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RESEARCH REPORT

Procurement, Reduction, and Use of Lithic Technology from ca. 9500–11,800 Years Ago at Niidhaayh Na’, Central Alaska

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ABSTRACT
The middle Tanana Valley near Fairbanks, Alaska has been the subject of nearly a century of archaeological research focused on the earliest inhabitants of the region. Recent research at Niidhaayh Na’ (XBD-110) provides new information about human behavior and technological organization at the Pleistocene-Holocene transition. This multicomponent site is located on the Delta moraine and overlooks Delta Creek (Niidhaayh Na’). The results of the first seasons of full-scale excavation research at the site, begun in 2017, reveal two lithic workshops dating to ca. 11,800 and 9500 calendar years ago, associated with core fragments, tools, debitage, and intact faunal remains. Future research at the site will advance archaeological understandings of human adaptive decision-making during the late glacial period in central Alaska, with implications for our understanding of the first Americans and human behavior more generally.

KEYWORDS
Lithic technology; late glacial; Denali complex; central Alaska; debitage

1. Archaeological record of the Pleistocene-Holocene transition in central Alaska

Many generations of archaeologists have conducted research in the middle Tanana Valley near Fairbanks, Salcha, and Delta Junction, Alaska. Indeed, research in this part of central Alaska has documented some of the earliest undisputed human occupations in North America dating to ca. 14,500 calendar years ago (cal yr BP; Potter, Holmes, and Yesner 2014). Through a combination of industrial, military, and academic-driven research efforts, several archaeological sites with late glacial components have been identified and comprehensively excavated in the middle Tanana Valley, such as Broken Mammoth, Delta River Overlook, Gerstle River, Holzman, Mead, Swan Point, and Xaasaa Na’ (Upward Sun River), providing archaeologists with a wealth of comparable material culture from the earliest moments of North American history (Holmes 2001; Potter 2005; Krasinski and Yesner 2008; Little 2013; Potter and Esdale 2016; Potter, Holmes, and Yesner 2014; Wygal et al. 2018). Archaeologists have martialed these data in debates over the influence of climate and environmental change on the behavior and culture of the earliest denizens of central Alaska, particularly during the Younger Dryas cooling period ca. 12,900–11,600 cal yr BP and the Milankovitch Thermal Maximum ca. 11,000–9000 cal yr BP (Graf and Bigelow 2011; Mason, Bowers, and Hopkins 2001; Rasmussen, Polyak, and Asmerom 2006; Viau et al. 2008; Wygal 2009).

Researchers agree that the Pleistocene-Holocene transition was among the most dramatic periods of climate variation in the human history of the Subarctic but disagree about the relationship between climatic, cultural, and/or behavioral changes throughout this period. Based on a complex and heterogeneous regional pollen record, some suggest that there was no regionally-unified environmental response to the Younger Dryas in central Alaska (Kokorowski et al. 2008). Based on this, some contend that climate changes associated with the Younger Dryas were regionally inconsistent, had only a slight effect on the region’s ecology, and likely did not influence human behavior (Bigelow and Powers 2001). Conversely, others have argued that a population decline, an increased use of microblades, a narrow dietary focus on grazers, and changes in settlement patterning in the archaeological record ca. 12,500 cal yr BP represent responses to the cold and arid conditions at the beginning of the Younger Dryas (Graf and Bigelow 2011; Potter 2008; Wygal 2009, 174). Archaeologists have also argued that the Milankovitch Thermal Maximum, a warm and wet interval that established the region’s first forests starting ca. 10,000 cal yr BP, is associated with a population decline and a related increase in bifacial

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technology (Bigelow and Powers 2001; Mason, Bowers, and Hopkins 2001; Potter 2008). The various conclusions regarding behavioral, demographic, and technological correlates of environmental change reveal the need for additional data on lithic technology, human behavior, and culture from sites across the region that date to 12,500–9000 cal yr BP.

Within the middle Tanana Valley, researchers have argued that the Nenana complex, characterized by triangular or teardrop-shaped Chindadn points and the distinctive lack of microblade technology, continues through the Younger Dryas until around 11,500 cal yr BP (Holmes 2011). Archaeologists contend that the Denali complex, represented by large lanceolate bifaces and typically associated with microblades, was first manufactured during the Younger Dryas in the Nenana Valley and appeared in the middle Tanana Valley following the Younger Dryas (Goebel and Potter 2016; Gore and Graf 2018; Graf and Bigelow 2011; Potter, Holmes, and Yesner 2014; Powers and Hoffecker 1989; Yesner 2001). However, conclusions about regional patterning may be influenced by research trends. More comprehensive research on human behavior during the Younger Dryas has been conducted in the Nenana Valley, and these sites comprise a greater diversity of ecological situations than sites investigated in the Tanana Valley, which tend to be in the lowlands on the modern road system (Graf and Bigelow 2011). Indeed, recent results from remote sites like Xaasaa Na' (Upward Sun River) and McDonald Creek show the importance of investigating human behavior at diverse locales throughout the Tanana Valley (Esdale et al. 2014; Goebel et al. 2017; Potter et al. 2014).

The preliminary results from excavations at Niidhaayh Na', located off the modern road system in a peripheral upland-lowland ecological zone, are pertinent to these debates. The oldest component at this site, Component I, corresponds to the terminal Pleistocene, ca. 11,240–12,460 cal yr BP, and is contemporaneous with the end of the Younger Dryas. Component II provides a comparable record of technological organization that corresponds to the early Holocene, ca. 9270–9480 cal yr BP, during the Milankovitch Thermal Maximum and contemporary with the region's earliest forests (Mason, Bowers, and Hopkins 2001). Here, we provide a preliminary appraisal of raw material use and lithic reduction at Niidhaayh Na' during the Pleistocene-Holocene transition.

2. Location and history of research at Niidhaayh Na'

Niidhaayh Na' (XBD-00110, also known as the Delta Creek site) is located on the northern shore of Delta Creek, or Niidhaayh Na' in the Middle Tanana language (Figure 1; Kari and Smith 2017). The site was initially identified and tested by G. Bacon and C. E. Holmes in 1978 as part of a larger survey project assessing cultural resources on U.S. Army-managed lands then associated with Fort Greely (Bacon and Holmes 1980). During the initial visit, Bacon and Holmes observed lithic artifacts and animal bones eroding out of a deeply stratified loess deposit on a moraine ca. 15 m above Delta Creek. In 1979, Bacon and Holmes returned and identified two additional loci through limited testing (i.e., scraping exposed profiles) that yielded microblades, microblade core fragments, an end scraper, a retouched flake, hundreds of pieces of lithic debitage, and fragmentary faunal remains. Two late Holocene radiocarbon dates were recovered from pieces of dispersed charcoal in association with cultural materials at approximately 40 and 80 cm below surface (Bacon and Holmes 1980, 59–60).

