allow subsistence fishing or hunting in nonsubsistence areas around Anchorage, Fairbanks, Juneau, Ketchikan, and Valdez.

Under federal law, rural Alaska residents are eligible for the subsistence priority. Rural residents make up about 20 percent of Alaska's population. Rural residents are defined as all Alaskans except those living in and around Anchorage, Fairbanks, Juneau, Ketchikan, Adak, Valdez, Wasilla, Palmer, Homer, Kenai and Soldotna. Under state law, all Alaskans are potentially eligible for the subsistence priority.

State management is administered by the Alaska Department of Fish and Game, particularly its divisions of Subsistence, Commercial Fisheries, and Wildlife Conservation. Under state management, a subsistence decision begins with a determination that a portion of a fish stock or game population can be harvested for subsistence consistent with sustained yield. The Board of Fisheries or Board of Game then determines how much of the harvestable portion of the population is "reasonably necessary for subsistence uses." Regulations are then adopted that provide a "reasonable opportunity for subsistence uses" (Alaska Statute 16.05.258).

State of Alaska subsistence regulations are developed by the Board of Fisheries and the Board of Game at their annual meetings. Each board is comprised of seven citizens appointed by the governor and confirmed by the legislature. Each board meets several times a year to consider proposals and take other action. The boards have authority to close and open seasons, set bag limits, and establish methods and means of subsistence harvest. They determine what fish stocks or game populations are customarily or traditionally taken for subsistence. The Boards consider subsistence proposals alongside proposals to change regulations for commercial, sport, and personal uses. The state boards receive recommendations from about eighty local advisory committees across the state. The committees are "grass roots" groups that have as many as fifteen members, each elected by their community or region of jurisdiction.

Under the federal program, rural residents may take fish or game for subsistence on federal lands and waters unless prohibited by federal regulation. That general allowance for subsistence is narrowed by "customary and traditional" use determinations, which limit subsistence uses of fish stocks or game populations in a particular location to a specific subgroup of rural residents. Customary and traditional use is defined as "a long-established, consistent pattern of use, incorporating beliefs and customs which have been transmitted from generation to generation (and) plays an important role in the economy of the community" (United Fishermen of Alaska 2008). In making a customary and traditional use determination, the federal board considers eight factors: a long-term and consistent pattern of use, uses recurring in specific seasons, uses involving methods of harvest that are efficient and economic, harvests and uses that are related to past ones and are reasonably accessible to a community, methods of handling and preserving resources that are traditional, allowing for some alteration for technological advances, uses involving the handing down of knowledge of harvest skills, values and lore from one generation to the next, uses in which harvests are shared within a defined community, and uses that involve reliance on a wide variety of resources and provide an area with cultural, economic, social, and nutritional elements. A use does not have to meet all factors to be determined "customary and traditional" by the federal subsistence board.

In state law, "customary and traditional" means "the noncommercial, long-term and consistent taking of, use of, and reliance upon fish or game in a specific area and the use patterns of that fish or game that have been established over a reasonable period of time, taking into consideration the availability of the fish or game" (United Fishermen of Alaska 2008). Under state law, the boards of fish and game identify stocks with customary and traditional uses, using eight criteria similar to those under federal regulation. Under state regulation, all eight criteria must be met to establish a customary and traditional use. The state then establishes an amount necessary to provide a reasonable opportunity for subsistence harvests of each stock with a customary and traditional designation.

Federal law allows subsistence managers to differentiate among subsistence users when fish stocks or game populations are not sufficient to meet subsistence demand. To determine subsistence eligibility at such times regulators consider: (1) customary and direct dependence upon the populations as the mainstay of livelihood, (2) local residency, and (3) availability of alternative resources. Under state law, if a harvestable portion of a fish stock or game population is not adequate for all subsistence users, the state differentiates users based on: (1) customary and direct dependence on the fish stock or game population by the subsistence user for human consumption as a mainstay of livelihood, and (2) ability of the subsistence user to obtain food if subsistence use is restricted or eliminated. In the case of competing demands or shortages, we see the minimalist and marginal definition of subsistence reaffirmed. Even as regulations have proliferated, anthropologists Wheeler and Thornton (2005:70) have observed that "the subsistence issue remains unresolved and is perhaps the most contentious, intractable public policy dilemma Alaska has faced in its history as a state."

CULTURAL ANTHROPOLOGISTS AND SUBSISTENCE MANAGEMENT

Cultural anthropologists have been involved in subsistence research in Alaska for more than 30 years (Wheeler and Thornton 2005). Even though state regulations emphasize rural, rather than Native or indigenous use, I believe that most research conducted to date focuses on indigenous resource use. Cultural anthropologists recognize subsistence not just as an economic system, but as a cultural system. They point out that subsistence was/is foundational to cultural identity, physical and mental health, cultural survival and political sovereignty. Yet neither federal nor state laws explicitly define subsistence, and Wheeler and Thornton (2005:73–74) stress that subsistence is not synonymous with hunting and fishing rights; subsistence is far more. Analogously, the laws do not protect specific places, only customary and traditional "uses" (Wheeler and Thornton 2005:76). Yet biological paradigms still dominate fish and game management and traditional ecological knowledge (TEK) is rarely considered (Wheeler and Thornton 2005). TEK combines both technical knowledge about resource availability and distribution, as well as procurement strategies, but also information about the worldviews of subsistence users. Presenting TEK in a way that provides a useful repository of information is one of the many challenges of contemporary researchers (Wheeler and Craver 2005).

