Evaluating the Social and Environmental Process of the Dene/Athabascan Migration from the Subarctic

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Anthropology)
in the University of Michigan
2020

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Dedication

For Carol

Acknowledgements

This story is not my own. I begin this story in the style of Northern Dene, whose strength continues to inspire me. Thank you to the Dene who permitted me to undertake this research on their material culture and heritage, represented by the Tanana Chief's Conference. Though I have called Alaska my home for almost my whole life, I have only just begun to understand the complex beauty of the Subarctic and I look forward to many more decades of learning from the Northern Dene.

The research that I conducted is not only mine either. I benefitted from the guidance, hard work, immense knowledge, and collaborative spirit of many people across and beyond the discipline of Anthropology. I began this research journey as a Field Technician for the Center for Environmental Management of Military Lands, where Julie Esdale and countless cohorts of CEMMListas helped me to find my footing in the immense field of Alaskan archaeology. Thanks especially to Caitlin Holloway, Brooks Lawler, Whitney McLaren, Dougless Skinner, and Kate Yeske, some of the strongest and most generous women I know, and to the many archaeology grads from the University of Alaska Fairbanks, Crystal Glassburn, Hillary Hilmer, and Joe Keeney among them, who welcomed me to their community with open arms. To my fellow graduate student contractors from the lower 48, Angela Gore, Joshua Lynch, and John Blong, thank you so much for sharing your ideas with a young upstart and walking me through my first directed excavations. After my first seasons with CEMML, François Lanoë told Joshua Reuther that I could use more data, and Josh took me seriously enough to invite me to take over

Carol Gelvin-Reymiller’s project at the Klein Site. One conversation in a bar really can change your career. From the Museum of the North, thank you to Sam Coffman, Holly McKinney, and Scott Shirar for your willingness to always lend a hand, an eye, and a spreadsheet. At the Klein Site, I had the great pleasure to work with Kristin Cimmerer, Emma Creamer, Angie Feak, Emma Jones, Annika Rebentisch, and Xinglin Wang, who generously shared their hard work, insights, and patience with me during my last two seasons of fieldwork. Once the artifacts got back to the lab, the peerless Senna Catenacci helped to organize, analyze, and digitize our findings. The field and lab research I report here was generously funded by grants from the Alaska Anthropological Association, the National Science Foundation (Award #1830705), the Wenner-Gren Foundation for Anthropological Research (Grant #9754), the National Geographic Foundation (Award #HJER1517), the Rackham School of Graduate Studies at the University of Michigan, and the University of Michigan Museum of Anthropological Archaeology. The U.S. Army Garrison Alaska provided access to sites on Fort Wainwright under Archaeological Resources Protection Act Permit 2016-001.

The story of my research began to take shape with the help of many faculty, staff, and generations of graduate students in the classroom and halls of the Museum of Anthropological Archaeology. To my elder statespersons, Anna Antoniou, Jess Beck, Lacey Carpenter, Chelsea Fisher, Christina Sampson, Colin Quinn, thank you for showing me how this is done, sharing your grants, lending your critical eye, and advising me not to sweat the small stuff. Thank you to my witches, Jordan Dalton, Elspeth Geiger, and Jo Osborn, for camaraderie, commiseration, and celebration over the years and over many beers. Thank you to Andrew Bernard, Tim Everhart, Marty Menz, Gyorgyi Parditka, Lauren Pratt, Jim Torpy, and all the other members of the Bad Movie club who kept me energized about my research, teaching, and grants and encouraged me to reach my potential. In classes with Rob Beck, Kent Flannery, and Joyce Marcus, my ideas took shape. Raven Garvey helped me to hone those varied ideas into a structured argument, efforts that resulted in the successful receipt of three external grants that funded this research. Amy Winchester, Elizabeth Noll, Darlinda Flannigan, and Lauren Fuka were true MVPs within the UMMAA and Anthropology community, each of whom always had an answer to my most obscure questions and went above and beyond to provide friendly help in my times of greatest need. Thank you for helping me to thread the needle that brought this story together.

Ultimately, the foundation of the story lies in the land of the midnight sun. My family and friends up north fed me, listened to my rantings and ravings about Northern cultures, put me up, and put up with me. Thanks especially to Miriam McGovern, who copy-edited every chapter of this dissertation and so much more, and to Richard Doering, who let me store field crews and gear in his house for several productive field seasons. Sorry I left so much dirt on the rug. Kate Pendleton and Ray Funk were consummate hosts and provided so many restorative meals and conversations. To Rachel Elmer and Morgan Hostina, thank you for convincing me I was just nutty enough to pull this off and showing me what work-life balance is all about. I cannot thank Darwin and Scott Reymiller enough for sharing Carol's legacy with me through stories, art, and notes and for inviting me to build on that legacy with the research presented here. And to Owen Funk, my constant companion and connection to the Subarctic, who helped me celebrate the best times, showed me how to move past the unhappy times, and above all, listened. For everything, thank you.

Finally, many people directly assisted in mustering this story into a dissertation. My committee members, Brian Stewart, Julie Esdale, Dan Fisher, John Kingston, and Henry Wright all provided helpful comments on the structure, organization and presentation of the dissertation, as did Bob Whallon and Josh Reuther. John Speth read many drafts of grants, papers, and chapters related to the research that I share in these pages and I am grateful for his consistent constructive mentorship. Brian Stewart, my chair, gave me the tools and advice I needed at all the right times, and Julie Esdale, my invaluable boss-laborator, was there with advice, encouragement and edits at every stage of the research and reporting process. I have done my best to address the poignant comments that my mentors have presented, but ultimately, any errata within are my own. To everyone who made this story about Dene resilience possible, *maasee' choo*! Thank you!

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Abstract

Approximately 1,500 years ago, Dene/Athabascans radically altered their lifestyle in central Alaska and Yukon, and many ultimately left this region entirely. In my dissertation, I evaluate the causes of this drastic transition using a multiscalar archaeological dataset that draws from excavation, geospatial, and ethnographic data. Specifically, I consider whether either a massive volcanic eruption or population change led to a sudden, wide-scale shift in Subarctic technology, diet, and trade, and an ultimate southward migration. The results of technological, isotopic, and geospatial analysis presented here strongly suggest that Dene/Athabascans responded to a regional population increase, likely driven by a shift in group organization predicated by the Dene/Athabascan kinship structure. In response, Dene/Athabascans became increasingly specialized and territorial until some Dene/Athabascans began a southward migration that finally terminated in the American Southwest over 500 years ago. The diachronic nature of my multiscalar research allows me to model this transition as a process, rather than an event, that can be compared to similar cultural processes to provide a comprehensive understanding of resilience, adaptation, and migration at different periods of history and around the world.

Chapter 1 Introduction

Hunter-Gatherer Migrations

Many multidisciplinary anthropological studies have focused on the subject of human dispersals or migrations, which are fundamental to the human experience (Cabana and Clark 2011a; Ruhlen 2009). Cultural anthropologists have studied the multiscalar experience of migration in real time, particularly as it relates to changing identities and social networks (Brettell and Hollifield 2013; Xiang 2013). Linguistic anthropologists have evaluated the impacts of migration on intercommunity dynamics (Duchêne et al. 2013) and have recognized past migrations through corresponding language changes (Hock and Joseph 2009). Biological anthropologists have identified and evaluated migration with genetic data that demonstrates broad-scale population dynamics (Hartl et al. 1997). However, archaeologists have rarely attempted to build on extensive discussions of migration in anthropology during the past few decades (Anthony 1990; Anthony 1997), forfeiting comprehensive multidisciplinary considerations of this important aspect of the human experience in the past and present. Here, I investigate the process of migration in the past with a multiscalar dataset and a theoretical model based in ethnographic analogy and human behavioral ecology that is generalizable to many migrations past and present. The case that I use to evaluate this model is the Dene/Athabascan migration, or the permanent southward migration of many Dene/Athabascan speakers from the Subarctic to the North American Southwest ca. 1,000 years ago (Derry 1975; Seymour 2009; Ives 1990). Here, I will consider the Dene/Athabascan migration in light of the Northern

Dene/Athabascan transition, which I define as a suite of changes to subsistence, technology, and mobility that occurred in the Subarctic prior to the southward migration, leveraging Northern Dene/Athabascan material culture from 2,000–500 cal BP to explain the partial Dene/Athabascan migration from Alaska and Yukon as far south as the present-day US-Mexico border.

Archaeological contributions to the anthropological conversation surrounding migration offer several distinct perspectives that advance disciplinary debates. The material evidence that forms the basis of archaeological inquiry is suited to resolving anthropological debates centered on the materialization of identity, multiculturalism, and the process of identity formation (Casella and Fowler 2005; Vertovec 2007). The material representation of community identity is a well-documented phenomenon that archaeologists employ in their considerations of migration (Sassaman 1998). Additionally, archaeological data offer a diachronic perspective that provides the resolution to understand migration as a prolonged, lived process rather than an event (Brettell 2003). While linguists and geneticists can offer certain details pertaining to chronological and directional dynamics of migration, archaeologists illustrate the structural details of this process with comparable material evidence from different times (De León 2013). Finally, archaeologists advance multiscalar studies of the process of migration by combining available data from distinct regions and relating these data to local processes (Glick Schiller 2015; Xiang 2013). Community identity is iterated and re-iterated during the migration process and archaeological data show how this process corresponds to the production of material goods with evidence that spans landscapes of migration (Hall 2006; Wilson 2011). Therefore, the spatially and temporally anchored material evidence that forms the basis of archaeological inquiry contributes to many important anthropological debates on the process of migration and offers a nuanced, multiscalar perspective.

Following Cabana and Clark (2011b:5), I define human migrations as relatively permanent residential relocation to a new “environment”. While animal migrations occur seasonally, anthropologists typically refer to permanent human dispersals or expansions as migrations (e.g., Timmermann and Friedrich 2016; Goebel et al. 2008). Migrations are important one-way journeys that represent the culmination of individual decisions and internal and external pressures, a complex process that can result in the permanent displacement of entire communities. Slobodkin (1968) and Colson (1979) suggested that the key to understanding drastic adaptive decisions, such as migration, lies in identifying and explaining the penultimate responses and decisions that culminate in a broader cultural transition. In essence, many small decisions and behavioral changes are considered and implemented before culminating in the radical decision to permanently relocate. These penultimate decisions should leave archaeologically identifiable material traces in domains such as diet, mobility, technology, and land use strategies. Additionally, linguistic data indicate that technologies associated with the Dene/Athabascan transition such as copper, ceramic, and bow and arrow technology were established prior to their migration (Wilson 2019). In central Alaska and Yukon, changes subsistence and mobility associated with, but preceding, the southward migration should reflect penultimate adaptive responses to an external pressure in light of this model of decision-making. The individual decisions that Northern Dene/Athabascans made between 2,000–1,000 cal BP can be evaluated within the framework of behavioral ecology to identify social or environmental factors that drove these systematic changes (Winterhalder 1991). I build on these models of individual decision-making in response to resource stress to investigate the causes the Northern Dene/Athabascan transition in mobility, subsistence, and technology to show how these changes ultimately culminated in the Dene/Athabascan migration out of the Subarctic (Figure 1.1).

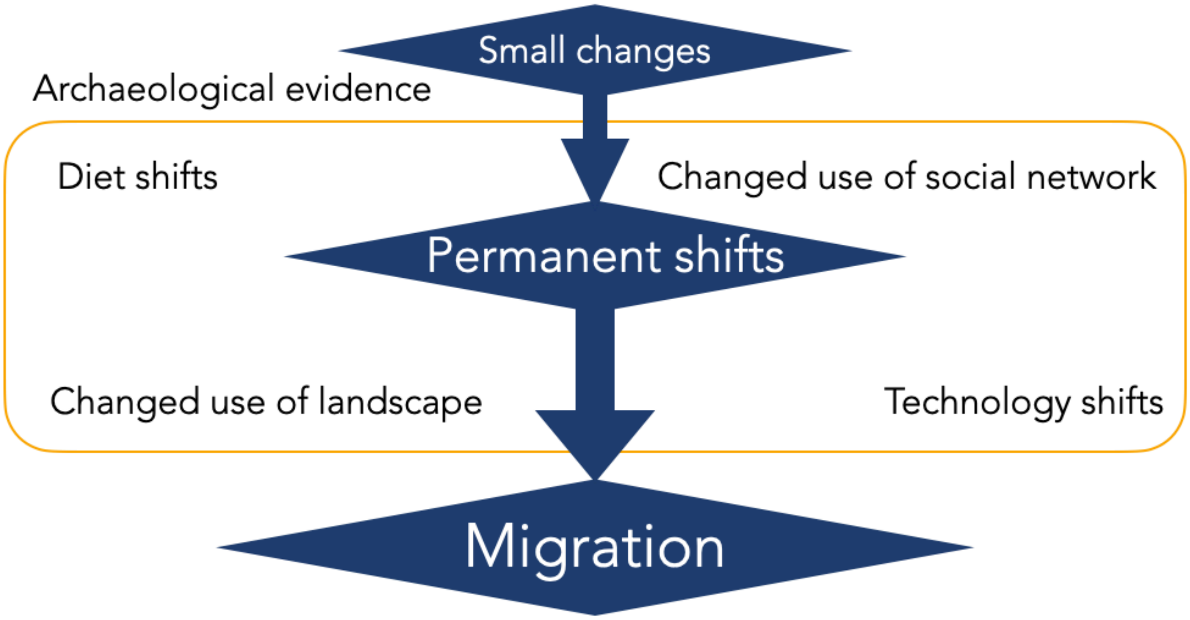


Figure 1.1 Material Model of Adaptive Decision-Making, sensu Slobodkin (1968) and Colson (1979)

Human Migrations as a Social Process

Significant research efforts have produced a wealth of data related to the process of migration throughout our species' history. Much of this work has followed Anthony's (1990, 1997) call to reconsider migration after decades of neglect by processual New Archaeologists. In these works, Anthony linked the paucity of processual archaeological research to migration's role as an explanatory factor in the culture-historic theoretical tradition of early 20th century archaeology (Anthony 1990:896). Culture historians relied on migration (or diffusion) as an *ad hoc* explanation for important changes that they observed in regional material culture rather than seeking to explain the process of migration itself (Cabana 2011:17). This simplistic approach also conflated potential *in* and *ex situ* developments, and many of these alleged "migrations" have subsequently proved to be entirely *in situ* cultural developments with no important demographic influx. Culture historians avoided tackling the interregional dynamics of migration by using it as an *ad hoc* diffusionist explanation for cultural developments.

In contrast, New Archaeologists of the 1970s and 1980s ignored migration almost completely. In part, they sought to avoid overly simplistic explanations based on migration asserted by culture-historians. Cast aside as an explanatory factor, migration languished in theoretical discussions of the culture focused on explaining the processes that underpinned or preceded migrations rather than the process of migration itself (Binford 1972:22). Migrations, classified by New Archaeologists as *events* rather than *processes* and as effects rather than mechanisms, were thus unworthy of additional scrutiny. Migrations posed another conceptual hurdle to New Archaeological frameworks: they are interregional processes that do not take place within a bounded system. New Archaeologists approached explanations of past cultural processes through a maintained focus on the inner workings of a bounded system (Trigger 1989:399). As events, migrations entailed movements external to that system, defying the epistemological model developed by systematic New Archeologists. Finally, some archaeologists dismissed the fundamental importance of migration within the human experience altogether (Chapman 1997). Combined, these factors led to a dearth of archaeological focus on migration during the second half of the 20th century.

Archaeologists soon recognized that an essential aspect of the human experience was missing from discussions of past cultural change and that migrations should be interpreted as important cultural processes rather than events (Anthony 1990). To overcome the multiscalar complexity associated with the process of migration, Anthony (1990) proposed employing a traditional “push” and “pull” paradigm from demography to frame archaeological considerations of migrations. This encompassed push factors at the origin and pull factors at the terminus of past migrations. Negative "push" factors might include local environmental stress, social tensions, or disease (Anthony 1990:23). In contrast, positive "pull" factors might be quantified in terms of these negative influences, e.g., improved access to resources, or they may represent knowledge of distant positive relationships or additive benefits, such as a low travel cost from the origin to the destination. This flexible model borrowed from demographic researchers has led to a renewed, if somewhat hesitant, archaeological interest in migration since Anthony's (1990) initial charge to reconsider migration events as processes demanding the attention of theory-driven researchers.