In 1998, as part of mitigation related to U.S. Army training activities, B. A. Potter and N. Jew of Northern Land Use Research revisited Niidhaayh Na' and documented continued erosion along the bluff face (Higgs et al. 1999). Archaeologists from Colorado State University's Center for Environmental Management of Military Lands (CSU-CEMML) conducted formal testing in 2012 to determine the potential impact of a proposed winter road and monitor the impacts of erosion (Esdale 2012). Only two of the three loci originally described by G. Bacon and C. E. Holmes were re-identified during this visit, Locus II and Locus III. Nineteen shovel test pits were excavated at these two loci, resulting in four positive shovel tests along the bluff edge. Many of the shovel tests further from the edge were terminated due to permafrost, but one test unit was excavated to 100 cm below surface and yielded numerous flakes between 50 and 100 cm below surface.

In 2017, a team led by B. Doering and J. Esdale returned to the site to conduct full-scale testing. In 2014, wildland fires near the site contributed to mass wasting along the bluff edge, and in 2017–2018, field research aimed to establish site chronology, formation processes, and integrity before further erosional activity destroyed the site's remaining cultural resources. The team tentatively relocated all three loci. It is believed that Locus III abuts Locus II to the north, in an area compromised by a large animal burrow system. The team excavated five 1 × 1 m test units in the area Holmes and Bacon identified as "Locus II" because it appeared to retain the greatest stratigraphic integrity (Figure 2). Indeed, these initial tests revealed four distinct cultural occupations and associated paleosols that provided dispersed charcoal samples, which were subsequently

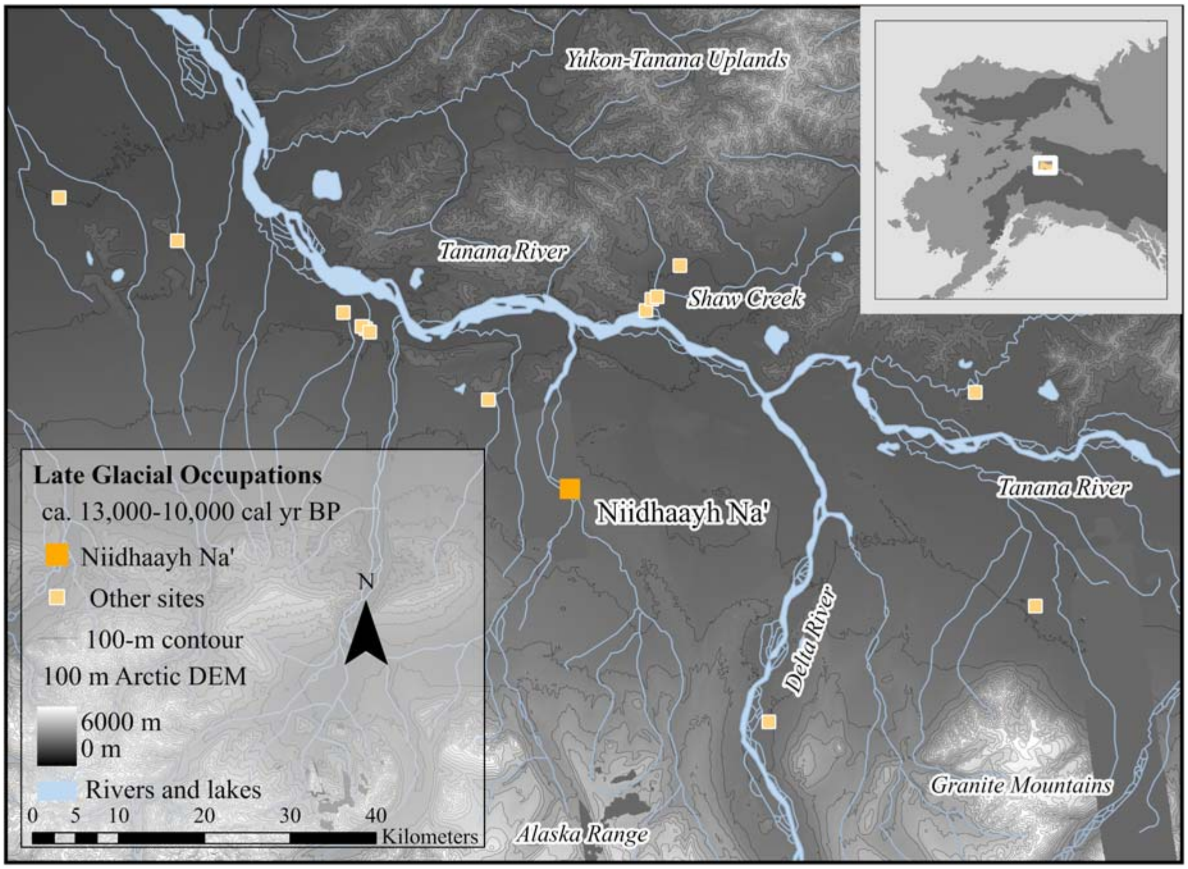

Figure 1 Map with the location of Niidhaayh Na' along with other sites with late glacial occupations in the Tanana Valley (ADNR-OHA 2019).

submitted for radiocarbon dating. In 2018, three units were expanded into 1 × 2 m blocks and yielded additional evidence for each of the four cultural occupations identified during the previous season. Though discontinuous, the excavated area comprises approximately 10 per cent of the total area of Locus II. An additional 1 × 1 m test unit was opened at Locus III that also resulted in cultural materials in association with a paleosol bearing dispersed charcoal. Combined, these investigations have resulted in over 6000 artifacts from four occupations across a total of 9 m^2 in discontinuous excavation units. Here, we share results of 2017–2018 fieldwork, focusing on lithic material from the site's two earliest components.