Since 1978, anthropologists with the Subsistence Division of the Alaska Department of Fish and Game have been working to "document all aspects of subsistence hunting and fishing so that the provisions of state and federal law can be implemented" (Wheeler and Thornton 2005:74). Across the state, Subsistence Division anthropologists have studied more than 190 communities. In 1994, R.J. Wolfe estimated that Alaskans harvested 53.5 million pounds of wildlife resources, with rural harvests comprising 80% of this total (Leask et al. 2001). For southeast Alaska, Subsistence Division anthropologists have published 35 technical reports since the early 1980s. State and federal cultural anthropologists have employed census surveys and key informant interviews and they have gathered oral histories and place name data in GIS systems in efforts to quantify subsistence (Callaway 2001; Wheeler and Craver 2005). These researchers have also participated in subsistence activities themselves. Federal cultural anthropologists are involved with collecting and analyzing data used for Customary and Traditional (C&T) Use Determinations that give community residents status as federally qualified rural subsistence users (Mason and Cohen 2001). To obtain subsistence resources from national parks, rural residents must apply for 13.44 permits (under ANILCA) or be members of a so-called "park resident zone" eligible to participate in subsistence. National Park Service anthropologists also write ethnographic overviews and assessments and collect TEK to document subsistence.

As described in the previous section, state and federal laws regulate the harvest of wild foods for personal or family consumption (Mason and Cohen 2001). In my view, this alone represents an intrusion into a way of life that has an antiquity of over 10,000 years. Hensel and Morrow (1998) describe how many Alaska Native hunters and fishers have been unaware of or uninterested in regulations and have simply tried to live their lives. In some cases, people persist in noncompliance with laws and regulations; in other cases, laws and regulations are actively resisted. Although researchers may have sought to document TEK, Hensel and Morrow (1998:70) warn that "decontextualizing pieces of local knowledge and reincorporating them as information in scientific reports seriously misrepresents indigenous perspectives." Thornton (2001:95) has written that "agencies tend to pursue TEK in an acquisitive and colonizing manner not unlike that of artifact hunters in the nineteenth and early twentieth centuries." Hensel and Morrow (1998:70) show how different worldviews lead managers and Alaska Natives to talk past each other: "Conservation for biologists concerns population numbers and future reproduction. For traditional Yupiit, it concerns proper human behavior." In this way, biological discourse itself, such as an announcement that "no fish are available" can become a self-fulfilling prophecy as it upsets the animals upon which the Yupiit depend (Hensel and Morrow 1998:70). Attempts at "co-management" may be well-meaning, but power inequalities inhere in the relationship between managers and Native communities.

In southeast Alaska, clear-cutting old growth forests by Native corporations created under ANCSA has had severe ecological impacts to the region that threaten both subsistence use of fish and wildlife and the populations themselves (Dombrowski 2007:3).[2] Over 275,000 acres of forest will eventually be clear-cut on corporation lands that overlap with the subsistence territories used by residents of Hydaburg, Klawock, Craig, and Kasaan (Dombrowski 2007:12). Dombrowski believes that the reports of cultural anthropologists working for the ADF&G Subsistence Division systematically underestimate harvest levels by the most active subsistence users. For example, while George and Bosworth's (1988) study reported no Angoon household harvested more than twelve deer per year (the legal limit for a two-adult household), the deer hunters Dombrowski worked with took as many as thirty to forty deer per year (Dombrowski 2007:16). These deer hunters obviously will not report such numbers to ADF&G researchers; while the ethnographers seek actual numbers, ADF&G enforcement personnel could arrest, fine, or confiscate equipment of such deer hunters. Yet these are the deer hunters whose families rely on subsistence for their livelihoods, since a full commitment to subsistence living precludes regular employment. At the same time, subsistence hunters and fishers require access to cash—usually through other family members—to purchase gas and maintain their boats and other equipment.

2. Dombrowski (2002) shows how the intersection of timber industry politics with those of ANCSA corporations has resulted in the "award" of resources to indigenous groups that are then forced to overexploit them.

While to some, subsistence is a "lifestyle," to others, it is a "livelihood" in the more marginal, economic sense of the word. In Dombrowski's (2007:10) words, "subsistence users in every village are now caught between the Scylla of decreasing resources and the Charybdis of intensifying village inequality—both of which have the effect of pushing them into more intense dependence on disappearing subsistence resources."