Anthropological Approaches for Documenting Past Migrations

Beginning in the 18th century, anthropologists have employed historical linguistics to identify possible past migrations (Hill 2011:175). By comparing linguistic similarities and differences and establishing language phylogenies, historical linguists successfully identified potential *urheimats*, or homelands, for similar language families that were occupied by ancestral speakers in the past. Tracing dispersal through further comparative study, linguists could both identify and track interregional population movements throughout the past. In the Subarctic, historical linguists have recently identified important links between the Yeniseian languages of Siberia and the Na-Dene languages of North America, including the Northern Dene that I consider here (Vajda 2010). The results of this research reveal the widespread commonalities between these families that indicate that migration was fundamental in the dispersal of these connected Dene-Yeniseian languages. Archaeologists have mobilized this linguistic research in their investigations of the initial peopling/colonization of the Americas (Potter 2010). Similar historical linguistic research on language groups around the world provide archaeologists with verification that these permanent, one-way moves did occur in the past, though with limited chronological and spatial resolution. Archaeologists can then use these important linguistic data to make inferences about the distance, timing, and number of migrants that generated these important historical linguistic shifts. Historical linguistics demonstrate the benefits of inter-disciplinary anthropological collaboration and are just as important to archaeological discussions of migration today as they were over 200 years ago.

Several new bioanthropological techniques have facilitated the identification, verification, and/or documentation of past migrations that complement methods based on linguistics (Burmeister et al. 2000). Through studies of ancient DNA, researchers have considered changes in population genetics and correlated these with past population movements (Lipson and Reich 2017), in some cases reconstructing past migrations that were previously invisible to archaeologists. The analysis of ancient population genetics relies on a rigorous statistical methodology that can only roughly approximate the timing of genetic shifts. Combined with evidence from material culture, studies of ancient DNA are revolutionizing the way archaeologists both conceive of and identify paleodemographic trends and human migration specifically.

Likewise, isotopic studies of strontium from human tissue have served to track temporary and permanent population movements in the past. Strontium isotopic composition is unique across many watersheds and measuring strontium isotopes in human bone and tooth apatite can roughly trace patterns of human movement in regions with established strontium profiles (Beard and Johnson 2000). Hydroxyapatite, or the mineral component of bones and teeth, is typically composed of calcium but can integrate elements with a similar valence such as lead and strontium. This method is more spatially and chronologically precise than population genetics because it can trace movements among individuals that can then be extrapolated to the population level. These isotopic studies have also revealed greater variability in human movements in the past that challenge archaeological models built implicitly or explicitly on the assumption of static and/or siloed regional populations (Wolf 1982:6; Trigger 1989). Ancient DNA and strontium isotope methods drawn from biological anthropology have established migrations and population movements, elucidating historical linguistic and archaeological research.

Archaeological Explanations of Migration

In recent years, several anthropologists have leveraged these important theoretical and methodological advancements to document and explain past migrations around the world. The theoretical domain of these recent studies can be grouped into three approximate categories: (1) the initial colonization of unpeopled landscapes, (2) the migration of agriculturalists into non-agriculturalist territories, and (3) population movement among existing groups of similar economic and/or subsistence base. The initial colonization of unpeopled landscapes involves many of our species' movements across the globe, such as the colonization or peopling of Australia and the Americas (Potter et al. 2018; Marean 2017), and involves humans moving from areas that are already populated to regions unpopulated by *Homo sapiens* or other hominins (Gamble 2013). The migration of agriculturalists into landscapes occupied by hunting and gathering groups, an aspect of neolithization, reflects changing or augmenting the subsistence potential of a different landscape (Bellwood 2001; Nikitin et al. 2019; Russell et al. 2014; Scharlotta 2018). Finally, population movements among groups of similar economic and/or subsistence bases does not necessarily connote increased subsistence returns and can occur among regional small-scale and agriculturalist populations alike, such as Bronze Age migrations, pre-colonial migrations in among indigenous Californians, and the Bantu expansion (Cassidy et al. 2016; Andrushko et al. 2009; de Maret 2013). These explanations are less intuitive because these migrations are not related to an implicit increase in productivity or resource base. Subsequently, causal explanations for this third type of past migration tend to require an additional burden of proof. Importantly, all three kinds of migration that I have designated can be differentially considered as partial or complete permanent population movements. These general migration types represent an analytical framework that allows for a comparison of the different ways archaeologists have employed recent theoretical and methodological advances to better understand migrations in the past.

In peopling or colonization migrations, researchers almost exclusively identify environmental factors in causal models. Specifically, studies that reconstruct initial peopling or colonization processes frequently invoke the push of increasingly crowded landscapes and resource stress with a coupled pull of an unknown but empty landscape with greater possible resource potential (Meltzer 1993; Fiedel 2000; Mandryk et al. 2001; Bettinger and Young 2004). Social dynamics are rarely considered as push or pull factors within this predominantly environmental explanatory framework, and most of these explanations leverage models from human behavioral ecology (Barton et al. 2004; Webb and Rindos 1997). Instead, archaeologists frequently assume that human-caused animal extinctions pushed past humans out of regions and into unpeopled lands (Haynes 2013; Choquenot and Bowman 1998; Borrero 2009).

Push and pull factors related to migrations among settled groups tend to incorporate both social and environmental factors to some degree. Researchers have suggested that landscapes occupied only by hunting and gathering peoples are attractive to herders, maritime specialists, and agriculturalists for production potential, lower population densities, and to take advantage of decreased intergroup conflict (Friesen 2016; Pinhasi et al. 2005; King et al. 2015; Fiedel and

Anthony 2003). Evidence for this causal framework comes primarily from isotopic, genetic, and linguistic data but these lines of evidence can be supported with evidence for changes in material culture, such as the introduction of new technologies, denser settlements, and changed subsistence in newly occupied regions. In the region of the migration's origin, material evidence for conflict can also be used to support additional evidence from linguistic and bioanthropological data.

The third case, migrations in populated regions with similar economic bases, typically requires additional evidence to reconstruct potential push and pull factors because it cannot be assumed that differential resource availability motivated permanent population movements, as in the first two cases. Further, the past migrations considered in this category are primarily among agricultural societies. Climatic perturbations, such as drought, can be used to suggest economic push and pull factors (i.e., increased resource potential in a different region culminates in the decision to migrate). Agriculturalists in particular are very sensitive to changes in precipitation and temperature and these studies attempt to leverage correlation to provide causative explanations. Therefore, environmental reconstructions are critical to arguments that correlate these past migrations and climate change. Sociopolitical explanations, such as increased territoriality, are also frequently considered in these scenarios, particularly among agriculturalists. Evidence for sociopolitical push and pull factors arises from large mortuary assemblages that document increased violence, increased construction of defensive architectural features, evidence for defensive technologies such as bow and arrows, and disruptions in regional trade networks (Glowacki 2015; Reindel 2009; Codding and Jones 2013; Maschner and Mason 2013). For migrations to regions populated by settled groups with similar resource bases, both social and environmental factors are frequently considered by archaeologists.

To illustrate these generalizations in archaeological explanations of migration, I will briefly consider the expansion of Bantu language-speakers. The Bantu expansion and migration provides a well-documented example of the dispersal of small-scale populations that has been thoroughly investigated using multiple lines of anthropological evidence. The Bantu expansion and migration provides a well-documented example of the dispersal of small-scale populations that has been thoroughly investigated using multiple lines of anthropological evidence. It thus serves as serves as an important comparative case to the Dene/Athabascan migration. While the Bantu case focuses primarily on environmental variables, archaeologists have illustrated how a theoretically-framed investigation can result in an improved understanding of past mobility. Archaeologists have integrated linguistic, genetic, and archaeological data to illustrate the iterative, multigenerational nature of the Bantu expansion that sheds light on the complexity of the process of migration.

Linguists identified the Bantu expansion primarily through comparative lexicostatistics that allowed for a relative chronological phylogeny (Bostoen and Grégoire 2007) and suggested that the Bantu *urheimat*, or linguistic homeland, was likely situated in the grasslands of Cameron (Vansina 1994). Synthesized sociolinguistic and archaeological evidence indicate directional transitions in burial practices, subsistence, and technology as proto-Bantu speakers spread south and east and split into Western and Eastern Bantu language families (de Maret 2013). The initial Bantu expansion is associated with material evidence for elaborate burials, new ceramic traditions, shifts in lithic technology, and the use of domesticated caprines and yams after ca. 5,000 cal BP. Evidence from excavations indicate that these innovations in technology and changes to burial practices were not unified and took place gradually over several hundred years (Oslisly and White 2007). Around 2,500 cal BP, archaeological evidence indicates a transition to small-scale agriculture and a technological transition from stone to metal tools that radiates southward from the proto-Bantu homeland (de Maret 2013). Genetic data indicate that the spread of Bantu peoples and associated shifts in material culture can also be linked to gene flow, with migrating Bantu-speaking men frequently reproducing with local, non-migrating women (De Filippo et al. 2012; de Maret 2013). Thus, the nexus of genetic, material, and linguistic data strongly suggests a gradual southward migration of Bantu-speaking people themselves from west-central Africa, not just the diffusion of Bantu languages and culture.

The Bantu expansion represents an example of the third case of migration: migrants to regions populated by settled groups with similar resource bases. Further, it represents the partial migration of a small-scale society. Explanations for the dispersal of proto-Bantu speakers from west-central Africa are limited but most rely, as for many proto- or non-agriculturalist groups, on associations with contemporaneous climate change (de Maret 2013). South-central Africa experienced several significant environmental changes during the mid- to late Holocene, including a decline of the African monsoon and related savannah expansion and opening of rainforests ca. 3,500 cal BP (Oslisly et al. 2013; Bostoen et al. 2015). Additionally, researchers note a regional population increase ca. 2,500–1,400 cal BP that they have explained as a consequence of the thinning of forests and introduction of metallurgy. Researchers have primarily linked coarse-grained evidence for environmental change and the Bantu expansion through chronological correlation rather than relying on categorical and theoretically situated predictions for decision-making, behavioral adaptation, and cultural frameworks (Oslisly et al. 2013; Bostoen et al. 2015). This case concisely illustrates archaeologists’ tendency to grant environmental factors more explanatory value than social factors, particularly among small-scale societies, and the complex, iterative process of past migration. With additional archaeological evidence and concise theoretical frameworks, past central African migrations and dispersals could better leverage environmental, genetic, linguistic, and archaeological data.

Considering the ways various environmental and social explanations have been mobilized by archaeologists researching the three kinds of migration, environmental explanations universally provide the easiest for archaeologists to identify and marshal theoretically. However, it is equally apparent that our ability to infer social explanations for these permanent long-distance movements among small-scale societies is hampered by a lack of conclusive direct evidence and theoretical models that can incorporate what evidence exists. While sociopolitical factors such as intergroup violence and territoriality can be convincingly documented in most settled agricultural assemblages, more mobile small-scale societies lack extensive mortuary complexes and/or permanent architecture. Evidence for defensive technologies and disruptions in trade in exotics are more easily recognizable among small-scale groups but still challenging to identify with certainty. The challenges associated with identifying definitive archaeological evidence for sociopolitical shifts among semi-sedentary or highly mobile groups explains the overwhelming emphasis on environmental explanations for explaining migrations among these populations. Renewed attention to migration can build on the current theoretical gap by providing novel approaches to track and identify social causes in various social processes, including migration.

History of the Dene/Athabascan Migration

From moccasins to dwellings, from skin-working tools to hunting gear, and from fish traps to water craft, the Dena exhibit in their technology that ingenuity and adaptability to make the most of what they have, or to borrow from others and transform it to meet their own needs, that distinguishes the Athabaskan. – Frederica De Laguna*, Tales from the Dena*, pg. 45

Central to the question of Dene/Athabascan migration is the immense wealth of anthropological research that pertains to Dene/Athabascan history. Dene/Athabascan scholarship has drawn from a diverse range of theoretical perspectives and all four fields of anthropology to advance broader understandings of identity, adaptation, and community within and beyond the Dene/Athabascan world. “Dene” and “Athabascan” refer to a large family of language speakers indigenous to central Alaska, western Canada, northern California, southern Oregon, and the American Southwest. The appellation “Athabaskan” was first used in 1836 by Albert Gallatin, a European interested in understanding the connections between American Indian language families (Krauss 1987). Gallatin derived this term from the Cree place name for the “Lake of the Hills,” or Lake Athabasca, based on reports composed by several European explorers of the region, and in his usage, Gallatin referred to a language family spanning central Alaska and western Canada to Hudson’s Bay (Gallatin 1836). Gallatin himself identified that the term was an “arbitrary denomination” based on the name first given to the territory (Gallatin 1836: 17). However, it was one that stuck: later 19th century linguists firmly established the term “Athabascan” within academic literature and added Apachean languages, including Navajo, to this designation (Krauss 1987).

The terminology that I use to refer to the migration (Dene/Athabascan) and associated suite of cultural changes (Northern Dene/Athabascan transition) that I consider here follows established conventions. Today, many groups initially identified under the “Athabascan” umbrella prefer to be identified as Dene or a variant thereof, a term that translates to “the people.” Other scholars have used these two terms interchangeably, even in the same work (c.f. De Laguna 1995), with various spellings that can cause consternation for later researchers. To avoid excessive confusion and respect the wishes of today’s Indigenous groups, I refer to this linguistic family as Dene/Athabascan. Readers will also note that I spell “Athabascan” as designated by the Tanana Chiefs Conference in Resolution 97-35 and not any of the alternative spellings applied in previous linguistic research (e.g., Athapaskan or Athabaskan). Further, I refer to Northern Dene/Athabascans when designating Dene-speakers who span the arbitrary geopolitical border between Alaska and Canada today and ethnohistorically in the tradition of linguistic scholars (Phyllis Ann Fast 2002; A. L. Kroeber 1937), as in the context of the Northern Dene/Athabascan transition. In contrast, I refer to the partial out migration of Dene/Athabascans from the Subarctic to the Great Plains ca. 2,000–1,000 as the Dene/Athabascan migration because it spans the Northern and Southern Dene/Athabascan communities. Genetic and historical linguistic data indicate that Dene/Athabascans have been present since at least 5,000 years ago and that Southern Dene/Athabascans are genetically related to Northern Dene/Athabascans (Raghavan et al. 2015; Moreno-Mayar et al. 2018). Dene/Athabascans are a dynamic and expansive linguistic and cultural group who have provided anthropologists with a wealth of foundational knowledge regarding Subarctic and desert subsistence, culture, politics, movement, resilience, and land use spanning millennia and pertinent to all four fields of anthropology.

Linguistic Research

Studies of the Athabascan language are foundational to current interpretations of Dene/Athabascan history, identity, territory, and culture, including the recent migration from the

Subarctic to the Southwest. From the early 19th century, Western scholars began collecting and publishing information on this extensive language family, one of the most widely diffused in North America (Fowler 1971). Even by the mid-19th century, scholars began to recognize connections between Northern Dene/Athabascan language and languages spoken thousands of kilometers south in the Pacific Northwest and even further south in the North American Southwest (Turner 1852). Linguists disagreed over the direction of Dene/Athabascan dispersal for decades, though Boas' argument for a southward migration based on Southern Dene mythology was ultimately cemented by Sapir's careful documentation of lexical, phonological, and morphological differences among Southern Dene languages (Boas 1897; Sapir 1915). Additionally, this early anthropological scholarship offered a foundational understanding of the geographic distribution of Dene/Athabascan language groups that is still recognized today (Osgood 1936; Krauss et al. 2011). Combined with oral histories, this linguistic scholarship provides substantial evidence for the partial southward migration of Dene/Athabascan speakers from Alaska and Yukon to the Pacific Northwest and North American Southwest.