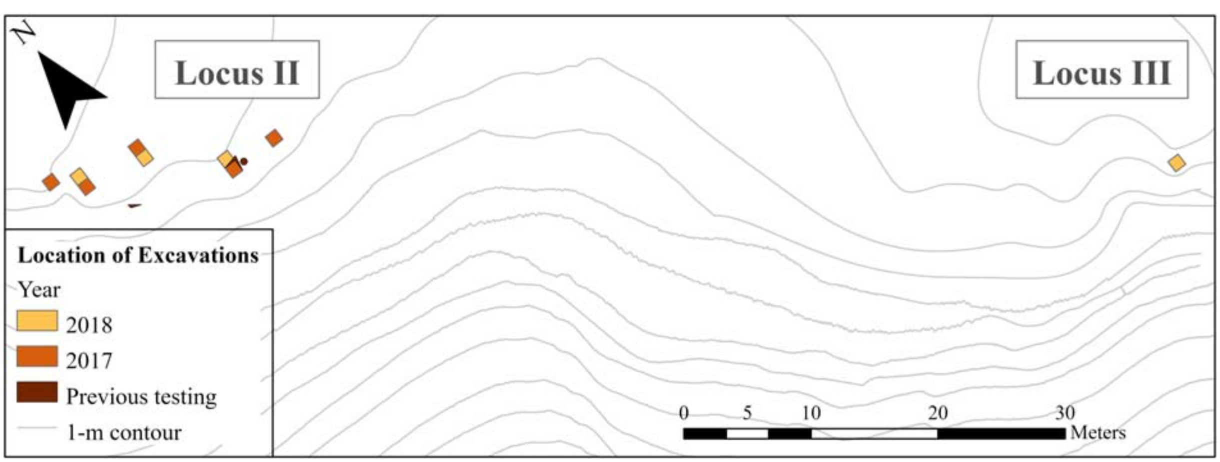

Figure 2 Units excavated at Locus II and Locus III during the 2017 and 2018 field seasons.

3. Field and lab methods

To evaluate the temporal, cultural, and behavioral dynamics at Niidhaayh Na', we undertook a comprehensive field and lab analysis program, including field testing, radiocarbon dating, assessment of site stratigraphy, geomorphology, and soil chemistry, faunal analysis, and a typological analysis of lithic technology.

3.1. Field methods

Excavation procedures remained consistent during the 2017–2018 field seasons. All units were placed on a north–south oriented grid and excavations were carried out by trowel in 5 cm arbitrary levels within cultural strata and 10 cm levels between cultural strata (Figure 3). Diagnostic material was three-point provenienced using a Sokkia Set 6 Total Station™ and additional excavated material was screened through 1/8th inch hardware cloth. Photographs recorded *in situ* faunal remains, tools, and potential features. Excavators completed a detailed unit form for every excavated level in addition to recording daily excavation notes. A stratigraphic profile was mapped from one wall of each excavated unit, all stratigraphic profiles were photographed, and sediment samples were taken at regular intervals to assess soil chemistry, including pH. Individual pieces of datable material (i.e., charcoal) were collected from each stratum and from excavated profiles during stratigraphic mapping when possible. After units were completely excavated to bedrock, they were backfilled.

3.2. Radiocarbon chronology and geomorphology

Site stratigraphy was mapped and photographed in each excavated unit upon completion of the excavation.

Figure 3 Excavation units N503–504 E140 at the end of excavations in 2018, photo courtesy Whitney E. McLaren.

Identification of sedimentary units and soil horizons was completed in the field, using direct references from the stratigraphic profile and excavation unit level notes to identify sediment texture and composition. Charcoal fragments were sampled from paleosols associated with cultural materials. No definitive cultural features were identified during excavations, so eight of these dispersed charcoal samples were selected based on size, location within the stratigraphic profile, and direct association with cultural artifacts. Selected samples were manually cleaned with a small brush and tweezers, then submitted in clean glass vials to NOSAMS radiocarbon lab for AMS radiocarbon dating. Their pretreatment involves a series of acid-base-acid leaches to remove mobile phases of organic carbon (fluvic and humic acids) and any inorganic carbon. AMS radiocarbon dates were calibrated with OxCal 4.4 software interface using the IntCal20 calibration curve (Ramsey 2020; Reimer et al. 2020, 20). One discontinuous tephra was identified at the site. It is still in the process of being analyzed, but a comparison between established regional tephrochronology, stratigraphy, and site radiocarbon chronology is considered to propose a tentative identification.

3.3. Soil chemistry

Subarctic archaeologists have attributed poor faunal preservation in the region to high soil acidity, or low soil pH, associated with coniferous boreal forests (Doering, Esdale, and Catenacci 2020, 6; Ping et al. 2008; Weiner and Bar-Yosef 1990; White and Adrien Hannus 1983; Yesner 2001). Scholars have argued that soil pH was particularly low (acidic) after 4000 cal yr BP (Dilley 1998). Previous experimental research suggests that osteological faunal remains are best preserved in neutral or slightly alkaline soil environments (i.e., pH = 7–8), and low soil pH yields the poorest faunal preservation (i.e., pH = 3.5–4.5; Nicholson 1996). However, subarctic archaeologists rarely report soil pH, and soil acidity's role in differential bone preservation remains a subject of archaeological debate more generally (O'Connor 2000, 24). To contribute to on-going debates and assess whether diagenesis at the site may be related to soil acidity, pH was sampled throughout the stratigraphic sequence following standard USDA methods (Soil Survey Staff 2014; Supplemental Online Material, 1).

3.4. Faunal analysis

Faunal materials collected during excavations were analyzed following standard osteological identification methods. First, specimens were sorted into those potentially identifiable to element or taxon to calculate the number of individual specimens (NISP) (Gifford-Gonzalez 2018). Ultimately, this revealed that all faunal specimens were, at best, only minimally identifiable to taxonomic size class due to cultural fragmentation and/or diagenesis. Thus, minimally identifiable specimens were compared to general taxonomic size to assess the approximate size of fauna processed at the site (Klein and Cruz-Uribe 1991).

3.5. Debitage analysis

To reconstruct technological organization at Niidhaayh Na', we completed a comprehensive analysis of stone tools and lithic debitage following standard identification methods (Andrefsky 2001; Sullivan and Rozen 1985). First, all lithic material was cleaned, counted, and weighed. Material type was assessed in comparison to raw materials found in local drainages (i.e., Delta Creek) and common exotic types. Subsequently, lithic material was separated into formal tools and tool fragments based on established central Alaskan types, diagnostic debitage with an identifiable platform, and fragmentary debitage/shatter. To evaluate the focus of the reduction sequence, all diagnostic debitage pieces were assigned to one of four production phase categories related to regional tool types (Esdale 2009; Odell 2000; Shott 1994): early core reduction, bifacial reduction, microblade reduction, and unifacial reduction. Within each category, debitage was assigned a subcategory related to reduction phase (Supplemental Online Material, 2). Only debitage associated with components I and II will be considered in depth in the results section due to the relatively low density of stone tool material associated with later occupations at the site, though see Doering, Esdale, and Catenacci (2020) for an additional consideration of debitage from Component IV.