Dombrowski argues that ANCSA has intensified local inequalities in Native communities across southeast Alaska. He suggests that cultural anthropologists have failed to capture the important role "Indian foods" play in contemporary ceremonial and political events. At such large gatherings, such foods mark these functions as "Native" and are valorized for their symbolic and social meanings. As Dombrowski (2007:13) states,

> 'Indian foods' come to be seen as icons of Native lifeways, any threat to their viability becomes, by extension, a threat to the community they mark. In this way Native foods and the subsistence practices that produce them become a sign not just of the community, but of its potential dissolution, and hence the need for greater solidarity—even across the economic lines that separate those who supply the food from those who sponsor the events at which they are consumed.

Thornton (2001:90) and others (Wolfe et al. 2007) have shown how individual bag limits and other regulations fail to accommodate the communal aspects of subsistence. Even though subsistence is crucially important to cultural and clan identity, physical and psychological health, and to spiritual balance (Langdon 2000, 2006a, 2007; Monteith 2008; Thornton 1998, 2001; Worl 2002), competing interests within indigenous groups cannot be overlooked.

GOVERNMENTALITY AND TECHNOLOGIES OF GOVERNMENT

Anderson (2001:317) claims that Alaska Natives are subject to more federal laws, regulations, court decisions, and administrative rulings than any other indigenous group in the United States. As has been shown, subsistence use of fish and game in Alaska is tangled in a web of contradictory and complex state and federal legislation and regulation. Laurajane Smith's (2004) work on archaeological theory and the politics of cultural heritage can help us understand debates about subsistence in Alaska. Smith shows how archaeology has been hijacked by government bureaucrats and unreflective practitioners who don't fully realize the role they play in "managing" the "social problem" of descendent communities' claims to heritage. The governmentality literature (e.g., Burchell et al. 1991) shows how expertise—in this case, anthropological knowledge—can be employed by governments to control and constrain, i.e., to "manage" the social problem of "subsistence users."

From my years living in Alaska from 1978, when the state subsistence law was passed, through the mid-1980s, I thought I had a fairly good understanding of subsistence. Little did I realize how convoluted the story of subsistence had become. The institutional means that have grown to dictate and document subsistence demonstrate how technologies of power have been wielded to control Alaska Natives. The management of subsistence in Alaska—what Thornton (2001:83) has termed the subsistence crisis— is very much about race and ethnicity. Despite all the discourse about rural residents and "customary and traditional" users, these words are deliberately chosen to obscure racial difference. In this discourse, anthropologists have played roles as "mediators" or "interpreters" between the state and federal governments and indigenous communities. Governmental needs to manage the "social problem" of subsistence are very much entangled with the development of intellectual discourse of anthropology. The institutions, laws, regulations, policies, procedures, and reports are the ways power is and has been used to deny, control, restrict, and constrain the most basic of human rights—the right to obtain food for oneself and one's family. Yet our roles as professional anthropologists—as producers of technical, rational knowledge—explicitly depoliticize subsistence struggles. Has anthropology simply become just another technology of government used to manage a "social problem" and control Indigenous hunters, fishers, and gatherers? Following Smith's (2004:77) line of thinking, we must ask: are anthropologists just one more type of "regulatory agent" who function to collect, record, and report information? Is our work just another form of surveillance and enforcement? Are competing interests with stakes in fish and wildlife management (commercial and recreational users, environmentalists, biologists, etc.) so powerful that there is no way out of the monstrous maze that subsistence management has become?

As Korsmo (1994) has explained, Alaska Natives have continued to assert their resource rights. They have lobbied for changes to the Alaska constitution. Some Native corporations have closed their lands to nonshareholders in an attempt to reserve parts of their subsistence territories for themselves. Representatives of

Native organizations serve on the federal regional advisory councils and state local advisory committees. In the face of declining habitat, global warming, and pollution, subsistence will continue to be a site of struggle. At times like this, I recall a Tlingit friend who told me, "I am just a fisherman." I would argue that being "just a fisherman" in Alaska is a more formidable challenge than anywhere else in the world.

"SUBSISTENCE" TO THE TLINGIT—A WAY OF LIFE IN BROADER PERSPECTIVE

In 2003, I was asked by Lillian Petershoare of the Forest Service to write a new preface for a book coauthored by Tlingit scholar Richard Newton and me, *The Subsistence Lifeway of the Tlingit People* (Newton and Moss 2005). First published in 1984, this was a compilation of information on subsistence Mr. Newton and I gathered from interviews with twenty-three Tlingit culture-bearers. When the Forest Service wanted to print a third edition, Lillian, working with Joanne Wiita (Goldbelt Corporation) and Don Bremner (Central Council of Tlingit and Haida Indian Tribes of Alaska), met with elders in Juneau to receive guidance. They wrote that the elders,