Comprehensive comparisons of linguistic differences among Dene speakers researched by historical linguists have firmly established the directionality of the Dene/Athabascan migration but this linguistic evidence provides only a vague reference for the timing and origin of the southward migration. Linguistic evidence indicates that Dene/Athabascans reached the Southwest around 800 years ago, ca. 1200 C.E, and oral historic evidence suggests that it was more recent, ca. 1500 C.E. (Seymour 2009). Present-day political and territorial disputes among the Hopi and Navajo revolve around these conflicting interpretations and further complicate anthropological inquiries into the timing of the Dene/Athabascan migration (Washburn 1989). Additionally, linguists continue to debate whether the Dene *urheimat*, or linguistic homeland of

Dene, lies within the central Alaska/Yukon borderlands (Davis 1981:68), the Tanana River Valley in central Alaska (Kari 1996:464), or in western central Alaska (Wilson 2011:276). In sum, indigenous and Western knowledge corresponds on the North-South directionality and comparative linguistic research suggests that the migration began either in the central Alaska/Yukon borderlands or in western central Alaska after 2,000 years ago.

Linguistic and oral historic research has contributed more generally to our understanding of pre-Columbian Northern Dene/Athabascan social networks, politics, and resilience. Kinship terminology indicates an exogamous local group alliance system reliant upon seasonal aggregation and resource redistribution (Ives 1990:310). Further, oral histories note three separate clans of Northern Dene/Athabascans that are organized by matrilineal descent and dictated marriage regulation (De Laguna 1995:22–23, 199). These lines of evidence reveal a linguistic identity with clear ties to social organization, mobility, and subsistence strategy in the past that are foundational to understanding human-environment interaction.

Research focused on historical linguistics has presented evidence for the long history of Dene/Athabascans in the Subarctic through studies of language relatedness and place names (Kari 2010). By considering trans-Subarctic linguistic ties, scholars have recently identified links between the Dene/Athabascan language and Yeniseian language families in Siberia (Vajda 2010). Place name documentation provides substantial evidence for Dene/Athabascan cosmology and sense of space, and several place names provide details of ice masses that melted millennia ago. While these placenames would suggest Dene/Athabascans' uninterrupted use of this dynamic landscape spanning over 10,000 years (Kari 2010), this contradicts the most recent population genetics research that suggests Dene arrive in the region around 5,000 cal BP

(Moreno-Mayar et al. 2018). Nevertheless, such historical linguistic research informs the social-scientific research conducted in this Subarctic region.

Currently, linguistic scholars are also engaging with language revitalization and studies of the post-colonial Northern Dene/Athabascan experience (Phyllis Ann Fast 2002). Such research continues to contribute to the anthropological understanding of Dene/Athabascan identity and presents new ways for engaging with the long trajectory of Dene/Athabascan history in the Subarctic. Particularly, this scholarship highlights the value of cultural revitalization in the form of linguistic heritage in healing post-colonial trauma (Meek 2012). Such scholarship pushes anthropologists across the discipline to consider ways that their research affects present and future Northern Dene/Athabascans and ways that diverse scholars can contribute to heritage management and post-colonial healing in these communities. By offering a study of Dene/Athabascan resilience, the research presented here aims to share additional evidence of Dene/Athabascan strength pertinent to Dene/Athabascans today.

Cultural and Ethnohistoric Research

Ethnographic research in central Alaska and Yukon provides a basis for understanding Dene/Athabascan life in the post-colonial Subarctic that is linked to pre-contact culture associated with the Dene/Athabascan migration. However, the ethnographic record must be understood foremost in terms of the Euro-American colonization before drawing parallels with the deeper past. The remoteness and massive scale of this region resulted in its relative insulation from Western colonial forces through the 19th century in contrast to coastal and southern North American indigenous groups (Andrews 1975; Davis 1981; Figure 1.2). By the time that Western colonial forces had settled and forcibly removed many American Indians from their ancestral territories ca. 1890 C.E., only a handful of Western traders had attempted (and largely failed) to establish permanent residences in Alaska and Yukon (VanStone and Goddard 1981; Frink 2016). The situation changed drastically following the Western discovery of gold in central Alaska in 1898 (Wickersham 2010). Soon thereafter, a wave of colonizers descended upon this remote region, establishing roads, settlements, and outposts through the very heart of this vast territory (Huntington 1993; Wallis 2003). The historical and colonial context of the region structured the trajectory of Dene/Athabascan cultural and ethnohistoric research.

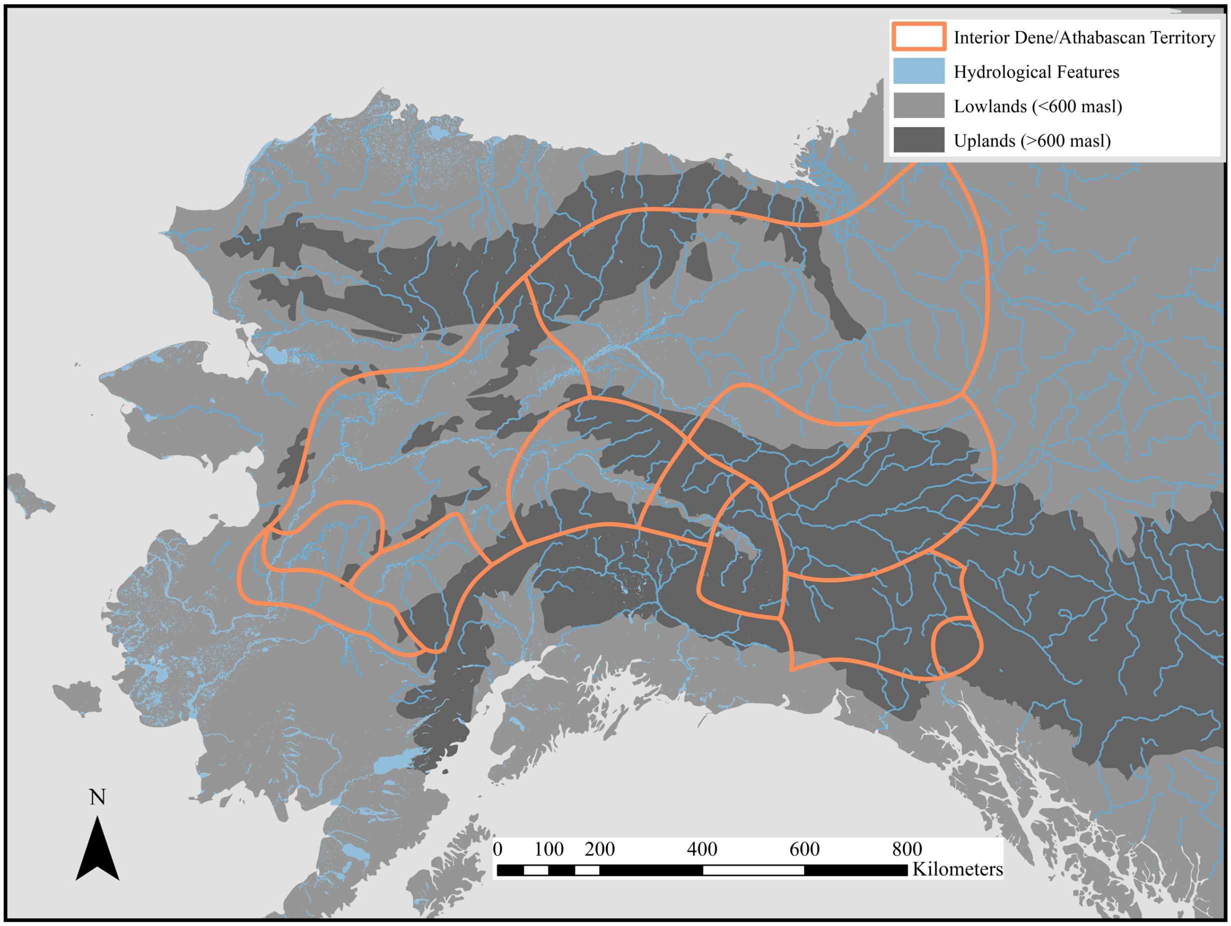


Figure 1.2 Map of central Alaska and Yukon's Ethnohistoric Territorial and Linguistic Groups

Explorers, religious figures, and government researchers from Russia, Canada, and the United States provided Western academic and general audiences many of the first accounts of Dene/Athabascan ingenuity, rich social networks, and resilience to the variable Subarctic climate

(Davis 1981). Though limited in scope and translated through a colonial lens, early records describe the cultural and natural landscape in advance of extensive Western settlement of the region (Stuck 1915:366). Such accounts reveal the extent to which Northern Dene/Athabascans maintained their rich cultural heritage in the 19th century while incorporating Western goods and economic traditions into their annual, seasonal, and even daily rounds through largely indirect contact with the Western trapping industry (McKennan 1969). Specifically, Western clothing and weapons were adopted prior to large-scale Western settlement of the region. Such goods were traded in exchange for trapped furs through Northern Dene/Athabascan trade networks (VanStone and Goddard 1981). The first European trading post in central Alaska opened in Nulato in 1838 (Zagoskin 1967:146–147) and the Hudson's Bay Company opened the second at Fort Yukon in 1847 (Murray 1910:44), followed by a third at Fort Selkirk (Simeone 1995:20). Traditional trade networks facilitated the swift exchange of furs from the Yukon drainage and Western goods from these settlements on the Yukon River into the most remote areas of central Alaska and Yukon and consequently, shifted the Northern Dene/Athabascan economic base and regional social organization (Burch 1979:133; Stuck 1915:361). Notably, Northern Dene/Athabascans adapted the existing social network complex to obtain and circulate these novel technologies, highlighting Northern Dene/Athabascan ingenuity, flexibility, and resilience.

Even as Western goods were incorporated into everyday Northern Dene/Athabascan life during the late 19th century and colonial powers began to directly impact Northern Dene/Athabascans through missionization and federally-mandated education, several Western accounts reveal the many ways in which Northern Dene/Athabascans maintained their heritage through language, oral histories, subsistence traditions, and other important cultural practices. Father Jules Jetté actively documented Nulato's rich community of Koyukon Dene/Athabascans, located on the middle Yukon valley on the Northwestern edge of Northern Dene/Athabascan territory (Jetté 1907, 1908; Davis 1981). His accounts reflect the broader structure of Northern Dene/Athabascan interregional politics, including tensions with neighboring Inuit, as well as Northern Dene/Athabascan conceptions of landscape that formed the basis of subsistence and mobility decisions that will be considered in great depth in later chapters.

Following Jetté, several sociocultural anthropologists dedicated their careers to a kind of salvage ethnography of Northern Dene/Athabascan life that reflected shifting Northern Dene/Athabascan traditions and culture throughout the region during the 20th century (Heaton 2012:109; Davis 1981). Ethnographers in the early 20th century such as McKennan and Osgood viewed interior Northern Dene/Athabascans as particularly far removed from Western influence and thus important fonts of ethnographic data (Osgood 1936; McKennan 1969). The assertion that Northern Dene/Athabascans were outside the reach of colonial cultural influence is problematic given the long history of the fur trade and Christian missions in the region and thus, this perspective denies Northern Dene/Athabascans' post-colonial history (Heaton 2012). Though outside the research area considered here, Binford's (1978) treatment of the Nunamiut can be similarly criticized. Nevertheless, I acknowledge the wealth of the knowledge preserved in these accounts, both in the form of historical cultural considerations as well as tacit information pertaining to the dynamics of Northern Dene/Athabascan adaptation to evolving social environments.

Archaeological Research

Archaeologists and bio-anthropologists have built on the extensive background provided by Northern Dene/Athabascan language, culture, and oral historic research by offering tangible spatial and regional anchors for Northern Dene/Athabascan history. Initial archaeological surveys of the region were primarily culture historic and informed by Northern Dene/Athabascans who retained traditional knowledge of many settlements and lifeways (Rainey 1940; De Laguna 1947; Giddings 1941). Moreover, this early research benefitted from the late colonization of the region and the limited impact of Euro-American settlement through most of the 20th century. Ultimately, early researchers offered some of the most thorough considerations of recent Northern Dene/Athabascan history and excavation data pertaining to late and protohistoric Northern Dene/Athabascan culture.

Two dominant factors shaped central Alaska and Yukon archaeology following the first academic surveys: interest in the colonization of the Americas, and the location of proposed oil, gas, and mineral extraction projects. Development beginning in the 1960s and culminating in the construction of the Trans-Alaska Pipeline yielded archaeological materials at a scale that was arguably unmanageable for Alaska's small archaeological community (Cook 1977). Indeed, Alaskan archaeologists are still attempting to completely synthesize these datasets today. Government-mandated cultural resource inventories of federal land has yielded thousands of archaeological sites, many of which have still yet to be fully evaluated for eligibility in the National Register of Historic Places in Alaska (ADNR-OHA 2019). Similarly, Yukon attracts gold prospectors and other extractive interests that have resulted in a similarly extensive inventory of cultural resources (Martindale et al. 2016). Consequently, these cultural resource management projects have yielded a vast amount of locational data and a meager amount of chronological, cultural, behavioral, spatial, or other data. Moreover, these data are typically only published as government-mandated reports. The legacy of late 20th-century industrial resource extraction has resulted in extensive archaeological survey and site salvage but comparatively few synthetic summaries of regional chronology, interaction, or culture.

Extensive cultural resource surveys of the 1970s and 1980s led archaeologists to recognize the long history of human presence recorded in the region's deeply stratified loess deposits, which produced projectile points that were similar in form to Paleoindian points from the U.S. Great Plains (MacNeish 1963; Giddings 1963). Additionally, the University of Alaska's zoology collections accumulated well-preserved remains of several extinct species, including mammoth, many of which were found in permafrost and donated by local placer miners (Guthrie 1982a). Growing interest in the earliest Americans inspired Alaskan archaeologists of the early 20th century to offer their first material contributions to the intense debate over the "peopling of the New World" via the Beringian Land Bridge (Nelson 1935; De Laguna 1947; Bever 2001). The introduction and improvement of dating techniques in the second half of the 20th century provided the results regional archaeologists needed to assert that Alaska and Yukon represent the gateway to the first Americans, thus establishing the interior Subarctic firmly within this scholarly debate (Bever 2001). However, this productive emphasis on late Pleistocene archaeology represents one of several factors that have separated interior and coastal researchers, as the earliest coastal sites are millennia younger than the earliest sites in central Alaska (Bever 2001). In sum, a central Alaskan and Yukon focus on the late Pleistocene has pushed disciplinary interests toward environmental reconstruction, extensive excavation at deeply stratified sites, and an overwhelming focus on archaeological evidence from the terminal Pleistocene. These efforts have provided information pertinent to the earliest periods of the region's history and the initial colonization of the Americas. Yet, this myopic focus on the first Americans has led many regional archaeologists to avoid or completely ignore mid- and late Holocene assemblages at sites with more deeply stratified deposits, resulting in a significant gap in our understanding of late Holocene Northern Dene/Athabascan identity, culture, and coastal-interior interaction.

Despite these disciplinary biases, a number of researchers have conducted extensive excavations and/or synthetic research to synthesize late Holocene Northern Dene/Athabascan history. Several archaeologists have completed dissertation or thesis research at large late Holocene village occupations found on lakes or rivers (Shinkwin 1979; Plaskett 1977; Holmes 1986). Archaeologists have also been motivated by linguistic research on the Dene/Athabascan migration and have made various material and theoretical contributions to the debate that will be considered in greater detail below (Ives 1990; Mullen 2012; Kristensen, Andrews, et al. 2019). Further, recent research has emphasized the potential of regional syntheses based on artifactual and subsistence data derived from archaeological sites (Cooper 2012; Potter 2008a; Hare et al. 2012). This scholarship, while limited compared to the scope of late Pleistocene research, below, provides ample background for the research considered here.