4. Results

In this section, we present the results of field and lab work conducted at Niidhaayh Na' since 2017. We review the stratigraphy and chronological context of the site, then consider the cultural materials recovered from distinct site occupations and the preservation context in reference to recovered faunal remains and soil pH. Finally, we consider the results of our analysis of components I and II lithic material and use a series of Pearson's chi-squared tests to identify significant differences in raw material use and reduction represented within these debitage assemblages.

4.1. Stratigraphy and dating

The archaeological remains at the Niidhaayh Na' site are situated in a mantle of silt, ranging from 130 to 190 cm in depth (Figure 4). This mantle lies above the Delta moraine of the middle to late Quaternary Delta Glaciation (Péwé 1975). In the field, we identified two sedimentary units and four cultural components in the stratigraphic profile. The basal unit of the site profile is a decomposing granulitic bedrock that makes an abrupt boundary with the overlying Stratum 1, which likely accumulated after a period of either low or no sedimentation and/or wind-driven erosion during the late Pleistocene (Thorson and Bender 1985). Stratum 1 consists of a cohesive olive brown (2.5Y 4/3) sandy silt with a very dark grayish brown (10YR 3/2) continuous buried A horizon, or paleosol (2Ab2), and a discontinuous buried A horizon (2Ab1). Stratum 1 has an abrupt and smooth boundary with the overlying Stratum 2. Stratum 2 is a brown (7.5YR 4/4) sandy silt that features two brown (10YR 4/3) weakly developed B horizons, both of which are associated with cultural materials, and a strong dark grayish brown (10YR 4/2) A/E horizon that underlies the very dark brown (10YR 2/2) O Horizon. A discontinuous tephra was observed within Stratum 1 and beneath Bw2.

Radiocarbon results from charcoal sampled within paleosols at the site indicate that cultural occupations spanned the terminal Pleistocene to late Holocene (Table 1). Component I materials were recovered within or immediately below 2Ab2, which was identified within all three 1 × 2 m test units ca. 150–160 cm below the site surface. Four pieces of dispersed charcoal sampled from 2Ab2 resulted in an approximate age of 12,460–11,240 cal yr BP, and the median ages of the four samples suggest a date around 11,800 cal yr BP for this paleosol. Above Component I, we identified a thin (ca. 2–5 cm) sterile layer of sandy silt followed by Component II, which was associated with a discontinuous paleosol, 2Ab1, ca. 140–150 cm below surface. Charcoal associated with this paleosol resulted in an AMS radiocarbon date of 8360 ± 45 ^{14}C yr BP (9480-9270 cal yr BP). Subsequent and more ephemeral soil development events, Bw2 and Bw1, were stratigraphically associated with components III and IV, respectively. Dispersed charcoal pieces associated with Bw2 resulted in a radiocarbon date of 3880–3698 cal yr BP, and charcoal from Bw1 resulted in radiocarbon dates of 1989–1380 cal yr BP. Based on these radiocarbon results, the stratigraphic position of the discontinuous tephra found beneath Bw2 is consistent with the Hayes Set H tephra that was deposited in this part of central Alaska ca. 4205–3910 cal yr BP (Davies et al. 2016). Ongoing analyses

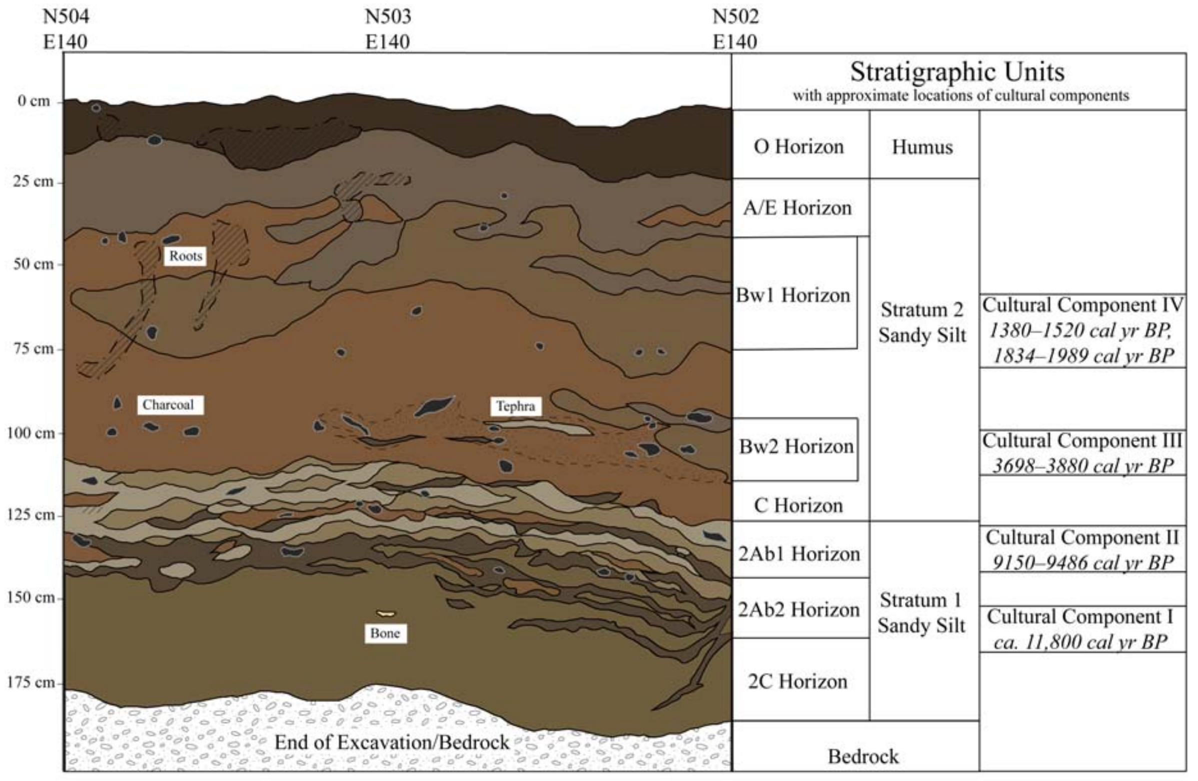

Figure 4 Stratigraphic profile from Niidhaayh Na' N503 E140 and N504 E140 east walls with four identified cultural components.

will contribute to a conclusive identification of this tephra and of the woody taxa represented by charcoal sampled from different paleosols in the stratigraphic section.