> shared the pain they carry in their hearts toward the Forest Service, towards those western ways that attempt to minimize the sacredness of our traditional ways. As Tlingit, Haida, and Tsimshian people, we are taught to have respect for our food; for the animals and plants that constitute our food; and for the teachings of our Elders with regard to the gathering, preparing, sharing and eating of our food. Our respect for our food is evidenced in the beautiful totem stakes that our Tlingit ancestors placed in streams to greet the salmon as they returned to their birth places; in our intricately carved feast dishes; in the stories we teach our young about the relationship between the Tlingit, the Haida, and the Tsimshian and the animals that are our sustainers of life; and in our songs and dances, as is evidenced when our beloved berries are brought in at a *k̲oo.eex'* (memorial party). Each Elder at that first meeting and at successive meetings, passionately objected to having their understanding of Tlingit food reduced to a regulatory word like "subsistence." (Wiita et al. 2005:viii)

Through consultation with Tlingit community members and Nora and Richard Dauenhauer, the book title was changed to *Haa atx̲aayi Haa K̲usteeyix̲ Sitee*, which translates to "our food is our Tlingit way of life." This experience demonstrates that while "subsistence" remains a rallying cry for many Alaska Natives, it simultaneously retains pejorative connotations about eking out a meager, marginal, and miserable existence (Wheeler and Thornton 2005:70). By changing the title, Tlingit community members were expressing deep resentment about how their way of life has been regulated, controlled, and devalued over the past several decades. I can empathize with the position that subsistence regulation is a grave insult to the sustainable ways of living that have proven themselves, not just for hundreds, but for thousands of years. Threats to subsistence must be clearly acknowledged as threats to Tlingit cultural survival (Thornton 1998). In effect, the Tlingit advocates for changing the book title were trying to decolonize subsistence.

To help decolonize subsistence, we anthropologists and archaeologists might consider rethinking application of the terms "hunter-gatherers" or even "foragers" to the Tlingit. First Nations of the Northwest Coast were (and are) food-producing societies. Even though fishing is by convention subsumed under the term "hunter-gatherer," fishing was and is of such primary importance to the peoples of the North Pacific that the term "hunter-gatherer" misses the point. The Tlingit and other Pacific coast societies practiced many different types of fishing, and social groups maintained control over fishing territories. They were not just fishers, but fisheries resource managers. They successfully harvested a wide range of species, but their management and control of salmon are especially significant. The Tlingit mastered the technologies of fish processing and storage, leading them to accumulate substantial surpluses. They were food producers, even though this term is usually reserved for horticultural or agricultural societies.

The keys to Tlingit food production were both fishing and fish-product storage technologies. They invested in infrastructure—such as building hundreds of wood-stake fishing weirs—and altered their physical environments to promote fisheries production. They managed harvests through systems of territorial ownership[3] and control, and restrained uncontrolled resource use through systems of

3. Whereas a clan's territory was held in common, it was divided among its constituent households and inherited matrilineally. Salmon streams, camping areas, house sites, seal camps, sea otter camps, and contiguous waters were all lineage possessions (Emmons 1991:46–47).

social relations. Tribes, clans, and households were caretakers of particular watersheds, fish streams, and stretches of ocean shoreline. Langdon (2006b) has documented how the Tlingit also transplanted fish eggs and modified streams to enhance fish habitat. The Tlingit managed harvests as trustees who had established long-term respectful relationships not only with resource territories, but with the plant and animal persons with whom they shared the world (Langdon 2000; see Easton [2008] and Nadasdy [2003] for descriptions of the relationship between the Dineh and food animals in the Yukon Territory).

In addition to fish, other Northwest Coast societies also produced food surpluses. The Makah and some Nuu-chah-nulth processed large quantities of whale and fur seal oil that they traded widely (Huelsbeck 1988). The Kwakwaka'wakw, Coast Salish, Nuxalk, Nuu-chah-nulth, and Haida cultivated plots of Pacific silverweed and springbank clover in estuarine gardens (Deur and Turner 2005). The Coast Salish maintained plots of camas, and the Chinook intensified use of wapato-filled wetlands (Darby 2005; Turner and Peacock 2005). The Haida selectively logged ancient cedar trees and manufactured seagoing vessels that they traded to others. The Tsimshian on the lower Nass River specialized in the large-scale production of eulachon oil. The Kwakwaka'wakw of the Broughton Archipelago practiced mariculture through the construction and maintenance of clam gardens (Harper et al. 2002). The Tlingit grew tobacco and potatoes, perhaps prior to their eighteenth-century introduction by fur traders (Moss 2005). I argue that the ethnographically known societies of the Northwest Coast, and many of their ancestors, are more appropriately conceived of as fishing and food-producing societies than as "hunter-gatherers" or "foragers." Yet we must be careful not to simply exchange one outdated anthropological category for another, fully cognizant of the social evolutionary baggage such typologies carry. The archaeological data we generate also represent important archives of information that can inform societal understanding of the issues at stake in contemporary conflicts over subsistence.