The Northern Dene/Athabascan Transition and Dene/Athabascan Migration

Archaeologists have argued that a significant shift in mobility, subsistence, regional interaction, and technology took place during the late Holocene approximately 2,000 years ago on the basis of material remains, settlement patterning, and ethnohistoric data (Table 1.1; Potter 2008; Holmes 2008; Hare et al. 2012). In brief, Dene/Athabascans became less mobile and pursued a broader resource economy during the late Holocene, with coincident shifts in material culture. The Northern Dene, Athabascan, or late Holocene transition, as archaeologists variably refer to it, represents an important moment of cultural and behavioral changes that also appear to coincide, at least roughly, with a southward migration of some of the region's Dene/Athabascan speakers, or a partial southward migration (Kristensen, Andrews, et al. 2019; Mullen 2012; Ives 1990). The material evidence marshalled by archaeologists in the ongoing debate surrounding this partial migration south has been explicitly and implicitly linked to the Northern Dene/Athabascan transition primarily through environmental explanations (Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019; Mullen 2012; Workman 1979). However, archaeologists have only vaguely considered the role demographic and social shifts may have played in Dene/Athabascan decisions, culture, and, ultimately, migration during this critical interval.

Table 1.1 Reconstructed Dene/Athabascan Subsistence, Mobility, and Technology from the Mid- to Late Holocene

	Mid-Holocene	Late Holocene
Subsistence	Narrow; focused on caribou/moose	Broad; reliant on large game (moose, caribou) and small game (fish, hare, birds)
Evidence	Site placement, faunal remains at mid-Holocene sites, hunting-focused technology	Faunal remains at late Holocene sites, ethnographic data
Mobility	High	Semi-sedentary
Evidence	Sites rarely reoccupied, small site sizes, low assemblage variability represented in stone tool assemblages	Larger, village-type settlements, evidence for serial reoccupation, storage pits, house pit construction

Volcanism and Dene/Athabascan History

Environmental explanations for the Dene/Athabascan transition and migration are based on ecological rather than climatic shifts, in part because paleoecological reconstructions indicate that the region’s precipitation and temperature were consistent from 5,000 years ago to present (Kaufman et al. 2016). In the turbulent Subarctic environment, climatic consistency represents similar temperatures, precipitation, flora, and fauna at interannual intervals. Pollen cores, isotopic evidence, fossils, and subfossils from lakes around central Alaska and Yukon indicate that no significant changes in any of these variables took place on a regional level from around

5,000 years ago to present (Anderson and Brubaker 1994; Kaufman et al. 2016; Bigelow and Edwards 2001; Bunbury and Gajewski 2009). Thus, anthropologists have consistently argued that a massive volcanic eruption during the late Holocene caused the Dene/Athabascan transition and migration following Workman (1979). The scale of this eruption was such that it arguably decimated local ecologies, which anthropologists have mobilized to argue that Dene/Athabascans responded by rapidly reorganizing their subsistence, mobility, and technology to survive, resulting in the archaeologically-documented Northern Dene/Athabascan transition (Mullen 2012; Hare et al. 2012; Workman 1979; Phyllis Ann Fast 2008). Accordingly, anthropologists argue, the severity of ecological changes during a relatively stable climatic interval pushed part of the region's population to migrate south (Derry 1975; Workman 1979; Kristensen, Hare, et al. 2019). Therefore, this argument relies primarily on coincidental timing of the volcanic eruption and southward migration and thus far, few anthropologists have considered specific theoretical correlates for these cultural changes.

Volcanoes have played a significant role in the geological history of the western Subarctic, which lies on the Ring of Fire (Mulliken et al. 2018). During the late Holocene, two eruptions originating in the Mount Churchill-Mount Bona massif of the Wrangell-St. Elias Mountain Range in Southeast Alaska may have disrupted central Alaskan and Yukon ecological systems (Richter et al. 1995). The first, which has been dated through carbon associated with tephra deposits in central Alaska, occurred ca. 1,625 cal BP (Reuther et al. 2019; Lynch et al. 2018). Tephra associated with this eruption, known as the White River Ash north (WRA north), was blown primarily northward and visible deposits are present as in Eagle, roughly 500 km north of the Mount Churchill-Mount Bona massif (Mullen 2012; Reuther et al. 2019). The second eruption, known as the White River Ash east (WRA east), blew eastward as far as

Greenland and has been dated to 1,148 cal BP using charcoal from trees buried in the ash adjacent to the volcano as well as ash preserved in Greenlandic ice cores (Jensen et al. 2014; Clague et al. 1995). While both ashfall events occurred between 2,000–1,000 years ago, the earlier WRA north event was relatively smaller and would have primarily affected central Alaskan Dene/Athabascans and the later WRA east event appears to have generated a much greater quantity of ash that was distributed over thousands of kilometers to the east that would have primarily affected Yukon Dene/Athabascans.

The effect of volcanic ash on ecological systems depends on several factors, including the magnitude of the eruption, the season of eruption, and the uniformity of ashfall across the potentially affected region. The Mount Churchill-Mount Bona eruptions resulted in rhyodacite bilobate Plinian fallout deposits (Richter et al. 1995), referring to the chemical composition of the tephra (more than 68% SiO_2 and less than 4% K_2O), the two lobes of tephra, and the tall vertical shape of the eruption column from a vent that led to the widespread wind-blown distribution of tephra across the region. Plinian eruptions eject debris at least 30 km into the air and are considered very large, cataclysmic eruptions (Wilson 1976). However, magnitude does not necessarily result in permanent ecological impacts. Ecologists have painstakingly documented the decadal effects of the Mount St. Helens eruption, also Plinian, and have found that the heterogenous distribution of ash produced differential ecological effects across the fallout zone, with many plants, fish, and mammals showing near complete recoveries only three decades after the eruption (Nelson et al. 2018; Blackman et al. 2018; Crisafulli et al. 2018). Thus, archaeologists cannot assume that either the WRA east or the WRA north produced severe and/or long-term regional ecological effects.

Indeed, paleoecological reconstructions based on the study of pollen, isotopes, and fossil microorganisms do not suggest any significant ecological changes associated with the WRA north eruption in central Alaska (Reuther et al. 2019). In contrast, ecological and genetic data suggest that the WRA east had an impact on both terrestrial and lacustrine ecosystems. Pollen data from lake cores suggest disruptions related to the WRA east (Hughes et al. 2013; Lacourse and Gajewski 2000), in part because the late Holocene climatic reconstructions show little to no fluctuation in temperature or precipitation during this period (Kaufman et al. 2016). Similarly, geneticists have proposed that the WRA east eruption led to a caribou population bottleneck in Yukon, a demographic change posited by genetic data (Kuhn et al. 2010). Ecologists and anthropologists have proposed that volcanic ash may have choked lichen that are the basis of barren ground caribou diets (Kuhn et al. 2010; VanderHoek 2009:127). However, more recent research suggests that the genetic basis for the proposed caribou population bottleneck requires additional scrutiny (Letts et al. 2012), and studies of Mount St. Helens plant ecologies suggest that lichen populations can rebound within a few years of a volcanic event (Nelson et al. 2018). Critiques aside, current ecological evidence is suggestive of a potential link between the WRA east and downline ecological effects but does not indicate any ecological effect associated with the WRA north event.

In light of these ecological and volcanic data, anthropologists have argued that the WRA east (and possibly WRA north) had a significant impact on Dene/Athabascan lifeways. This argument is in part circumstantial: volcanic activity and changes to subsistence, technology, and mobility are correlated temporally, and this is particularly evident in ice patch finds in southern Yukon (Hare et al. 2012). These circumstantial observations are furthered by equivocal oral historic evidence from Dene/Athabascans in present-day Canada (Phyllis Ann Fast 2002;

Moodie et al. 1992). Yet, previous research suggests that caribou herds suffered frequent population crashes at regular 100–200 year intervals and that the WRA east may not have led to a significant change in Northern Dene/Athabascan lifeways (Burch 1972:356). Northern Dene/Athabascans, and Arctic peoples more generally, are impressively impervious to episodes of prolonged ecological degradation due to their complex social networks and the flexible and innovative technological systems they honed over millennia of survival in these dynamic environments (Gordon 2012; Berkes and Jolly 2001; Ives 1990). Moreover, scholars have recently called into question the extent and severity of ash-induced ecological failure that archaeologists link to the Dene/Athabascan transition and migration (Gordon 2012; Letts et al. 2012). Such explanations of the Dene/Athabascan transition and migration are largely circumstantial and lack a predictive framework informed by theoretical understandings of human culture and local oral history. Combined, these perspectives highlight the need to critically re-examine the potential cause(s) of the Dene/Athabascan transition and migration.

Social Dynamics and Population Change

Archaeological data collected over decades of extensive surveys of the region suggest another important change at this critical interval: the number of sites from ca. 2,000–100 cal BP is nearly twice that of the total for the preceding four thousand years (6,000–2,000 cal BP; ADNR-OHA 2019; Martindale et al. 2016;Figure 1.3). This increase suggests that an important demographic shift took place between 3,000 and 1,000 cal BP that is contemporaneous with the Northern Dene/Athabascan transition and may be correlated with the Dene/Athabascan migration. Indeed, researchers have previously employed radiocarbon and site survey data to estimate population decline and growth throughout the region’s archaeological record (Anderson et al. 2019; Potter 2008a; Graf and Bigelow 2011). Recently, archaeologists have suggested that populations in central Alaska grew during the late Holocene based on these data and should be considered alongside environmental explanations of the Dene/Athabascan transition and migration (Potter 2008a).

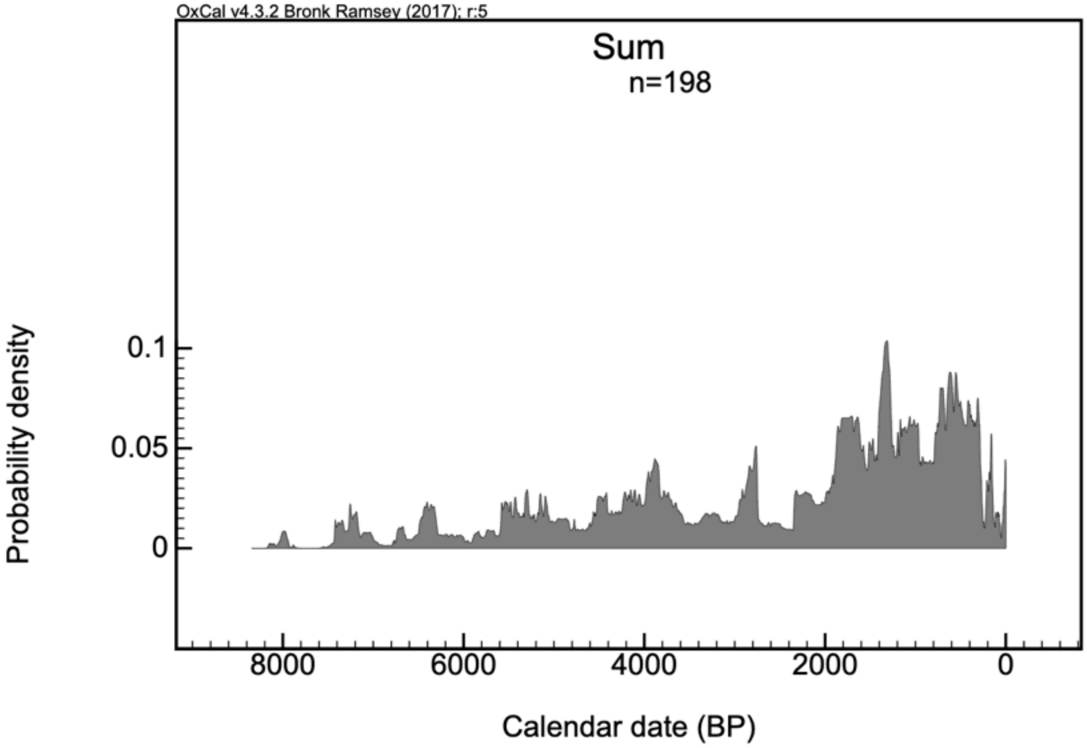


Figure 1.3 Summed Probability Distribution of Radiocarbon-Dated Occupations within Northern Dene/Athabascan Territory (Ramsey 2009, 2020)

Archaeologists have increasingly applied population size estimates based on radiocarbon data and site surveys in reconstructions of past human behaviors, decisions, and cultures, particularly in North America where radiocarbon dating is common (Kelly 2014). Summed probability distributions of radiocarbon dates provide archaeologists with one way of roughly estimating past population sizes, though this approach is most reliable when drawing from datasets of over 500 dates (Williams 2012). In Alaska and Yukon, many sites are impossible to date and still others have yet to be completely tested, resulting in a dataset that is too small to definitively interpret via this method. Nevertheless, the radiocarbon data suggest general trends in population size that archaeologists have used to argue for demographic changes at various periods through temporal frequency distributions (Graf and Bigelow 2011; Potter 2008a).

The quality of regional survey and radiocarbon data remains a central concern for any study involving past population size estimates and several sources of potential bias must be considered before advancing arguments based on temporal frequency distributions. First, survey and radiocarbon dating bias can lead to a lower representation of sites from periods of lesser disciplinary interest or an under sampling of sites with multiple components. Due to the high cost of radiocarbon dating, it is not uncommon for archaeologists to practice bracket dating, in which only the oldest and youngest components from multicomponent sites are radiocarbon-dated. Second, taphonomic bias and the destruction of sites from older periods can lead to an overrepresentation of later occupations (Surovell and Brantingham 2007). Third, the radiocarbon calibration curve itself can bias results and overrepresent sites at certain periods (Bamforth and Grund 2012). Finally, site number is an equivocal representation of population size, as highly mobile hunter-gatherers may occupy more but smaller sites on the landscape than sedentary groups (Rick 1987). Each of these factors must be considered on balance in population size estimates based on radiocarbon data.

The Dene/Athabascan case considered here is certainly not free from these potential sources of bias. However, I argue that the record has merit and a population increase is worth investigating for several reasons. While such a late increase in overall number of sites might be associated with survey or taphonomic bias, research in this region has been focused on occupations associated with the initial colonization of the Americas (≥12,000 cal BP), and this research bias likely negates taphonomic effects associated with meandering rivers, which can destroy sites on riverbanks as they change their course, among other factors (Anderson et al.

2019). Additionally, the radiocarbon calibration curve is relatively consistent at this late time period and the chronological period of interest is relatively broad. Finally, I consider site size and overall number in my evaluations of the landscape level patterning to determine whether an increase in overall number of sites reflects a population increase or a change in residential mobility. Upon consideration of the potential sources of bias, the chronological data are robust enough to serve as the basis of a population estimate, though more data would allow researchers to conduct summed probability distributions and other critical demographic research in the future.

Radiocarbon and site survey data from central Alaska and Yukon suggest a relative increase in population size occurred around 2,000 years ago. Several environmental and social factors may have led to this population increase that we will consider briefly here before a more detailed evaluation in subsequent chapters. Environmental reconstructions suggest a relatively stable climate very similar to climatic conditions in the region today from ca. 6,000 years ago to the present (Kaufman et al. 2016). This climatic stability may have fostered a population increase, though it is unclear why it would take three millennia for Northern Dene/Athabascans to adapt to climatic and ecological consistency. Alternatively, the population movement from the coasts of Alaska and Canada to the inlands may have displaced populations into central Alaska (Friesen 2016). This explanation aligns chronologically and is supported by oral histories that describe a legacy of conflict between Inuit and Northern Dene/Athabascan groups (Burch 1974). Finally, linguistic and archaeological research has shown that Northern Dene/Athabascans have had Dravidian kinship structures with cross-cousin marriage alliance systems for millennia and that this can yield local group growth and external competition. In sum, one or all of these factors may have contributed to a population increase ca. 2,000 years ago suggested by radiocarbon data, though I argue that the last explanation is the most parsimonious based on theoretical predictions and existing interpretations of Dene/Athabascan culture.

Despite a clear increase in radiocarbon dates ca. 2,000 years ago, archaeologists have yet to propose a population-related cause for the Dene/Athabascan transition or migration. Demography is frequently invoked in archaeological explanations of both cultural changes and migration in other regions and it is therefore surprising that Subarctic and Alaskan archaeologists have not incorporated this documented increase into their discussions of Dene/Athabascan history and culture (Anthony 1997:22). However, this omission may relate to the tacit environmental determinism that continues to shape Alaskan and Canadian theoretical frameworks. I will consider demography as a possible complement or alternative to volcanic explanations of the Dene/Athabascan transition and migration to provide a more wholistic account of late Holocene Dene/Athabascan history.