4.2. Description of the cultural components

During Bacon and Holmes' initial visit to the site, they identified two cultural components at three loci, and the results of their initial radiocarbon dating efforts suggested that the site was occupied during the late Holocene (Bacon and Holmes 1980). Our research efforts corroborated late Holocene activity at the site as well as multiple occupations at two of three loci. Further, our excavation and radiocarbon dating efforts suggest that Locus II was occupied at least four times from the terminal Pleistocene to the late Holocene. During the 2017–2018 field seasons at the site, we recovered two complete bifaces, 5431 pieces of lithic debitage and shatter, 214 faunal fragments, 33 charcoal samples, two pieces of ochre, two tephra samples, and one piece of fire cracked rock (Figure 5; UA2017-91, UA2018-70).

A total of 854 artifacts, including 21 bone fragments and 146 pieces of complete lithic debitage, were recovered from Component I, which was found in close vertical association with a paleosol dated to ca. 11,800 cal yr BP. Material was recovered in all but one of the excavated units (Figure 6). The total weight of lithic material was 0.4 kg, and the average piece of flaked lithic material, including shatter, weighed 0.44 g. Faunal material associated with Component I was fragmentary and heavily weathered, but the general size indicates

Table 1 Results of AMS radiocarbon dating from Niidhaayh Na' components I–IV.

NOSAMS sample ID	Northing	Easting	Depth below datum (m)	^{14}C age	Age error	Calibrated years BP (2-sigma)	Median probability	Component/ stratum	Material
OS-140923	503.877	145.759	99.718	1560	25	1380–1520	1456	IV/2Bw1	Charcoal
OS-140924	497.188	150.156	99.231	1980	20	1834–1989	1912	IV/2Bw1	Charcoal
OS-140925	497.988	150.834	98.121	3520	30	3698–3880	3782	III/2Bw2	Charcoal
OS-140900	497.09	150.228	98.568	8360	45	9150–9486	9376	II/3Ab1	Charcoal
OS-144348	503.605	145.49	98.678	9970	80	11,237–11,749	11,459	I/3Ab2	Charcoal
OS-144346	498.866	150.429	98.53	10,150	140	11,269–12,460	11,776	I/3Ab2	Charcoal
OS-144490	497.266	150.282	98.332	10,200	45	11,651–12,002	11,868	I/3Ab2	Charcoal
OS-144349	497.088	150.405	98.333	10,300	55	11,830–12,464	12,086	I/3Ab2	Charcoal

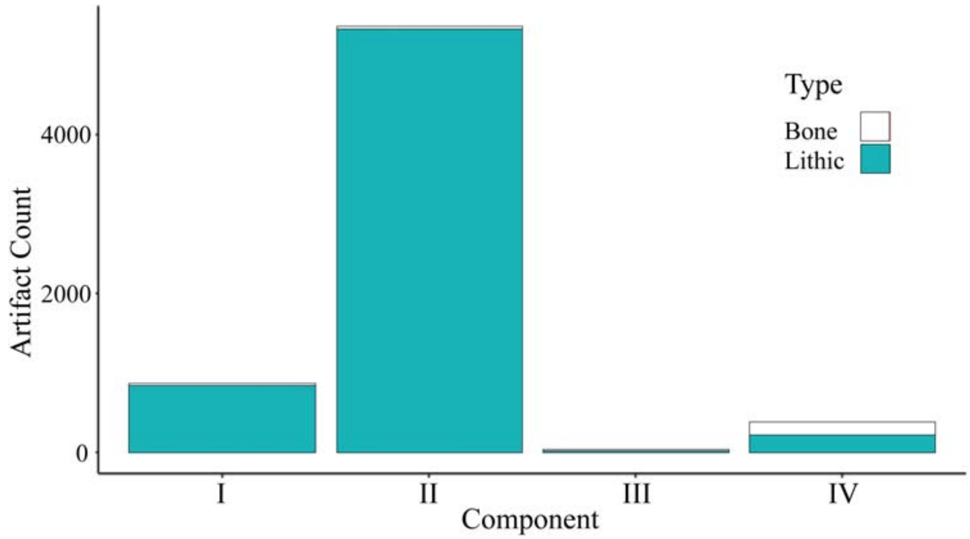

Figure 5 Faunal and lithic material at Niidhaayh Na' Locus II by component.

that the faunal remains were from large or extra-large mammals. Artifacts were most concentrated in the central test units at Locus II.

Over 5000 artifacts were recovered from Component II, including two complete bifaces, 23 bone fragments, and 617 pieces of diagnostic debitage, making this the richest component identified. Artifacts associated with Component II were recovered from all but one of the excavated units (Figure 7). The total weight of lithic material recovered was 1.4 kg, and the average weight of each lithic piece was 0.32 g. Faunal remains associated with this component were severely affected by weathering and/or bioerosion and are only generally identifiable by their size as the remains of large or