HOW ARCHAEOLOGY AND ZOOARCHAEOLOGY CAN CONTRIBUTE

How can archaeology contribute to efforts of the Tlingit and other Alaska Natives to assert their rights to continue their reciprocal relationships with animals? How can zooarchaeology contribute to improved management of fish and wildlife?

The emphasis on fishing in the previous section reflects my experience as a zooarchaeologist. Over 85% of bones in most southeast Alaska faunal assemblages are fish bones, and this also holds for the greater Northwest Coast (Moss and Cannon in press). The most widely recognized fish of cultural importance is salmon, the iconic fish of the Northwest Coast. First Nations have been using salmon on the Northwest Coast for over 7,000 years (Cannon and Yang 2006), yet after just a few centuries of Euro-American exploitation, Northwest salmon are threatened with extinction (Montgomery 2003). Cannon et al. (n.d.) and Campbell and Butler (2010) have identified several different organizational strategies Northwest Coast groups used to obtain and manage salmon. A few of these involve resource ownership, such as that indicated at one of the Coffman Cove sites (49-PET-067), located close to the mouth of Coffman Creek in southeast Alaska (Moss n.d.a). The faunal assemblage, dated 4200–2000 cal BP, is dominated by salmon bones. Salmon cranial bones are represented, as well as vertebrae, indicating on-site butchery of whole fish. The predominance of salmon in the assemblage suggests a group with ownership rights to the local salmon stream over a long period of time. A wood-stake weir has recently been identified along Coffman Creek (Jane Smith pers. comm. 2010), but has not yet been dated. Knowing the age of this investment in infrastructure would help establish the antiquity of resource ownership in the area. Nevertheless, the Coffman Cove example strongly suggests that resource ownership and management is not just an ethnographic pattern, but has significant antiquity in Tlingit country. This is consistent with the age of other fishing weirs and traps in southeast Alaska.

Although focus has often centered on salmon, other taxa occur in abundance in the region's archaeological sites, including codfishes, herring, rockfish, and halibut. Recent examination of records from 181 excavated sites in southeast Alaska reveals that only twenty-eight sites were investigated with methods appropriate for documenting small-bodied herring (Moss et al. in press). Of this subset, twenty-one (75%) contained herring bones, highlighting the consistent use of herring in the past. The earliest herring remains date to 9300–7900 cal BP from Chuck Lake on Heceta Island, but most records date from the last 4000 years. Many long-standing Tlingit towns and villages are associated with important historical herring stocks. We know Pacific herring is a bellwether species for North Pacific marine ecosystems and that biologists and managers have only a very limited understanding of its long-term population dynamics and ecology. Since herring were overfished in the twentieth century (Funk 2009), archaeology can provide a more complete picture of the spatial distribution and abundance of herring in southeast Alaska. As is the case for many species, herring are being managed in a depleted status that represents a mere fraction of their historical abundance and distribution.

Whereas salmon and herring have been commercially important species for decades, zooarchaeology has the power to reveal information about species that may be of lesser commercial importance. Pacific cod are abundant at Hidden Falls, North Point, Killisnoo Picnicground Midden, Cape Addington, and Coffman Cove. In a recent review, I found twenty-six sites with a minimum of 100 NISP (number of identified specimens) identified to at least the family level. Twelve of the sites contained abundant cod remains (Moss in pressb). Zooarchaeological records can be used to trace past distributions of species such as Pacific cod which may likely gain in commercial and subsistence importance as other fish decline. Future work analyzing the ancient DNA in fish bones—of herring, salmon, and cod—can be used to better understand how representative today's stocks are of those in the past.

We can assume that fish and wildlife abundances in southeast Alaska have changed over the past several thousand years. Elsewhere in the world, resource scarcity or overexploitation of one fish taxon leads to "fishing down the food web" to use smaller-bodied or less optimal species (Reitz 2004). At this time, we have no archaeological evidence of over-exploitation of fish or wildlife in southeast Alaska (see Butler and Campbell [2004] for a Northwest Coast-wide review). This is a significant finding, but how did the Tlingit and others make the necessary adjustments to changes in resource abundances and distributions?

Recent study of Northern fur seals is revealing how changes in one part of the North Pacific affect other parts. Study of this species also demonstrates how zooarchaeological data can expose genuinely new and unexpected information about biogeography of relevance to fish and wildlife managers. While working on the Cape Addington project, we were surprised to find the remains of Northern fur seal pup bones. Since most Northern fur seals are born in the Pribilof Islands today, and pups don't swim before they are four months old, and because the Pribilofs are located ~2500 km away from Cape Addington, we wondered whether the fur seal remains were from animals migrating south in the fall, from stranded seal pups, or whether there was a breeding area located somewhere near Cape Addington in the past (Moss 2004). We pursued this question with isotopic and ancient DNA studies of fur seal bones and were able to confirm that at least two Northern fur seal pups and two juveniles were present at Cape Addington (Moss et al. 2006). We pursued this question with isotopic and ancient DNA studies of fur seal bones to see if and how they were related to Pribilof seals and where they foraged in the ocean. We were able to confirm that at least two Northern fur seal pups and two juveniles were present at Cape Addington, but the genetic evidence of their relationship to the Pribilof seals was ambiguous. Even though a Northern fur seal breeding site in southeast Alaska has not been identified, it remains a possibility.