Modeling Explanations for the Dene/Athabascan Transition

The research presented here draws data from multiple scales together in a synthesis of the Dene/Athabascan transition that immediately preceded and/or coincided with the Dene/Athabascan migration from the Subarctic to the Northwest Coast, Plains, and Southwest of North America. I draw from artifactual remains, such as lithic and faunal data, as well as geochemical data related to subsistence, and landscape data reflected by site placement and ecological information to present a holistic account of the process of cultural change that spans time and space.

Drawing from Multiple Scales

A synthetic consideration of past cultural processes must be made using multiple variables from several levels of analysis from a range of periods. Put another way, archaeological synthesis requires a diachronic and multiscalar data set because each scale of analysis reveals different insights into cultural and behavioral change (Mills et al. 2015:4). Migration, a type of cultural process, unfolds at several scales (individual, group, region) over time; it would be impossible to establish the cause of a migration using one dataset or one site because of the multiscalar nature of this process. Therefore, I consider data from site and landscape levels to infer individual and group behavior pertaining to the process of cultural change and migration that unfolded in the Subarctic during the late Holocene.

To unite data collected from multiple scales, I have established a theoretical framework that provides predictions for each of my material correlates based on human behavioral ecology and ethnographic analogy. This framework provides solidarity between materials and data collected by different archaeologists during the past five decades. Additionally, the theoretical predictions marry disparate data from sites of various functions, sizes, and testing extents. A multiscalar approach is not new to archaeology and it remains a critical way to harness a multivocal synthesis that draws from several perspectives, datasets, timescales, and landscapes to reconstruct historical trajectories.

Material Correlates

I employ artifactual, geochemical, and geospatial data to evaluate whether the Dene/Athabascan migration and associated cultural changes were most likely motivated by (1) a cataclysmic volcanic eruption that decimated the region's unique ecological landscape and/or (2) demographic pressure associated with increased populations. An archaeological approach is uniquely situated to evaluate these explanations of the process of the Dene/Athabascan migration because archaeological evidence is historically and spatially anchored (Roger and Hug 2006). I consider four distinct forms of evidence to address the above research questions. First, evidence from stone tools and stone tool production provide proxies for subsistence and mobility by demonstrating the abundance of exotic stone and the structured of toolkits in different ecological zones. Second, isotopic and faunal evidence demonstrate the degree of resource specialization at late Holocene occupations, an important correlate of mobility and territoriality. Third, chronological information reflects the timing of late Holocene changes in subsistence and mobility. Finally, settlement patterning data such as site size, occupation length, and ecological setting offers comparative information related to site function and duration spanning the mid-Holocene to the protohistoric period.

Material data collected during excavations at four sites spanning the critical Northern Dene/Athabascan transition period from ca. 2,000–1,000 cal BP and comprising distinct ecological zones serve to reconstruction subsistence, mobility, and technological organization pertaining to the Northern Dene/Athabascan transition. At each site, I excavated at least 10% of the total site area, which was determined through a shovel test grid. The sites that I selected came from various ecological zones with access to different landscape resources, such as rivers, lakes, and prominent vantages of the surrounding area. Lithic remains recovered through these excavations were evaluated through a typological analysis of both tools and debitage, and faunal materials were evaluated through a traditional analysis of physical faunal remains and a compound-specific isotopic analysis of fatty acid methyl esters extracted from hearth residues. Therefore, these material data comprise several modeled variables associated with late Holocene Northern Dene/Athabascan subsistence, technology, and mobility.

I consider material from two sites associated with traits characteristic of Subarctic upland ecological zones. Excavations at the Clearview site, occupied ca. 1,450 cal BP, yielded 1,477 diagnostic lithic artifacts, including 55 tools, tool fragments, and cores, made on at least 13 raw material types. This site provides an example of lithic production in upland ecological zones associated with hunting pursuits and two distinct lithic production areas that provide insight into bifacial and microblade reduction. Excavations at the Delta Creek site, another upland hunting site occupied at roughly the same time, 1,450 cal BP, yielded 27 diagnostic lithic artifacts made on at least four raw material types. Calibrated radiocarbon dates indicate that both of these sites pre-date the White River Ash east event. Faunal remains were limited from these sites, potentially due to poor preservation associated with boreal soils (Ping et al. 2008).

I present data from two sites and three components located in characteristic Subarctic lowland ecological settings near lakes. Caribou Knob, occupied approximately 1,350 cal BP, yielded 568 diagnostic lithic artifacts made on at least seven raw materials, including one expedient scraper and one unifacial scraper fragment, and an intact hearth cooking feature analyzed via compound-specific isotope analysis of fatty acid methyl esters, associated with several thousand burned or calcined bone fragments. The Klein Site on Quartz Lake yielded two late Holocene components. The upper locus of the Klein Site, occupied ca. 1,200 cal BP, yielded 209 diagnostic artifacts, including a copper awl, three expedient tools, two unifacial scraper fragments, and at least 11 raw materials, as well as extensive faunal remains, several hearth features whose contents were analyzed via compound-specific isotope analysis of fatty acid methyl esters, and one possible fermentation pit. The lower locus of the Klein Site, occupied ca. 500 cal BP, yielded 44 diagnostic artifacts, including one microblade core fragment, one unifacial scraper, one expedient flake knife, and at least six raw materials in addition to copious faunal remains and a large hearth cooking feature whose composition was analyzed via a compound-specific isotope analysis of fatty acid methyl esters. Caribou Knob and likely the Klein Site upper locus pre-date the White River Ash east event and the Klein Site lower locus post-dates this event, providing a measure of chronological continuity spanning this potentially important volcanic eruption.

These intra- and inter-site excavation results are complemented by the results of a landscape analysis of all radiocarbon-dated archaeological components recovered from Northern Dene/Athabascan territory in central Alaska and Yukon. I gathered site location, testing, and chronological information from the Alaska Heritage Resource Survey and the Canadian Archaeological Radiocarbon Database, both available publically upon request, from over 200 occupations within the region. I compared these data to ecological information and landscape features to generate a model of land use during the Northern Dene/Athabascan transition that informs explanations of both the Northern Dene/Athabascan transition and the partial migration from the Subarctic.

Each of the datasets that I consider augment our understanding of Northern Dene/Athabascan history by providing pertinent information about subsistence, mobility, and/or technology. These data serve to refine archaeological interpretations of the Northern Dene/Athabascan transition while providing the information necessary to evaluate potential volcanic and demographic influences on this transition and subsequent migration. Rather than focusing on one site in one location, I considered data derived from multiple sites within two ecological contexts that represent several cultural correlates through material data. Together, excavation and landscape analysis information provide a powerful lens for understanding Northern Dene/Athabascan history, culture, behavior, and the process of migration.

Structure

In this chapter, I have presented an introduction to migration, the history of Northern Dene/Athabascan research, and an outline of arguments proposed for the Dene/Athabascan migration that foregrounds the arguments central to this work. Chapter 2 addresses the geographic history of the study region, broadly defined, and includes a synthesis of geology, ecology, and Northern Dene/Athabascan history that underlies the critical questions raised in future chapters. Importantly, this chapter acquaints readers with some of the central ecological and social variables under consideration. Chapter 3 builds on this topical background with an overview of theoretical issues related to hunter-gatherer resilience, adaptation, and resource use that informs the theoretical model evaluated with the data presented in subsequent chapters. The theoretical model evaluated here draws on human behavioral ecology and ethnographic comparison. This chapter reviews these theoretical paradigms and establishes expectations for Northern Dene/Athabascan decision-making given specific environmental and social pressures. These first three chapters frame the research question, current understandings of Northern Dene/Athabascan history, and theoretical paradigms that are the basis for the data collected and evaluated here.

The next three chapters explore the results of fieldwork, laboratory analysis of technological, isotopic, and faunal data, and a comprehensive geospatial analysis of the region's cultural heritage resources. Chapter 4 presents the results of excavations at four central Alaskan sites with a total of five late Holocene Northern Dene/Athabascan occupations and the results of a comprehensive lithic analysis from the resulting material culture. Chapter 5 considers a residue analysis via compound-specific isotopic analysis of lipids from four hearths from three of the late

Holocene Northern Dene/Athabascan occupations presented in the preceding chapter. Chapter 6 contextualizes excavation results within a landscape analysis of site placement and size from sites spanning the Northern Dene/Athabascan transition from the entire Northern Dene/Athabascan region. These data comprise a multiscalar effort to document specific correlates of adaptive decisions that culminated in the Dene/Athabascan migration.

In Chapter 7, I argue that the Northern Dene/Athabascan transition represents the culmination of adaptive decisions in response to population pressure using data presented in previous chapters and the theoretical model of hunter-gatherer adaptation from Chapter 3. The final chapter considers the data, theoretical paradigms, and previous research in a synthetic model that weighs various interpretations of the Dene/Athabascan transition and migration. Finally, this chapter serves as a conclusion to this multiscalar analysis that contextualizes the central findings of the research presented here and offers future directions for additional research on Northern Dene/Athabascan history, migration, and adaptation and resilience.

Synopsis

Here, I aim to explore the various social and environmental factors that influenced the Northern Dene/Athabascan transition and migration between 1,000 and 2,000 years ago from central Alaska and Yukon toward southern North America. For the purposes of this research, I am concerned with the process of migration as it relates to demographic and climatic factors by evaluating a linguistically and genetically documented partial outmigration from the Subarctic. Previous explanations of the Dene/Athabascan migration and Northern Dene/Athabascan transition more broadly have focused on environmental causes to the exclusion of demographic, social and political factors. My aim is to actively model the process of this migration by incorporating natural and social factors into theoretically driven explanations of Subarctic decision-making. I draw from human behavioral ecology, which accounts for individual decision-making in different resource environments, and ethnographic examples that present heuristic examples of group organization. The multiscalar data that I evaluate within this theoretical framework exhibit significant are not consistent with a volcanic or environmental explanation for the Northern Dene/Athabascan transition or migration. Instead, trends in the data are much more consistent with expectations for adaptations to a prolonged population increase, perhaps related an important shift in kin structuration that led to increased endogamy, territoriality, and regional conflict. Therefore, this research shows how hunter-gatherer social structure and history can be conclusively evaluated through a theory-driven, multiscalar approach and how migrations can be conclusively modeled using material data collected at multiple scales.

I reject previous research that depended upon correlation to explain Dene/Athabascan decision-making, cultural transitions, and past hunter-gatherer migrations. Likewise, I challenge previous research that has failed to incorporate social and demographic considerations into explanations of Subarctic history. Instead, I advocate for theory-driven syntheses of regional data that incorporate multiple causal factors to better reveal the complex social lives and adaptive flexibility among hunter-gatherers. I reject research assumptions that relegate hunter-gatherer decisions to ecological triggers and deny the complex social histories of so-called “small-scale” societies. If we ignore the capacity for human sociality to affect decisions in what are considered “marginal” environments among “simple” societies, we have de-historicized and dehumanized past human cultures to the detriment of the field’s advancement.

Chapter 2 The Geography of Central Alaska and Yukon

Introduction

The natural environment of the Subarctic stands in stark contrast to Dene/Athabascan cultural history. The first is highly variable on multiple temporal scales: through millennia, over the course of a year, and frequently during a single day. In contrast, Dene/Athabascan is an incredibly conservative language (Kari 2010) and associated Dene/Athabascan material indicates a similarly consistent cultural tradition with consistent subsistence, mobility, and technology from ca. 6,000 years ago until 2,000–1,000 years ago (Potter 2016). The contrast between natural and cultural systems is unsurprising because foragers in unpredictable resource environments tend to pursue conservative strategies to avoid unnecessary risk (Nonaka and Holme 2007). However, it is important to consider the degree of natural and/or social pressures that would have triggered an adaptive shift away from the Dene/Athabascan cultural system of the mid-Holocene and the subsequent migration of part of the population thousands of miles from the Dene/Athabascan homeland. The geographic context provides a window into the drastic changes(s) that must have occurred to trigger an adaptive shift among Dene/Athabascans, and ultimately, the departure from the landscape they successfully occupied for thousands of years.

Defined by natural, ethnohistoric, and linguistic boundaries, the study region extends south from the Brooks Range to just north of the Alaska Range, and east from the Nulato Hills to just west of the Mackenzie Mountains, encompassing the interior Yukon River drainage (Figure 2.1; Burch 2012; Ives 1990; Kari and Potter 2010). The study region comprises approximately

150,000 square km and represents roughly half of the area occupied by contemporary Northern Dene/Athabascan speakers (Krauss et al. 2011). The region was bordered by ice during the last glacial maximum, shaping the geographic features present today both directly and indirectly (Péwé 1975, 16). Melting glaciers and permafrost feed major rivers that promote the growth of several plant species that would be otherwise absent in this desertic environment (Viereck et al. 1992). Limited rainfall and extreme annual temperature fluctuations have shaped the ecological spectrum of this heterogeneous landscape and, subsequently, Northern Dene/Athabascan behavior and culture for millennia. Therefore, a thorough summary of the ecological setting is inherent to any discussion of regional history, cultural change, and adaptation.

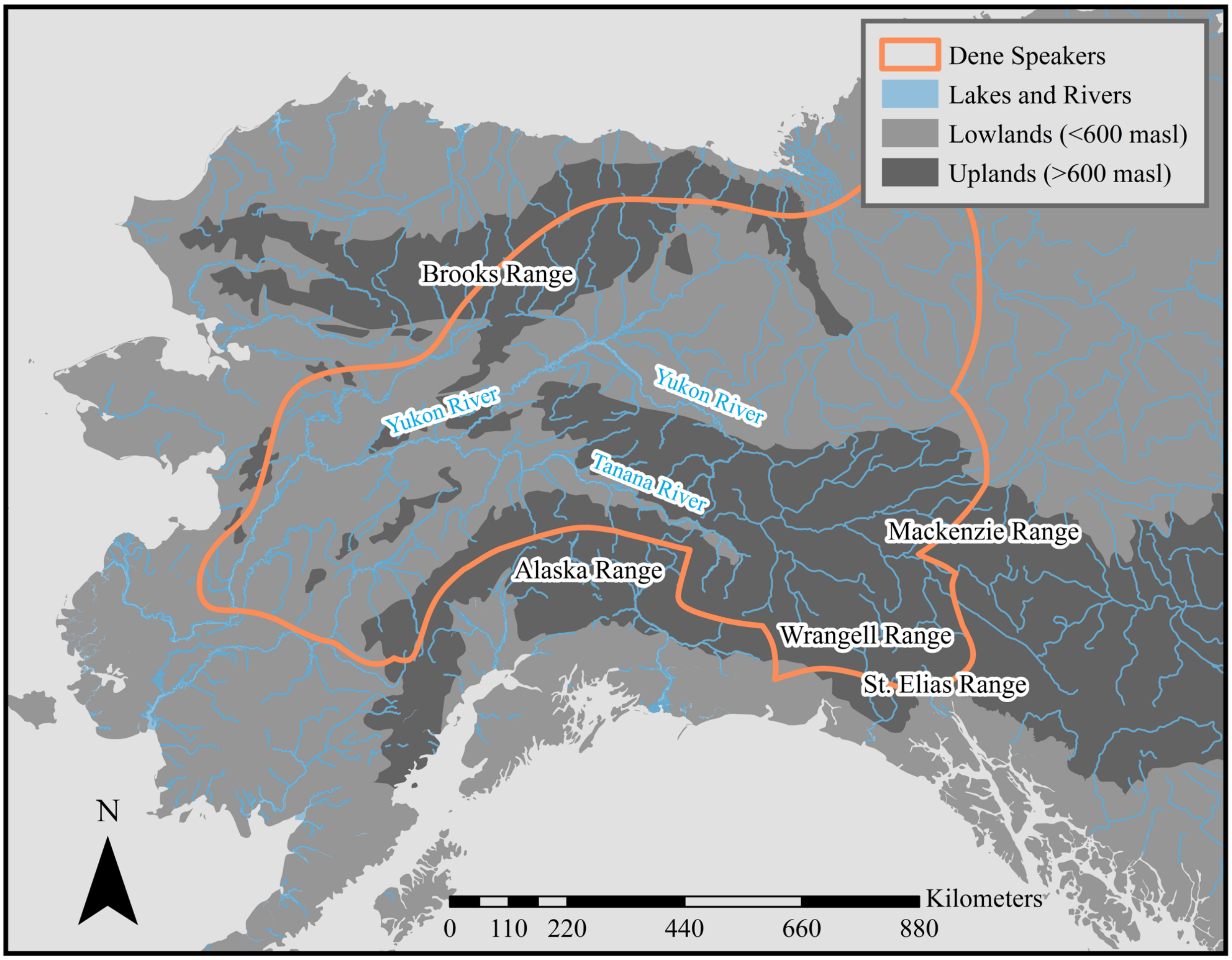


Figure 2.1 Overview of Natural Features within the Study Region

Topographic relief is stark on this landscape and mountains provide the primary delineation of the interior Northern Dene/Athabascan region considered in this research, a natural boundary represented in the deeper past by concomitant archaeological and linguistic evidence. Place name studies and historical linguistic research indicate that Northern Dene/Athabascan-speakers have lived consistently within these natural bounds since their arrival at least 5,000 years ago, according to genetic data (Kari 2010). Mountain ranges represent the historic extent of the Northern Dene/Athabascan speakers considered here to the north, south, and east. The Western border, along the Yukon-Kuskokwim River Delta, does not have a physiographic boundary, but ethnohistoric and archaeological evidence strongly indicates that coastal and interior groups have been distinct for at least 5,000 years (Davis 1981). Finally, oral histories from both Northern and Southern Dene (Navajo, and Western Apache) converge upon an understanding that their ancestors lived in the Subarctic for many generations before some moved in a southerly direction along the mountains as far south as present-day Arizona (Seymour 2012a), an understanding that accords with linguistic (Seymour 2012b, 2014; Ives 2010; Wilson 2011) and genetic data (Erickson 1999; Moreno-Mayar et al. 2018) from both Northern and Southern Dene/Athabascan populations. It must be noted that a bitter and on-going land rights dispute between Navajo and Hopi have led Navajo to claim permanent ancestral residency in the Southwest (Washburn 1989). Nonetheless, these transdisciplinary lines of evidence illustrate important multigenerational Northern Dene/Athabascan ties to North America's western Subarctic.