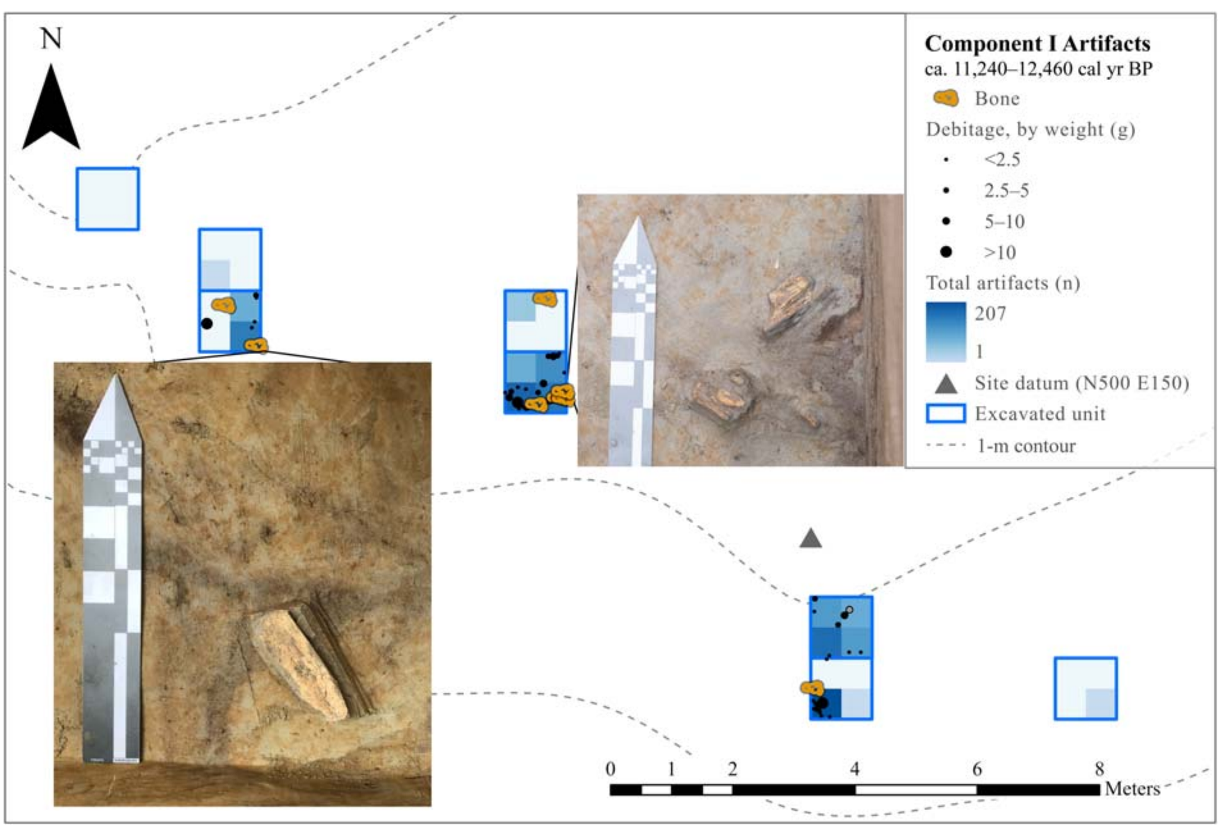

Figure 6 Spatial distribution of artifacts from Niidhaayh Na' Component I and images of in situ faunal elements recovered in association with Stratum 2Ab2.

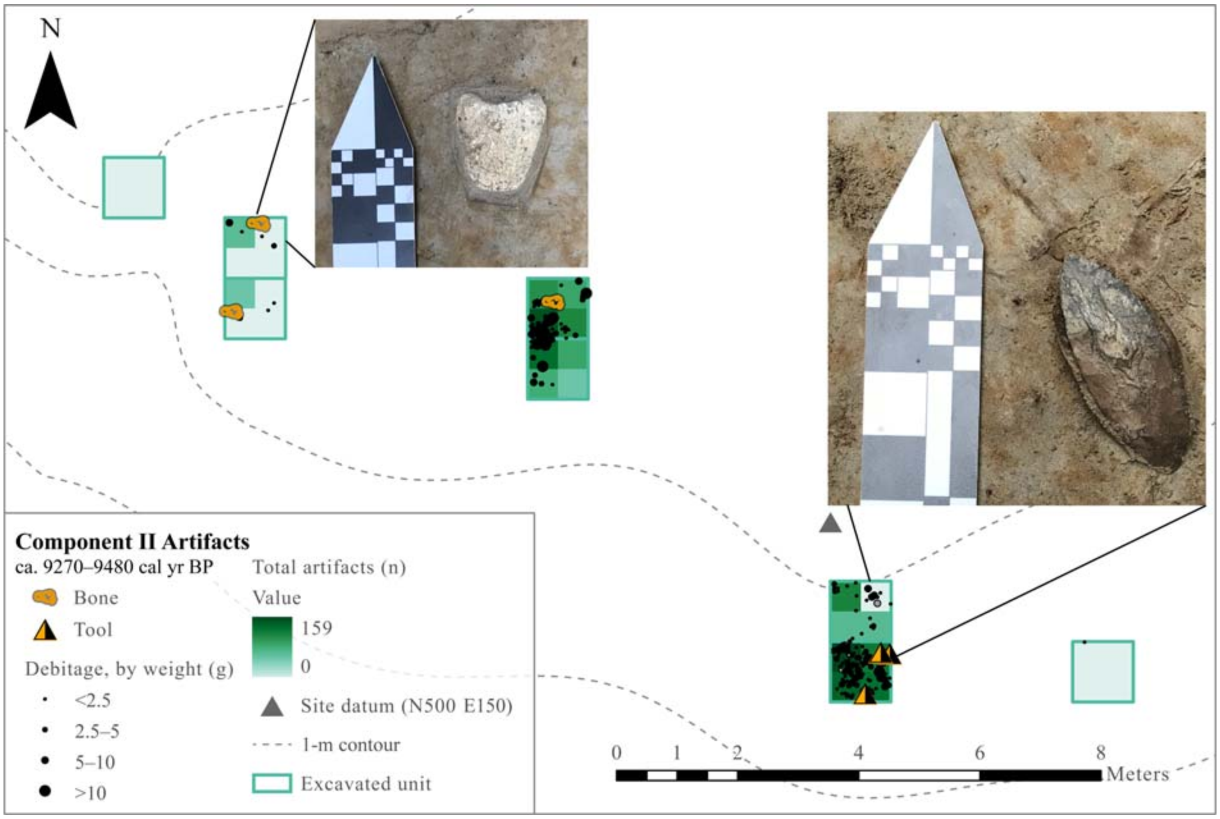

Figure 7 Spatial distribution of artifacts from Niidhaayh Na' Component II and images of in situ artifacts recovered in association with 2Ab1.

extra-large mammals. Artifacts were again most concentrated in the central and eastern units.

Excavations yielded a lower density of cultural materials from both components III and IV than the earliest components at the site. We recovered only 16 artifacts in two of the 1 × 1 m test units from Component III, including 7 bone fragments and 1 diagnostic piece of debitage. Component IV yielded 391 artifacts, including 163 well-preserved burned bone fragments, 27 diagnostic pieces of debitage, and two pieces of red ochre. Bone fragments recovered from Component IV were consistent with medium to large bodied fauna, and possibly caribou. Due to the low density of lithic material from these components, they are not considered in Section 4.4.

4.3. Faunal preservation and soil pH

Soil pH at Niidhaayh Na' falls well within the optimal preservation range (pH = 7–8), with slightly alkaline to neutral soil pH throughout the stratigraphic section (Table 2). Faunal preservation varied from excellent for remains associated with Component IV to poor for remains associated with components I and II. Faunal remains from the earliest components had little structural integrity and a creamy texture that suggest heavy chemical weathering despite soil pH results (Smith et al. 2007). Future quantification of calcium carbonate precipitate within the stratigraphic section may show that past soil pH conditions were different and led to chemical weathering (Muhs et al. 2008; White and Hannus 1983). Therefore, additional chemical and micromorphological investigations are necessary to evaluate factors that contributed to taphonomy, bioerosion, and diagenesis at the site (Hesse and Wapnish 1985, 26; Jans et al. 2004).

4.4. Technological organization at Niidhaayh Na'

Lithic materials from components I and II were considered in a comprehensive analysis of tool type, raw

Table 2 Results of soil pH analysis conducted by M. Ferderbar of the Cold Regions Research and Engineering Laboratory, Ft. Wainwright, Alaska.