Meanwhile, Gifford-Gonzalez et al. (2005) were causing a stir among marine mammal biologists because they found abundant Northern fur seal remains in California sites dated to the middle and late Holocene. Gifford-Gonzalez suggested that in the past, Northern fur seals had maintained breeding colonies in California. This was a radical idea that at least some biologists adamantly rejected, yet work by Lyman (1988), Etnier (2002), and Crockford et al. (2002) supports the idea that Northern fur seals had breeding colonies along the coasts of California, Oregon, Washington, British Columbia, and locations other than the Pribilofs in Alaska. Crockford and Frederick (2007) have suggested that the Pribilof Islands were not accessible to Northern fur seals for breeding during the height of the Neoglacial, estimated to have been 3500–2500 ^{14}C yrs BP. They propose that during this period, winter sea ice on the Bering Sea extended farther south than it does now and that ice persisting longer into the summer would have blocked access to the Pribilofs at a crucial time in the reproductive cycle of fur seals. What biologists had thought was a stable pattern of fur seal fidelity to the Pribilof breeding grounds (Gentry 1998) turns out to be a result of post-Neoglacial warming after 2500 ^{14}C yrs BP. This suggests that Northern fur seals are capable of significant behavioral flexibility over the long term, and certainly the peoples of the North Pacific were just as resilient. Not until fur seals were hit by industrial hunting in the early twentieth century was the species in jeopardy. Understanding the long-term history of this species that adapted not just to environmental change, but to human hunting pressure, is crucial for understanding how fur seals should be managed today.

My final example concerns seabirds. In today's society, one might think that Alaska Native use of seabirds is unnecessary; after all, any grocery store sells chickens and eggs. Study of the Forrester Islands, however, showed that collecting eggs and birds from this place was an exceedingly important sociocultural practice (Moss 2007). Assemblages from five archaeological sites yielded identifications of eleven seabird taxa. Even though the Kaigani Haida, the Tlingit, and their ancestors had been harvesting seabirds during spring and summer on the Forrester Islands since 1600 cal BP, the Forresters, as part of the Alaska Maritime Wildlife Refuge, are off limits to Native egg collecting and bird-hunting today. One of the ironies is that even though it has been illegal for the Tlingit and Haida to take birds from the Forresters since 1912, in the 1910s through the 1920s, biologists were busy shooting birds and collecting eggs for museums, because this is the way field ornithology was done at the time. This is parallel to the case of the Huna Tlingit, who traditionally collected gull eggs from the Marble Islands, now located within Glacier Bay National Park. Hunn et al. (2003) documented the traditional way the Huna collect eggs; if eggs are taken properly at specific times, the gulls will re-lay, and the number of surviving gulls every year will not be reduced by egg removal. Even though Huna are still prohibited from collecting eggs from the Marble Islands, biologists were allowed to remove gull eggs (following Huna protocols) to test the efficacy of this traditional practice. These ironies notwithstanding, ideally, zooarchaeology can help support claims of Alaska Native resource rights and calm the fears of wildlife managers threatened by traditional uses.

CONCLUSIONS

Zooarchaeology has tremendous potential to contribute new knowledge of Alaska Native use of fish and wildlife over time. This long-term perspective is of crucial importance because it documents times before industrial depletion of fish and wildlife in the twentieth century. It remains true that much ecological research is based on local field studies of relatively short duration, usually since the 1950s. Many fish and wildlife populations in Alaska are still suffering the cumulative effects of earlier over-exploitation. Pauly (1995) pointed out that policy makers and resource managers base many decisions on recent observations or on historical catch statistics that may span just a few decades (Erlandson and Rick 2008:1). Pauly termed this the "shifting baselines syndrome," where fisheries managers use a relatively recent historical baseline to manage fisheries without full recognition that the baseline itself is a consequence of drastic reductions having already occurred. Decisions continue to be made upon baselines that are not only "shifting," but receding (Stephen Langdon, pers. comm. 2009).

Zooarchaeology has demonstrated that Alaska Natives successfully and sustainably harvested fish and wildlife for thousands of years. Investigations at Coffman Cove suggest not just thousands of years of salmon use, but thousands of years of resource ownership and stewardship of salmon. This helps counter the idea that the landscape of Alaska has been a "pristine wilderness" free from human impacts for over 12,000 years. Southeast Alaska has been a strongly humanized landscape for millennia, and the fish and wildlife of southeast Alaska have been adapting to human activity for a very long time. Resource managers should not expect to return ecosystems to a state of preindustrial equilibrium; such equilibrium may have never existed. Alaska ecosystems have been dynamic systems in which humans have played leading roles for millennia. We should also consider how societies conceived of or failed to recognize environmental impacts they faced, and how they responded or adapted to change (Kirch 2005:432). Zooarchaeology has the potential to reveal genuinely new information about the long-term histories of fish and wildlife.