Topography and Geology

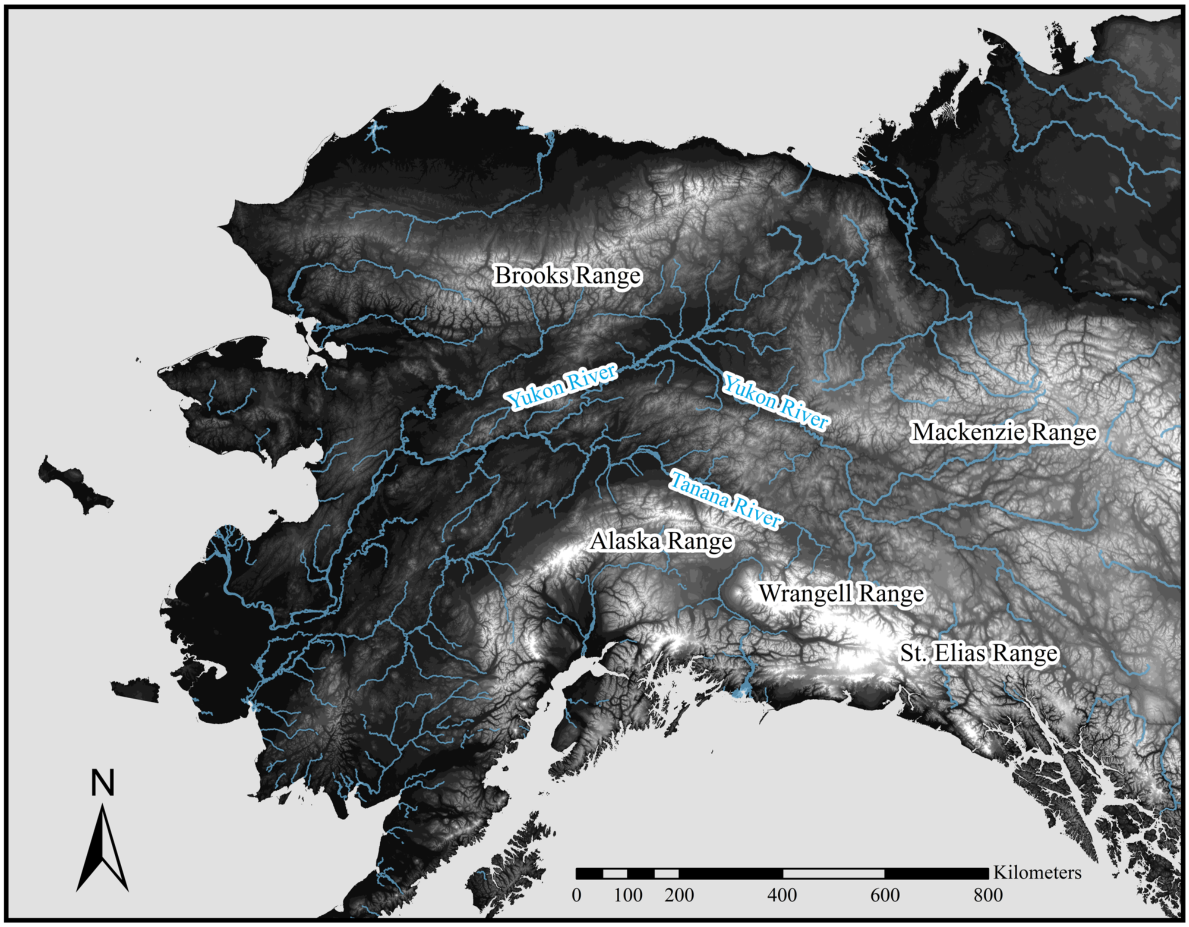


Figure 2.2 Topography of Study Region; elevation ranges from 0 to 6,190 masl (USGS 1996:30)

The Northern Dene/Athabascan region encompasses a significant degree of topographic variability owing to past glaciations and its situation in a highly active geophysical zone (Figure 2.2). This mountainous post-glacial landscape has vast extremes, from glacial-cut valleys that sit just 100 m above sea level, to the tallest peak in North America, Denali, which rises to over 6,000 m above sea level. Geologists have provided particularly detailed accounts of the history of this vast and complex landscape to facilitate the discovery of mineral and petroleum deposits. This region is bordered by the Brooks Range to the north and the Alaska Range to the south, and comprises three other significant mountain ranges: the Wrangell Mountains, the St. Elias Range, and the Mackenzie Mountains (Amand 1957; Péwé 1975). While not a mountain range, Yukon-Tanana Uplands are another prominent topographic feature on this landscape (Amand 1957). These mountain ranges and upland areas border the lowlands in the center of the study area and serve as a natural boundary for both climate systems and linguistic groups.

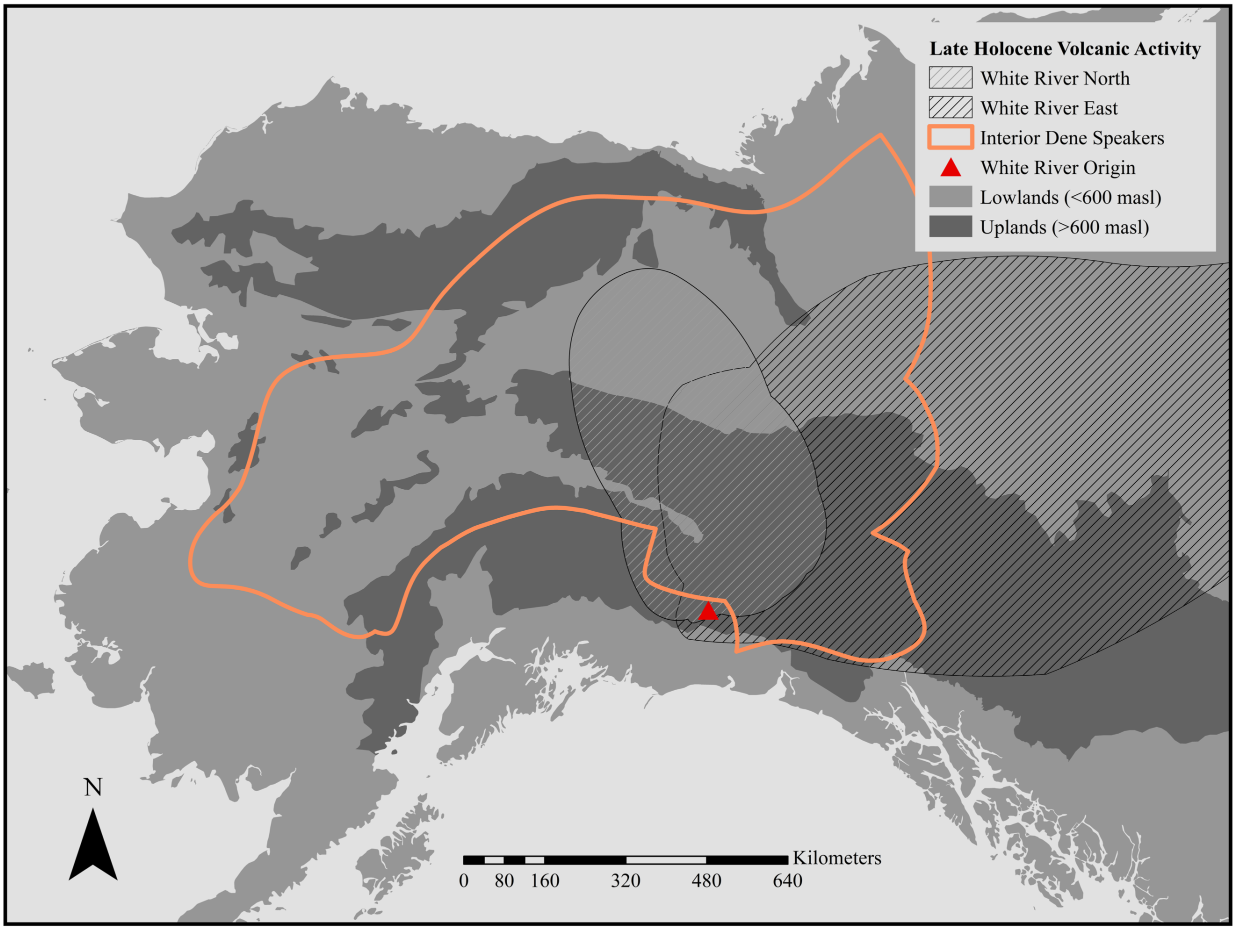


Figure 2.3 Approximate Distribution of the White River Ashes and Location of Regional Obsidian Sources

Earthquakes and volcanic eruptions are commonplace in this seismically active region, which includes both the Denali and Shakwak faults (Richter and Matson 1971:1530). Researchers have recorded an average of around 20,000 earthquakes every year and of those, one magnitude 7 or higher earthquake occurs every year on average, making the western Subarctic one of the most seismically active regions in the world (Aho et al. 2012:7). Volcanic eruptions are also quite frequent, and geologists have estimated that at least 90 volcanoes erupted in the North American Subarctic during the last 10,000 years (Schaefer and Nye 2008). Of these, the late Holocene White River Ash (WRA) events ca. 1,150 cal BP and 1,800 cal BP that emanated from Mount Churchill/Mount Bona in the Wrangell-St. Elias Range are some of the most significant central Alaskan eruptions of the Quaternary period (Mulliken et al. 2018; Péwé 1975:80). The spread and timing of both WRA events are well-documented within the geologic record of Alaska and Yukon and their extents indicate that one or both of these events may have led to a massive environmental collapse (Figure 2.3). Intense geophysical activity may have provoked cultural changes among the regions' peoples throughout their tenure in the area.

Geologists and archaeologists alike have contributed to research on Subarctic North America's complex glacial history. Partially, this impressive body of research owes to the region's significance in the initial colonization of the Americas during the late Pleistocene, which coincided with the late Wisconsin glacial period (Anderson, et al. 2014; Heintzman, et al. 2016; Péwé 1975). The results of this research show that glacial ice covered the mountain ranges bordering this region as well as most of central Canada but left most of the study area ice-free during both the Wisconsin and preceding Illinois glaciations (Péwé 1975: 16). Nonetheless, glacial activity on the border of the study area directly and indirectly transformed the landscape through moraine formation, soil deposition, and glacial melt. Terminal moraines, or the gravel and soils deposited at the foot of advancing glaciers, continued to form through the late Pleistocene and into the early Holocene near large mountain ranges on the perimeter of the study area, such as in the middle Tanana River Valley (Lawler 2019:62). These large moraines provide important vantage points and sources of lithic raw materials on this landscape. Glacial melt is also associated with the release of fine-grained silts that were subsequently deposited by wind and water across the study area (Péwé 1975:3). Importantly, these silt deposits provide a fine matrix that facilitates the preservation of stratified archaeological deposits and buried paleosols that can span thousands of years. Finally, glacial melt continues to feed the region's largest rivers and streams and provides one of the most enduring impacts of glacial activity in the region.

The rivers that flow between the region's impressive mountain ranges have dramatically shaped this dynamic geographic setting. The Yukon, Tanana, Nenana, and Delta Rivers have all dumped massive fluvial deposits throughout the unglaciated portions of the region that contributed to the formation of the lowlands of central Alaska and Yukon (Péwé 1975:117). Many of these rivers, such as the Yukon and Tanana, are fed by glacial runoff and characterized by opaque, silty waters (Ager 1975). Post-glacial shifts in sea level and coastline have led only to moderate changes in the course of these rivers over the last 15,000 years, though floodplains allow these rivers to meander widely across the landscape (Péwé 1975:117). The Tanana River, for example, is braided and migrates based on inter-annual changes in precipitation, temperature, and other factors (Cleve, et al. 1993). These rivers contribute to the flattening of the expansive lowlands and the transport of glacial deposited silts and till.

Many of these glacial deposits carry raw materials ideal for producing stone tools, products of the region's significant geophysical activity. From volcanic rocks, such as obsidian, rhyolite, basalt, and andesite, to metamorphic or sedimentary cherts, fine-grained knappable materials are distributed in river valleys and quarries throughout the region. Importantly, high quality native copper can also be found in rivers and streams, particularly to the southeast of the study area. Geologists and geoarchaeologists have had mixed success sourcing these diverse raw material resources due to particularities inherent to their geochemical structure and the ubiquity of these glacially transported materials across the landscape (Lawler 2019, Rasic 2016, Coffman and Rasic 2015, Gore 2016). However, obsidian is a common raw material type at sites spanning human occupation of the region that features a unique geochemical signature with few sources in the interior. For these reasons, obsidian sourcing studies have yielded the most promising results. Geoarchaeologists have subjected several thousand obsidian artifacts from sites in the western Arctic to sourcing analysis via X-Ray Fluorescence and identified several chemically-distinct obsidian groups (Rasic 2016:138). Of these, two of the most common sources of obsidian at western Arctic sites, Batza Tena and Wiki Peak, are located within the study region (Potter et al. 2011; Rasic 2016; Figure 2.4). Researchers have used these data to consider mobility and social networking across this broad region in the past.