Depth below surface (cm)	pH 1:5 DI H_2O	pH 1:5 0.1M $CaCl_2$
40	7.84	7.02
60	7.39	6.82
80	7.45	7.13
100	7.69	6.92
120	7.25	6.86

material, and reduction phase. Results from these two components were compared using a series of Pearson's chi-squared tests. This test of significance was selected because all expected values were greater than five. Results of $p < 0.05$ are considered significant here.

4.4.1. Component I lithic material

No diagnostic tools were recovered from Component I, but an extensive assemblage of complete debitage pieces provides pertinent information about raw material use and reduction. Debitage from Component I was large: the mean piece was 1.9 g with a standard deviation of 5.0 g. Just under half of all debitage was < 1 cm^2 (43.8%), about one-third (31.5%) was > 1 and < 2 cm^2, and the remaining debitage was > 2 cm^2 (24.7%). Gray chert and black chert were the only distinct raw materials represented by Component I debitage (Table 3). Cortex present on early reduction debitage is suggestive of alluvial cobble cortex. This indicates that gray and black chert were collected from riverbeds rather than mined from geological sources, and cobbles of gray and black chert are abundant in the alluvium of Delta Creek, approximately 15 m below the site. The majority of lithic debitage recovered from Component I was gray chert (77.3%), and the remainder was black chert (21.7%).

Component I offers substantial evidence for core preparation and bifacial lithic reduction (Table 3). Bifacial reduction comprises the majority of lithic debitage from this component (77.0%), and early core reduction comprises about one-fifth (20.5%) of the debitage. Half of the early reduction debitage was primary decortication flakes that exhibited cortex on over half of the flake's surface. Bifacial debitage was associated primarily with late-stage reduction, such as edge shaping, sharpening, and retouch, comprising 58.9% of all bifacial debitage. The remaining 41.1% of bifacial debitage pieces were related to early and late-stage bifacial thinning. One unifacial pressure flake provides tentative evidence for unifacial reduction. The focus of on-site knapping activity from Component I appears to be bifacial and early reduction, with limited evidence for unifacial reduction. No microblade reduction debitage was identified within Component I lithic materials.

4.4.2. Component II lithic material

Two intact bifaces were recovered from Component II (Figure 8). Both bifaces are of a lanceolate, biconvex type, exhibit use wear on their edges, and present hafting elements at their bases (i.e., the bottom of the tools in Figure 8; see Andrefsky 2005, 169). The first exhibits a pronounced dorsal ridge and edge retouch consistent with hafting (Figure 8(a)), and the second features edge retouch and basal grinding (Figure 8(b)).

Table 3 Results of debitage analysis of Component I and Component II.

	Raw material	Primary decortication	Early reduction secondary decortication	Interior	Early thinning	Late thinning	Bifacial reduction Alternate	Edge preparation	Bifacial pressure	Unifacial reduction Unifacial pressure flake	Total
Component I	Black chert	6	4	2	5	4	3	1	8		33
	Gray chert	9	4	5	6	31	10	10	34	1	110
	Total	15	8	7	11	35	13	11	42	1	143
Component II	Banded gray chert	3			1		1		1		6
	Black chert	11	15	7	23	83	31	24	59		253
	Chalcedony		1								1
	Gray chert	17	24	12	25	83	37	44	99	1	342
	Quartzite		3	1		2	1	2			9
	Total	31	43	20	49	168	70	70	159	1	611

Figure 8 Bifaces (a,b) recovered from Niidhaayh Na' Component II.

This indicates that these bifaces were hafted and possibly used as projectile points or thrusting spear tips before they were discarded at the site. Lanceolate, biconvex bifaces such as these are commonly attributed to the Denali complex. However, Denali complex lithic assemblages typically (Powers and Hoffecker 1989, 275; West 1967, 370) but not always (Goebel and Bigelow 1992, 1996) include evidence of microblade reduction, which was not recovered during 2017–2018 excavations.

Debitage from Component II was large: the mean piece was 1.1 g with a standard deviation of 3.0 g. Like Component I, just under half of all debitage was < 1 cm^2 (44.1%), one-third (33.1%) was > 1 and < 2 cm^2, and the remaining debitage was > 2 cm^2 (22.8%). Debitage from Component II represents several locally available raw materials and one potentially exotic raw material. Similar to Component I, Component II debitage was predominantly comprised of black and gray chert. Debitage bearing cortex was consistent with alluvial cobble cortex indicating that these raw materials were collected from a local river. Quartzite and banded gray chert were also represented in Component II debitage. These materials were not observed in Delta Creek during preliminary raw material surveys, but pieces of quartzite and banded gray chert debitage featured cobble cortex consistent with alluvium and are relatively common in other middle Tanana Valley assemblages, indicating that these too may have been collected from Delta Creek or nearby. Finally, one piece of white chalcedony was recovered. Chalcedony, or a fine-grained chert, is rare and possibly exotic to the area. Known sources exist in the Yukon-Tanana uplands and in the Nenana Valley (S. Coffman, pers. commun. 2019; C. Holmes, pers. commun. 2019). Thus, most materials recovered from Component II were local, with one piece of possibly exotic chalcedony.

In Component II, bifacial technology comprises the overwhelming majority of diagnostic debitage (83.7%), followed by debitage associated with early reduction of cores (15.2%). Primary and secondary decortication debitage with cortex made up the majority of early reduction debitage (78.7%). Of the 516 pieces of bifacial debitage, 217 (42.1%) relate to early stage bifacial reduction (biface thinning), and 299 (57.9%) relate to late stage bifacial reduction (edge correction, preparation, and pressure flaking). The assemblage also provided tentative evidence for unifacial reduction, with one unifacial pressure flake. In sum, bifacial reduction dominated the knapping activities within Component II, with evidence for core preparation and possibly limited unifacial reduction.

4.4.3. Comparing Component I and Component II debitage

Results from a series of Pearson's chi-squared tests on Component I and Component II debitage suggest that there are few significant differences between these assemblages. Differences between the amount of early reduction (i.e., decortication and interior flakes) and bifacial reduction (i.e., early thinning, late thinning, alternate, edge preparation, and bifacial pressure flakes) debitage in each component were not significant, X^2 (1, $N = 752$) = 2.73, $p = 0.85$; nor was the difference between early bifacial reduction (i.e., early and late thinning) and late stage bifacial reduction (i.e., alternate, edge preparation, and bifacial pressure flakes) significant, X^2 (1, $N = 638$) = 0.60, $p = 0.44$. The only significant difference between these two assemblages is the ratio of gray and black chert employed in early core and bifacial reduction during these two different periods, X^2 (3, $N = 755$) = 24.70, $p < 0.001$. The results suggest that gray chert comprised significantly more bifacial reduction debitage in Component I and, conversely, comprised significantly more early core reduction debitage in Component II.