The word "subsistence" continues to have racial overtones in Alaska. In consideration of its history in anthropology and the way the word has been used to categorize "others" along a social evolutionary continuum, should we simply abandon the term? At least one cultural anthropologist, Stephen Langdon (pers. comm. 2009), goes out of his way to avoid using the word "subsistence" because of its associations. Some Tlingit resent the reductionist use of the term "subsistence" to categorize their way of life and their relationships with food animals. But debate over the term is about much more than politically correct language—the practice and regulation of subsistence have been institutionalized by both state and federal governments in part due to the efforts of anthropologists. Subsistence has been a growth industry for anthropologists who have played the role of mediators to help governments manage the "social problem" of subsistence. From this perspective, anthropologists have been complicit in the ways the power of the state has been used to deny, control, restrict, and constrain the rights of Alaska Natives to obtain food.

The time has come for anthropologists, including archaeologists, to recognize our privileged positions. Archaeological studies can document subsistence practices of the past and the long-term histories of fish and wildlife, but the results of our work should be widely disseminated so they can be used by Tlingit and other Alaska Natives to assert their resource rights. We must design future work that will yield results that proactively address contemporary struggles over fish and wildlife. We must not only rethink subsistence, but rethink the roles our discipline has played and continues to play in the bureaucratization of subsistence. Even so, it can be argued that "anthropologists are at best secondary players in what remains primarily the domain of biologists, who are also constrained by high-level politically oriented bureaucrats whose commitments to understanding subsistence issues are often questionable" (Ken Pratt pers. comm. 2010). Nevertheless, I sincerely hope that we can work to gain recognition for the Tlingit's wise use of animal resources, and assist others in working towards reducing the bureaucracy that overwhelms the use of food animals by the Tlingit and other Alaska Natives.

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REVIEW

ALEUT IDENTITIES: TRADITION AND MODERNITY IN AN INDIGENOUS FISHERY

By Katherine L. Reedy-Maschner, 2010. McGill-Queen's University Press, Montreal Paperback, 314 pages, 46 figures, nine tables, one appendix. ISBN: 978-0773537484

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Katherine L. Reedy-Maschner provides a detailed, thought-provoking ethnography of contemporary Aleut fishing communities in *Aleut Identities: Tradition and Modernity in an Indigenous Fishery*. In this volume she argues against essentialist understandings of ethnic and economic indigeneity. She eloquently describes how the globalized "indigenous commercial economies" of Aleutian communities defy traditional representations of cultural purity and the image of isolated subsistence-based communities in Alaska. Reedy-Maschner seeks to remedy the oversight, misrepresentation, and dehumanization that she asserts typify descriptions of Aleuts in ethnography, policy processes, and popular representations. Reedy-Maschner succeeds in delivering a powerful account of historical and contemporary processes of, and challenges to, livelihood and identity-making for Aleut peoples.

As the title suggests, the chapters in *Aleut Identities* are unified by explorations of identity, both as a theoretical construct and a lived reality. Reedy-Maschner begins by outlining the ways in which she investigates internal and external processes of identity formation and representation for the modern Aleut, twenty-first century fishermen. While acknowledging current theoretical trends viewing identity as inherently unstable, fractured, multiple, and constantly in the process of becoming, Reedy-Maschner argues rather for the fixity of Aleut cultural categories, as these have come to be definitive of identity in this context. She argues that for Aleut peoples, identity is inherently tied to both place and to fishing livelihoods. Within a commercial fishing milieu comes social categories such as permit owner, boat captain, crew member, fisherman's wife, and fisherman's daughter. Reedy-Maschner argues that these categories define status structures and relationships extending far beyond fishing into the very fabric of contemporary Aleut communities and culture, to the very essence of being Aleut.

Reedy-Maschner situates her investigation of present-day Aleut communities in a historical context, tracing Aleut culture and identity from prehistory through the Russian and American periods, filling in an important gap in the historiography of the Aleutians and the Alaska Peninsula. As we move into the contemporary period, Reedy-Maschner argues that deep commercial fishing engagements in Aleut communities are not evidence of modernity enveloping and homogenizing the practices of indigenous Aleuts, but rather demonstrate the adaptive continuation of Aleut dependence on the resources of the sea for livelihood, identity, and meaning. The richness of her twenty months of ethnographic research is evident in her "limited entry ethnography." Making use of the language of a restricted-access salmon fishing policy implemented in the 1970s that had dramatic social impacts on small fishing communities throughout Alaska, Reedy-Maschner describes multiple "limited entry systems" that have come to define Aleut lifeways. By linking salmon permits with demographic transitions, social and gender roles, status, subsistence, kinship and family dynamics, and broad processes of disenfranchisement, Reedy-Maschner's account is singular in its detailed portrayal of the lived realities of fisheries privatization. The book is therefore essential reading for anyone interested in understanding the social, cultural, and economic impacts of restricting and commodifying the right to fish.