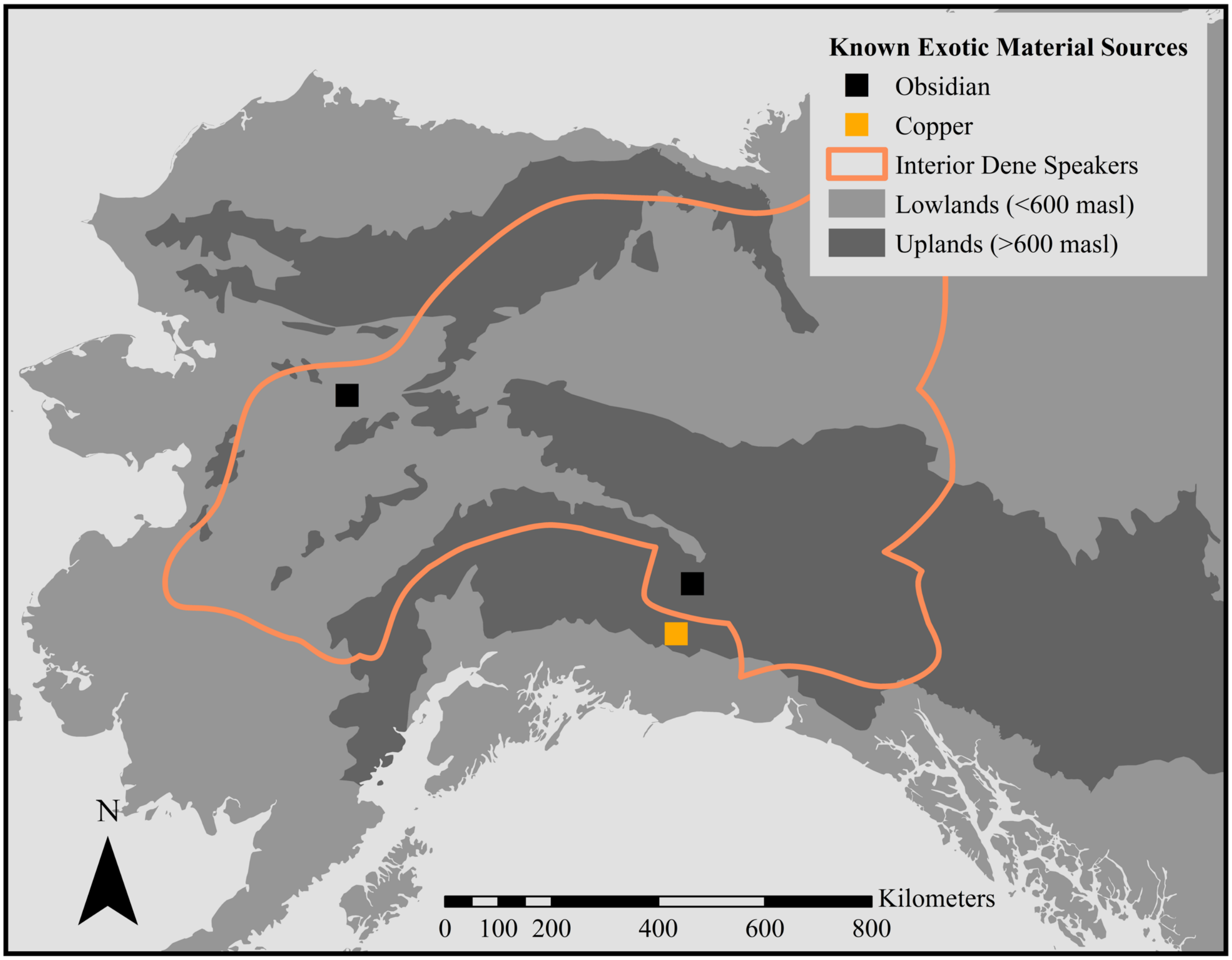


Figure 2.4 Known Obsidian and Copper Sources in and around the Study Region

Copper provides similar insights into mobility and social networking in the later past, with the earliest use documented around 1,000 years ago. Several sources of copper were known to Dene/Athabascans in Southeast Alaska, but most were situated within the Wrangell-St. Elias Mountain ranges home to Ahtna Dene/Athabascans (Cooper 2012:569). Dena'ina Dene/Athabascans also had copper sources within their linguistic regions, as indicated by place name data (Cooper 2007:32). Today, geologists continue to survey parts of the Alaska and Wrangell-St. Elias ranges for copper and the ambiguity of past copper sources presents a hurdle to researchers interested in inventorying identifiable geochemical signatures (Cooper 2007:1-2). Within the central Alaskan-Yukon study region home to interior Dene/Athabascans, no prominent copper sources have been identified and archaeologists presume that this resource was exotic to the region and likely originated from the Wrangell-St. Elias Mountain ranges due to the preponderance of copper available there and to ethnohistoric ties to Ahtna Dene/Athabascans (Cooper 2007:58,60).

In contrast, the chemical structure and appearance are much more ambiguous for the wide variety of fine-grained cherts, rhyolites, and basalts that can be found throughout the region's glacial-fed rivers. Adding further confusion to archaeological discussions of material sources, Alaskan and Canadian archaeologists frequently use "chert" as a placeholder for a wide variety of cryptocrystalline silicates, comprising both sedimentary and metamorphic forms (Lawler 2019:62). Cherts' ubiquity in river drainages, physical resemblances, conflated terminologies, and similarities in geochemical structure have made them extremely difficult to source using geochemical techniques, such as x-ray fluorescence, though recent studies have shown potential promise (Lawler 2019:25). The geochemical distinctiveness of rhyolite, an igneous material common to most sites in the region, makes it an ideal candidate for geochemical sourcing;

however, of the ten groups of rhyolite identifiable through geochemistry, only two sources have been conclusively located in the region (Coffman and Rasic 2015). Ongoing research indicates that basalt, another igneous rock common in the study area, may also produce distinguishable chemical signatures and is abundant in both cultural and natural contexts (Gore 2016). Chert, rhyolite, and basalt potentially offer archaeologists the opportunity to reconstruct past mobility patterns through geochemical sourcing and could complement obsidian and copper sourcing studies.

The topographic features of Subarctic North America implicitly shaped the decisions of its human inhabitants, both today and in the deep past. The interior regions of Alaska and northwestern Canada have featured active volcanoes, extensive mountain ranges, expansive flatlands, and rolling hills since humans initially arrived at least 14,000 years ago. Many lakes, rivers and streams also cut this geographically diverse region, though their presence has changed somewhat since the first humans arrived on this landscape. In addition to these prominent physical features, the locations of exotic raw material sources have shaped Northern Dene/Athabascan activities and provide unique opportunities for archaeologists to consider mobility and social interaction through material exchange in the past.

Climate During the Late Holocene

Far from the ocean and the equator, the interior Subarctic experiences unique extremes in precipitation and temperature that extend into the deeper past. Paleoclimate researchers have synthesized the results of isotopic, palynological, and geomorphological studies to reconstruct general temperature and precipitation amounts spanning the late Quaternary period. Comparing coarse-grained data from the last 3,000 years to fine-grained temperature and precipitation data recorded during the last century in Alaska and Canada reveals both general climatic trends and the specific degree of interannual climatic variability in the Interior. Generally, researchers have found that the climate gradually became warmer and wetter during the mid-Holocene, ca. 8,000–5,000 years ago, but no major climatic shifts have occurred since that time period, resulting in a relatively stable environment from the mid- to late Holocene (Kaufman et al. 2016). Thus, I will consider the results of paleoclimate research and elaborate upon these coarse-grained data with modern climate records to infer the climatic regime that likely characterized the region during the Northern Dene/Athabascan transition.

Regional Paleoclimate

Sediment cores from across the interior Subarctic provide the greater insight into the region's ecological history. Sampled from lakes, these cores preserve pollen, fossil microorganisms, subfossil midges and clams, and isotopic data in addition to sediment that was deposited in the past (Anderson and Brubaker 1994). At each lake, these different lines of evidence can provide a history of vegetation, lake levels, precipitation, and temperature. Paleoecologists have compiled data from several lakes across the region to reconstruct ecology and climate since the late Pleistocene. For nearly 50 years, coring efforts have targeted lakes throughout the Western Subarctic and these results consistently indicate a thermal maximum, or when average annual temperatures were at their peak, at the beginning of the Holocene (Anderson 1975; Kaufman et al. 2004). Paleoecologists infer this through the abundance of plants such as balsam polar (*Populus balsamifera*) that thrive in warmer summers (Kaufman et al. 2004:536). Following this period of warmth, pollen records indicate that average annual temperatures decreased but both vegetative communities and temperatures appear to stabilize around 5,000 years ago (Anderson and Brubaker 1994).

Conclusions about regional climatic consistency are based on data from cores in Northcentral Alaska, Central Alaska, the Alaska Range, and Yukon. Mid- to late Holocene data from cores in central Alaska, such as Healy Lake, Birch Lake, and Quartz Lake in the middle Tanana River Valley, are very similar, to the extent that researchers no longer consider pollen from these periods worth investigating. Data from the middle Tanana River Valley indicate that vegetative communities and climate during the mid- to late Holocene are consistent with present conditions (Abbott et al. 2000:154; Reuther 2013:435; Anderson 1975). Isotopic data from lake sediments and subfossil clams in the middle Tanana River Valley suggest that the mid- to late Holocene was characterized by localized ecological shifts rather than regional climatic and ecological change (Wooller et al. 2012:96). Similarly, lake core data from Northcentral Alaska, near the Arctic Circle and the Brooks Range, indicates consistent vegetative and climatic histories during the last 5,000 years (Anderson and Brubaker 1994:71). In the Nenana River Valley north of the western extent of the Alaska Range, pollen coring efforts again reveal vegetative and climatic regimes consistent with present-day conditions (Bigelow and Edwards 2001:212). Finally, pollen, subfossil midge, and isotopic data from Yukon lake cores trace a similarly consistent paleoclimatic history from around 3,000 years ago to the present, with a possible neoglacial phase ca. 4,000 years ago (Kurek et al. 2009:252; Cwynar and Spear 1995:34; Bunbury and Gajewski 2009:366). Combined, pollen studies, bulk stable isotopic analysis of oxygen and carbon, analysis of subfossil midges and clams preserved in lake sediment, and sedimentation rates from across the region indicate that precipitation, temperature, and ecology have remained consistent for at least the last 3,000 years.

Analogs with Modern Climate

Regional climatic reconstructions, while coarse-grained, consistently indicated that late Holocene climate is consistent with present-day conditions. Modern climate records provide insight into the likely dynamics of annual and interannual variation in the recent past and during the Northern Dene/Athabascan transition. Since modern climate recording began around a century ago, the Interior region of the western Subarctic has consistently received low annual amounts of rain and snow compared to neighboring coastal regions. The areas furthest from the coast receive rainfall comparable to the Mohave Desert (Slaughter and Viereck 1986). The Yukon Flats, for example, receive only 170 mm of precipitation annually on average (Hinzman, et al. 2006). Snow covers the landscape from mid-October to mid-April, with maximum annual accumulation around 75–100cm, low compared to other Subarctic regions (Van Cleve and Viereck 1981). Researchers have established that the Alaska, Brooks, and Mackenzie ranges serve as a geographic shield from large coastal weather fronts that would otherwise bring high amounts of precipitation to the Interior and provide a greater degree of temperature regulation (Hinzman, et al. 2006). Paleoclimatic reconstructions indicate that annual precipitation was even lower until around 5,000 years ago when the region's climate stabilized and precipitation became consistent with modern levels (Table 2.1). Average annual precipitation values mask the high degree of variability in precipitation experienced interannually, however. Fairbanks, Alaska has a 50-year average annual precipitation of 247 mm, but a range of 142–478 mm within that 50-year period. Therefore, the coarse scale of paleoclimatic reconstructions from the region may not reveal changes in the interannual variance of precipitation amounts.

Table 2.1 Cultural Periods in Central Alaska and Yukon with Associated Climatic and Vegetation Regimes (Potter 2016)

Approximate Time Period	Climatic Profile	Vegetation	Cultural Period
14,000–11,000	Glacial retreat; dry, windy, cold	Grasslands, shrub tundra	Paleoarctic/Denali
11,000–6,000	Wetter, warmer	Willow, poplar	Paleoarctic/Denali
6,000–Present	Paludification and bog formation	Spruce, birch	Northern Archaic
1,000–Present	Consistent with previous period	Consistent with previous period	Athabascan

Blocked from the moderating forces of coastal weather systems, the Interior has lower annual average temperatures and a high degree of intra-annual variation in temperature compared to neighboring Subarctic coastal regions (Bieniek et al. 2012). Today, the average annual temperature is below freezing, at -4ºC to -6ºC (Péwé 1975: 5), and temperature variation in the Interior can surpass 75ºC annually, with extreme winter temperatures exceeding -40ºC and the warmest summer temperatures reaching above 35ºC (Hinzman, et al. 2006). Paleoclimatic records indicate that temperatures, much like precipitation, have been relatively consistent in the region for the last 5,000 years (Kaufman et al. 2016; Anderson et al. 2003). Tree-ring data from just south of the region indicate that past temperature fluctuations had a high degree of intra-annual variation, similar to present, with interannual variation around ±0.5ºC over the past 500 years associated with solar insolation or volcanic eruptions (Davi, et al. 2003). The Interior is characterized by low average annual temperatures but high intra- and interannual temperature variation, factors that influence the landscape and ecology of the region.

Below 0ºC average annual temperatures have promoted an abundance of perennially frozen ground, or permafrost, which underlies more than half of the sediments in the region (Péwé 1975: 44). Permafrost in the Subarctic also contains ground ice that leads to instability and unpredictable movement of associated sediments. Indeed, melting permafrost and ground ice can transform a forested area into bog within the span of a few decades (Péwé 1975:66). Gradual warming around 8,000–7,000 years ago led to increased soil moisture and paludification, or the accumulation of organic matter over time, due to permafrost and ground ice melt (Mason and Bigelow 2008). Melting permafrost is associated with the formation of different kinds of bogs unique to this periglacial environment (Péwé 1975:66). Annual melt from permafrost and ground ice provides an important source of water to this dry, desertic environment but also promotes instability and rapid localized ecological shifts on this dynamic landscape.

Ecology

The diversity of plants and animals in the Western Subarctic is structured by the complex array of climatic and geological variation found within this characteristically unstable Subarctic region (Chapin et al. 2006; Gillespie 1981; Smith 2008). Several ecological trends are apparent despite this variability, and paleoecological research indicates that the same plants and animals have consistently inhabited this landscape for the last 5,000–6,000 years (Kaufman et al. 2016). This indicates that late Holocene ecology was broadly consistent with the modern ecological situation and the preceding ecological situation of the mid-Holocene. The cold Subarctic climate limits decomposition and nutrient turnover, resulting in narrow ecological diversity, particularly among plant species (Van Cleve and Viereck 1981). Elevation continues to be the primary driver of ecological variability and boreal ecologists have divided the region into upland and lowland ecological zones that are dominated by different plant and animal species (Gallant et al. 1995). Uplands are locations at or above 500–600 m above sea level (masl), comprising 42.2 % of the study area, and lowlands are areas below 500–600 masl and make up 57.8 % of the study area. Ecologists have associated and mapped characteristic upland ecologies in the north and south of the study region, associated with the Brooks and Alaska Ranges, respectively, and to the region's east, in the Yukon-Tanana Uplands. Lowland ecological zones have been identified and mapped between these locales with higher elevations, within the river valleys Indeed, these ecological zones have been employed by the region's archaeologists for fruitful analysis of the relationship between the environment and human behavior through time (Wygal 2010; Potter 2008a; Blong 2016)While these categories mask a certain degree of variation present on this landscape, they represent analytically valuable groupings for characterizing the complex ecologies that informed Northern Dene/Athabascan culture and behavior throughout the Holocene.

Lowland Ecology

Plants and animals of the lowlands, or forested and marshy areas below 500–600 masl, reflect inputs from additional water, soil accumulation, and slightly warmer temperatures compared to uplands, or higher elevation areas above 500–600 masl (Gallant et al. 1995; Smith 2008). Vegetation communities range from short, water-tolerant species in boggy areas to old-growth spruce forests in well-drained areas (Gallant et al. 1995). Common trees found in lowland forests include birch (*Betula papyrifera*), white spruce (*Picea glauca*), poplar (*Populus balsmifera*), alder (*Alnus* spp.), and aspen (*Populus tremuloides*; Viereck et al. 1992). Smaller plant species include the wild rose (*Rosa acicularis*), several grasses (e.g., *Eriophorum* spp.), dwarf birch (*Betula gladulosa/nana*), horsetails (*Equisetum* spp.), bluebell (*Mertensia paniculata*), and several species of berry-producing plants. Sphagnum mosses (*Sphagnum* spp.)

and several species of mushroom also grow on forest floors and in boggy areas across the region. Around lakes, peatlands, and wetlands, it is common to see more water-tolerant species such as Laborador tea (*Ledum palustre*), bulrush (*Schoenoplectus tabernaemontani*), bog blueberry (*Vaccinum uliginosum*), black spruce (*Picea mariana*), willow (*Salix* spp.), and tamarack (*Larix larcina*). Dozens of plant species grow across this vast region, but the species discussed above are representative of the vegetation communities in the region.