5. Discussion

Initial results from excavations at Niidhaayh Na' suggest that similar activities took place during the first two site occupations, which span the Pleistocene-Holocene transition. Both assemblages exhibited a notable amount of large core reduction debitage with visible cobble cortex, suggesting that residents of the site were processing river cobbles locally and perhaps directly from Delta Creek. The assemblages featured a significant difference between the use of gray and black chert in early core and bifacial reduction. Since both materials are locally available and of similar quality, this may represent an arbitrary or unsystematic difference in raw material collection and use. However, Component II debitage exhibits a greater diversity of raw materials than Component I. Researchers have argued that Denali complex assemblages from the Nenana Valley feature more exotic toolstone than Nenana complex assemblages (Graf and Goebel 2009), though researchers have also argued that exotic raw materials were frequently and consistently used in the Tanana Valley in both Nenana and Denali complex assemblages spanning the Pleistocene-Holocene transition (Little 2013). Additional research at the site will likely generate more lithic materials and potentially more raw material types that can better illustrate these interregional patterns.

Both assemblages were dominated by bifacial reduction debitage, with no conclusive evidence of microblade technology. Two bifaces associated with Component II are lanceolate points consistent with those found in Denali complex assemblages. No bifaces or biface fragments were recovered from Component I. Therefore, while the debitage is similar in both components, it is not yet possible to assign Component I to either the Denali or Nenana complex. Indeed, other Tanana Valley assemblages contemporaneous with the late Younger Dryas are associated with the Nenana complex because they contain bifacial Chindadn points and lack microblade technology (Cook 1996; Goebel and Potter 2016; Holmes 2001; Holmes, VanderHoek, and Dilley 1996; Potter, Holmes, and Yesner 2014). No definitive evidence for microblade reduction was recovered during these excavations, though Bacon and Holmes' (1980) initial research at the site resulted in microblades and microblade core fragments. These were likely deposited before the mid-Holocene according to their location beneath the discontinuous tephra that we identified in association with mid-Holocene radiocarbon dates (Bacon and Holmes 1980, 59). More research at the site should yield additional diagnostic materials that can define the technological complex of Component I and clarify the relationship between debitage and technological complex at Niidhaayh Na'.

Niidhaayh Na' represents one of only a few dozen central Alaskan sites with occupations that date to the Pleistocene-Holocene transition. Archaeologists have noted a paucity of assemblages dating to the terminal Pleistocene in particular (Potter 2016), which may be attributed to a well-documented radiocarbon plateau, ca. 12,410–10,720 cal yr BP (Williams 2012, 582). Further, only a half dozen analyses have been published on late glacial central Alaskan debitage assemblages, and even this small sample exhibits significant variation in reported attributes. Nevertheless, results from assemblages at Mead (CZ2 and CZ3b) and Gerstle River (C2 and C3) from the Tanana Valley lowlands and Dry Creek (C2) and Bull River II from the Nenana Valley can be coarsely compared to those from Niidhaayh Na' (Graf et al. 2015; Little 2013; Potter 2005, 759; Wygal 2010). Five debitage assemblages from Mead, Gerstle River, and Dry Creek all exhibited a low quantity of debitage with cortex (< 1%) and predominantly small to very small (< 0.5 cm^2) debitage. At Bull River II, in contrast, over 10% of all debitage had cortex and overall debitage size was relatively large. Large, early reduction debitage from Niidhaayh Na' components I and II is more similar to Bull River II than sites in the nearby Tanana Valley lowlands or Dry Creek (C2). Owl Ridge (C2 and C3), situated in a peripheral upland-lowland ecological zone in the Teklanika Valley west of the Nenana Valley, also exhibits an abundance of local raw materials and primary reduction debitage similar to Niidhaayh Na', but comparable size and cortex metrics have not yet been published (Gore and Graf 2018; Graf et al. 2020). Thus, debitage differences highlight interregional variability in lithic production at the onset of the Holocene and demonstrate the need for more comparative debitage research.

An initial comparison suggests that Niidhaayh Na' was used similarly to Bull River II and perhaps Owl

Ridge (C2 and C3). Like Niidhaayh Na', evidence from both of these sites indicates they were late glacial upland or peripheral upland-lowland large mammal hunting camps possibly used to "gear up" for the winter (Gore and Graf 2018; Wygal 2010, 117). Niidhaayh Na' is located on the periphery of upland and lowland ecological zones (Gallant et al. 1995), facing the uplands and Alaska Range to the south, and would have offered late glacial residents the opportunity to locate a diverse array of large game while they prepared local toolstone for later use. This preliminary comparison of Component I and Component II lithic material to contemporaneous central Alaskan debitage assemblages reflects the high degree of regional technological variability scholars increasingly associate with the Pleistocene-Holocene transition.

6. Conclusion

Initial results from components I and II at Niidhaayh Na' suggest that the site's residents made extensive use of local toolstone to prepare and shape bifacial tools, perhaps as a late fall camp used to gear up for winter and hunt large upland fauna. Lanceolate bifaces recovered from Component II at the site are consistent with the Denali complex. Similarities between Component I and Component II debitage suggest that both resulted from Denali complex-style lithic manufacture, but more data are needed to conclusively determine the typological affiliation of Component I. A preliminary comparison to regional debitage assemblages shows that the debitage at this site is distinct from contemporary assemblages at neighboring Tanana Valley sites such as Mead and Gerstle River but similar to debitage from the upland Nenana/Teklanika Valley sites of Bull River II and Owl Ridge. As more sites across the region are investigated, it is increasingly clear that central Alaskan technology use and manufacture were quite variable at the onset of the Holocene. More comprehensive research at diverse locales is needed to fully articulate the diachronic relationship between late glacial climate, environment, human adaptations, and material culture in central Alaska.

These preliminary conclusions indicate that further research at Niidhaayh Na' will yield additional information on human behavior and adaptation pertinent to on-going debates surrounding human-environment interaction in the Subarctic. Future fieldwork plans include further testing at Locus III and expanding 1 × 2 m tests at Locus II into a block excavation. This field research will elaborate on the findings presented here and provide additional insights into intrasite patterning, activity areas, and site use through time. Laboratory identification of tephra, faunal material, charcoal, and geochemistry are ongoing and will contribute to environmental reconstruction at the site. Additional results from Niidhaayh Na' can complement recent and on-going investigations into technological and cultural variability in central Alaska and contribute to broader theoretical debates concerning lithic curation, resilience, and behavioral adaptation during the late glacial period.

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