Consistent with her desire to explore the local contextual framings of identity, Reedy-Maschner spends an entire chapter investigating a hypothesis popular with her informants—less people fishing because of restricted access and economic downturns means less healthy villages. She draws upon her ethnographic data and crime statistics to conclude that plentiful and poor fishing seasons lead to different kinds of social problems. The restriction on access to fishing, however, has produced a directional shift. Less people able to pursue high-status roles, such as fishing captain, leads many, youth especially, into destructive practices such as alcoholism and violence.

Reedy-Maschner achieves her goal of disrupting commonly perceived dichotomies of indigenous/western, isolated/global, subsistence/commercial in her account of Aleut indigenous commercial economies. One of the most insightful contributions is her analysis of the many ways in which Aleut fishing families meld commercial and subsistence engagements. The importance of participation in the commercial realm is vital not just for subsistence but for cultural status, family-building, and well-being. Reedy-Maschner responds directly to conflicts of representation, both in ethnographic accounts and policy processes, of the Aleut as compared to the Yupiit or the Inupiat, groups often seen to be more "authentically indigenous" (p. 245). From her perspective, commercial fisheries do not detract from the indigeneity of the Aleut—they define it. In this thick description, she provides a welcome contribution to the anthropology of fishing, an activity that ethnographers often bifurcate into large-scale commercial or small-scale artisanal categories. Aleut fishermen and their families seamlessly interweave these realms and view them as inseparable.

Reedy-Maschner masterfully depicts Aleut communities as "entangled" subsistence and commercial cultures and economies and embedded locally and globally. The ethnic and cultural multiplicity and dynamism of individual and collective Aleut identities is also evident in the text, but often we see representations of "the Aleut" as a unified whole. As mentioned above, Reedy-Maschner discusses her deliberate choice of this framing. She provides a good rationale for why constructing unified Aleut identities for political purposes is appropriate and necessary. For example, we come to understand that Aleut peoples want collective representation at the decision-making table for fisheries policies that have systematically excluded them. But for understanding the social and cultural complexities of contemporary Aleut individuals and communities, we are left at times with unsatisfying generalizations.

Aleut peoples can appear in the text not as individuals, complex in their backgrounds, motivations, and behaviors, but unidimensional in their Aleut identity. Reedy-Maschner leaves the question of Aleut futures open. For example, she writes "for a boy to be a man, he must fish and strive to have a boat, crew, stable marriage, and large family" (p. 241), yet this ideal is available to fewer and fewer Aleut men. How are young Aleuts who are disconnected from the mainstay cultural and economic practices of commercial fishing formulating new understandings of what it is to be Aleut, Alaska Native, and indigenous peoples in globalized world?

At the conclusion of the text, we have gained a sense of the complexity, multiplicity, and contradictions evident in contemporary Aleut lives. By fixing Aleut identity in both place and livelihood, we are left to contemplate another question: how are Aleut futures going to be forged if place and livelihood connections do not remain intact? As Reedy-Maschner tells us in Chapter 7, we may be witnessing the last generation of fishermen in King Cove. If identity is fixed in place and lifestyle, what of those Aleut "adrift?" What becomes of Aleut identities as lived human-environment relationships transform into symbolic ties? Perhaps it is the possibility of the Aleut people losing their maritime homeland and lifeways that prompts Reedy-Maschner's rigid approach to place and identity. For her, that displacement and disconnection are simply not acceptable outcomes. The central place of commercial fishing for collective and individual Aleut identity remains fixed in this account. Reedy-Maschner has given a solid account of why it is; however, she has also given us evidence to question whether this will continue to be the case.

Aleut Identities is thoughtful and engaging, reflexive and gendered, authoritative and straightforward. It leaves us better equipped to contemplate these questions of identity and cultural continuity in context. Reedy-Maschner has brought us to the Aleutian communities, expertly interweaving narrative with explorations of theory and diverse presentations of data, producing an exemplary Alaska ethnography. We come away with a real understanding of what it is to sit in the Harbor House in King Cove sipping coffee and talking fish politics. We hear in her stories and see in her kinship diagrams, sharing networks, and distribution of catch charts the intimate fabric of commercial fishing in Aleut identities. As she concludes, "part of identity is to have a future" (p. 247) and it is with the hope of renewal, seasonally and generationally, that she concludes her story. *Aleut Identities* enables us to more fully grasp the emergent futures developing within Aleut fishing communities, fisheries policy processes, Alaska and fisheries anthropology, and indigenous political struggles within the state and beyond.