Forests and bogs in the lowlands are in constant flux due to fires, erosional action, and permafrost dynamics. Discontinuous permafrost pockets naturally divide the lowlands into well-drained, forested areas and poorly-drained, boggy areas (Péwé 1975; Van Cleve and Viereck 1981). Poorly-drained, boggy areas underlain by shallow permafrost are typically found in northern-facing areas with little sun exposure (Hinzman et al. 2006). Conversely, well-drained, forested areas are typically found on southern-facing rises, riverbanks, and lakeshores. Lowland forests follow a predictable succession pattern from willow and alder shrubs, to young poplar stands, to young alder, white spruce, and birch stands, to finally older birch and spruce stands, which typically never exceed 200 years in age (Van Cleve and Viereck 1981). Shifts in the depth or spread of underlying permafrost due to the complex interaction of snowpack, ground temperature and disturbance can transform a well-drained area into a poorly-drained area in a matter of decades, turning a mature forest into a bog (Hinzman, et al. 2006). These poorly drained areas are challenging to navigate, with uneven or unstable ground and large pockets of open water that are often partially masked by floating mats of vegetation. Additionally, fires sweep through areas every 50–200 years with some regularity and contribute to forest destruction and present additional challenges to mobility (Van Cleve and Viereck 1981). Recently burned old-growth forests feature large, interlaced downed trees and unstable ground that frequently lead to localized paludification in areas with underlying permafrost (Péwé 1975:66). In floodplains, where fires are less frequent, old growth forests are frequently destroyed by erosion caused by meandering rivers (Van Cleve and Viereck 1981). Vegetation communities develop and decline according to permafrost, fire, and erosional activity in the region that dictates the movement of animals across the lowlands.

Animals in the lowland ecozone are inherently less sensitive to situational changes in soil quality than plant communities and are more homogenously distributed across the lowlands (Alaska Department of Fish and Game 1973; Smith 2008; Gillespie 1981). Moose (*Alces alces*), black bear (*Ursus americanus*), and brown bear (*Ursus arctos*) are the largest mammals in the lowland ecozone. Many furbearers such as wolf (*Canis lupus*), coyote (*Canis latrans*), fox (*Vulpes vulpes*), ermine (*Mustela erminea*), wolverine (*Gulo gulo*), marmot (*Marmota marmota*), snowshoe hare (*Lepus americanus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*) are common as well (Chester 2016). Caribou are less common in the lowlands but do overwinter in some of the region's lowland areas, particularly the northwest portion of the study area (Figure 2.5). Several species of fish can be found in lowland rivers and lakes, including Arctic grayling (*Thymallus arcticus*), pike (*Esox lucius*), burbot (*Lota lota*), whitefish (*Coregonus* spp.), and several anadromous salmonids. Anadromous king or Chinook (*Oncorhynchus tshawytscha*), red or sockeye (*Oncorhynchus nerka*), and silver salmon (*Oncorhynchus kisutch*) migrate hundreds of miles up the Yukon River from the Pacific Ocean, and these salmon can be found in all major rivers across the study area. Several species of waterfowl pass through this region on their annual migration, including sandhill cranes (*Antigone canadensis*), Canada geese (*Branta canadensis*), trumpeter swans (*Cygnus buccinator*), and several species of duck. Year-round, spruce grouse (*Falcipennis canadensis*) and ptarmigan

(*Lagopus* spp.) can also be found browsing on willows. The bogs, rivers, lakes, and forests of the lowlands host a wide array of fish, mammals, and bird species that Northern Dene/Athabascans have pursued for at least 6,000 years (Holmes 2008).

Paleoecological and archaeological evidence shows that the animals and plants of the region have remained consistent for thousands of years until the present, with the major exception for the extirpation of bison (*Bison bison*). Archaeologists have consistently recovered bison remains at sites from the late Pleistocene until at least 3,000 years ago (Potter 2008a; Potter and Esdale 2016), indicating that bison inhabited this region in large numbers until the beginning of the late Holocene (Glassburn 2015:13). Their disappearance has been linked to paludification and associated bogginess, which increased beginning around 8,000 years ago, or to the possible introduction of bow and arrow technology ca. 1,000 years ago (Potter 2008a:419). Paleontologists have argued that long-legged moose outcompeted stockier bison when lowlands slowly transitioned from grassy plains to bogs and winter snowfalls increased, making the region more difficult to traverse for shorter-legged fauna (Guthrie 1982b). Oral histories include rare descriptions of bison, indicating a protracted disappearance from the region (Glassburn 2015:19). With the exception of bison, archaeological and paleoecological evidence indicates that lowland ecological makeup has remained consistent for thousands of years.

Upland Ecology

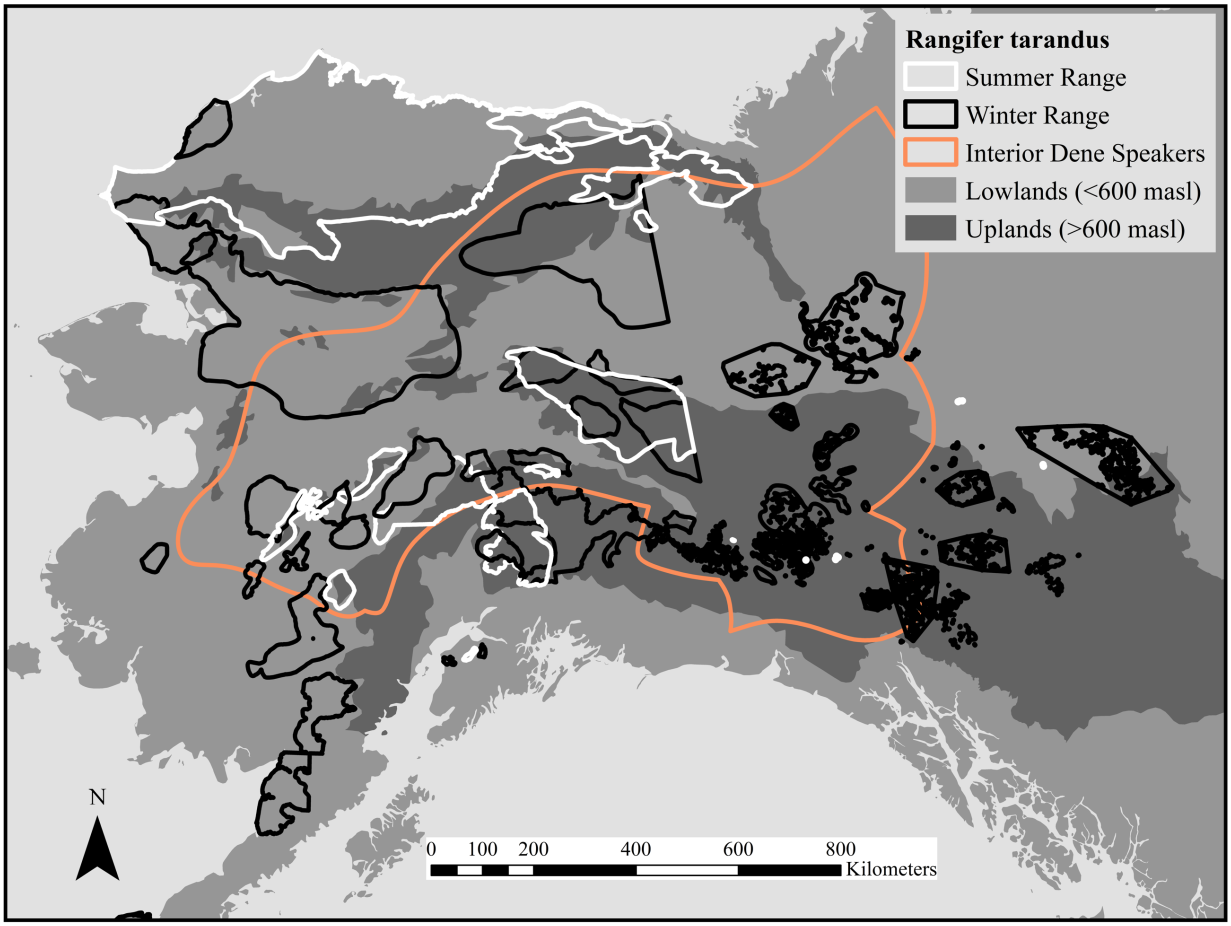


Figure 2.5 Caribou Herds of Alaska and Yukon (Alaska Department of Fish and Game 1973; Yukon Department of Environment 2014)

In upland locales over 500–600 masl, plants and animals are limited by cooler, drier climatic conditions (Gallant et al. 1995; Smith 2008). This ecozone is defined by fewer and smaller trees and a greater abundance of shrubs, along with a lower density of animal species. Cooler, drier conditions lead to more surface stability in this region, with fewer bogs and less melting permafrost. However, upland locales frequently experience more wind, which hampers soil development and limits vegetation growth. Dwarf birch (*Betula gladulosa/nana*), sphagnum mosses (*Sphagnum* spp.), lichens such as caribou lichen (*Cladonia rangiferina*), blueberry bushes (*Vaccinium* spp.), and black spruce (*Picea mariana*) are common and homogenously distributed in the uplands (Viereck et al. 1992). Few forests grow in exposed upland locales, but larger tree stands can be found near river drainages where water is more concentrated. Fires are less frequent in the uplands because there is less combustible biomass in this region (Bachelet et al. 2005:2251). Small, shrubby upland vegetation and poor soil formation provide increased visibility and more navigable terrain at these higher altitudes, though upland tundra can be deceptively uneven.

Animals in the uplands are well-adapted to this shrub tundra landscape, and barren-ground caribou (*Rangifer tarandus*) in particular have carved out their niche in this high, dry landscape (Alaska Department of Fish and Game 1973; Smith 2008; Gillespie 1981). Several well-researched caribou herds migrate through the study area today, including the Porcupine herd, the Nelchina herd, and the Fortymile herd (Figure 2.5). These herds are defined by their distinct seasonal ranges but herds occasionally experience some level of overlap, homogeneity, and loss to neighboring herds depending on seasonal temperature and vegetation changes (Valkenburg 1998). Caribou in the region migrate hundreds of miles between winter and summer grazing areas to avoid predators and optimize access to seasonally available foods, such as lichen (Bergerud 1996). In the fall, animals in these migrating herds can number in the thousands (Valkenburg 1998). In late March or early April, large herds of cows and young bulls travel to spring calving grounds and disperse after calving for their summer forage. The sheer number of caribou on the landscape, particularly during the late winter and fall, make them an appealing target for predators and parasites. Several animals prey on caribou year-round, including wolf, coyote, black and brown bear (Bergerud 1996; Klein 1991). During the summer months, several parasitic insects infest and compromise caribou skin, muscle tissue, and brain (Klein 1991). Caribou avoid these seasonal pests by resting on high snow patches or windy ridge lines. Caribou employ a high mobility strategy to avoid predators and maximize available foods, leading them to travel hundreds of miles across the tundra on an annual basis.

Beyond caribou, several terrestrial and aquatic species have carved out niches in this upland landscape (Gillespie 1981). Dall sheep (*Ovis dalli*) and mountain goat (*Oreamnos americanus*) range the highest elevation areas of this region (Alaska Department of Fish and Game 1973). Grayling and burbot can also be found in certain high lakes in upland locations. Several species of grouse can also be found in the uplands, along with several furbearing species, such as wolverine and marmot. In general, upland fauna are less diverse, more unpredictable, and less abundant than lowland fauna, with the major exception of caribou.

The ecological history of the uplands is not as well understood as the lowlands. Low soil accumulation rates leave many soil deposits exposed to wind, water, and snow action for centuries or potentially longer. Consequently, bone and stratigraphic preservation in this area is poor (Ping et al. 2008) and complicates assessments of upland paleoecology. Yet, limited data from archaeological sites indicate that fauna of the region were broadly similar from 3,000 years ago to the present and included Dall sheep, caribou, and possibly bison (Guthrie 2017; Blong 2018). In contrast, a handful of pollen studies indicate that vegetation regimes have remained consistent across the Interior uplands since at least 3,000 years ago and perhaps as long as 6,000 years ago (Blong 2016:66). Ecological records of animal life in this region are limited by preservation and potential research bias, such as limited road access, but palynological studies indicate that plant species in this region have remained constant since the mid- to late Holocene(Anderson and Brubaker 1994).

Environmental Variability at Multiple Temporal Scales

Climatic and ecological variation at different time scales must be considered to properly situate this landscape in the context of broader human history and segue into the unique cultural shifts that occur during the late Holocene. Environmental variability can be broken down into four distinct temporal scales: seasonal, daily, inter-annual, and long-term variation. In the Subarctic, seasonal environmental changes provide the most salient scale with which to contextualize human decision-making and strategies of hunter-gatherer behavior because they provide the most consistent and predictable shifts in this highly variable environment.

Seasonal Variation

Annual climatic shifts in Central Alaska and Yukon can be meaningfully divided into four seasons (Alaska Department of Fish and Game 1973). Temperature and daylight extremes affect biological communities and distinguish seasons based on available plant and animal life. Ethnohistoric data demonstrate how Northern Dene/Athabascans were adapted to shifting seasonal resource availability (Hosley 1981:543; Figure 2.6). In the interior Subarctic, winter is the poorest season in terms of resource availability. Defined by cold and darkness, winter begins in mid- to late October and lasts through March. Plant resources are limited to the bark of woody plants such as willow, shrubby branches of dwarf birch or alder, and lichens hidden under the snow during this four- to six-month period. Many large mammals are available but more challenging to locate in winter months as they disperse to find available vegetation for forage. Small game, such as ptarmigan, grouse and hare, are available year-round. Rivers and lakes freeze over, preventing the harvest of fish without constant efforts to maintain holes in the ice (Holsey 1981). In upland ecological zones, winter is a particularly challenging season due to windy and unpredictable conditions associated with winter storms. Blowing snow leads to white-out conditions and large snow drifts. Both of these factors can dramatically restrict visibility, hamper mobility, and obscure landmarks. Moreover, as the winter sunrise and sunset blend together on the southern horizon, sunlight is limited to only a couple of hours between November and February. Bears, another large predator on the landscape, have adapted to this resource-thin season by hibernating for up to six months at a time, allowing them to avoid the risks associated with winter foraging.

Temperatures begin to rise in mid-March and spring begins in earnest during early to mid-April, setting in motion migrations and activity across plants and animals. Grasses, horsetails, and other small plants are the first to emerge after the snow melts, followed by leaves on larger trees, and myriad flowers. The breakup of ice on rivers and lakes is usually complete by mid-May, promoting the return of migratory waterfowl who feed on fresh shoots and the first insects of the season. Spring insects are also targeted by freshwater fish found melting lakes and rivers. Caribou begin to move towards their summer calving grounds during this time as well. Moose target the shoots of willow found in lowland boggy areas and calve during this time. Bears emerge from their dens and begin foraging for roots, sprouted greens, and winter kills melting out of the snow. Spring is a time of movement and regrowth for animals and plants alike.

By June, the short Subarctic summer has begun. Plants and animals race to consume the abundant resources produced directly and indirectly by the seemingly limitless midnight sun and warmer temperatures. Caribou shed their rough winter coats and range individually or in small groups in high, windy locales or ice patches to avoid the onslaught of summer insects. Moose can be found cooling themselves and foraging for underwater plants in lakes and marshes. Masses of migrating salmon reach Interior rivers during the mid- to late summer months and turn these rivers red as they continue upstream to their spawning locales. Berry plants begin producing fruit during this part of the year, which are enjoyed by both smaller animals, such as ptarmigan, grouse and hare, and larger ones, such as black and brown bears. The stars are almost completely obscured by perpetual daylight between May and August, when the sun meets the northern horizon at twilight. All Subarctic species have developed strategies to take advantage of this unique season of abundance.

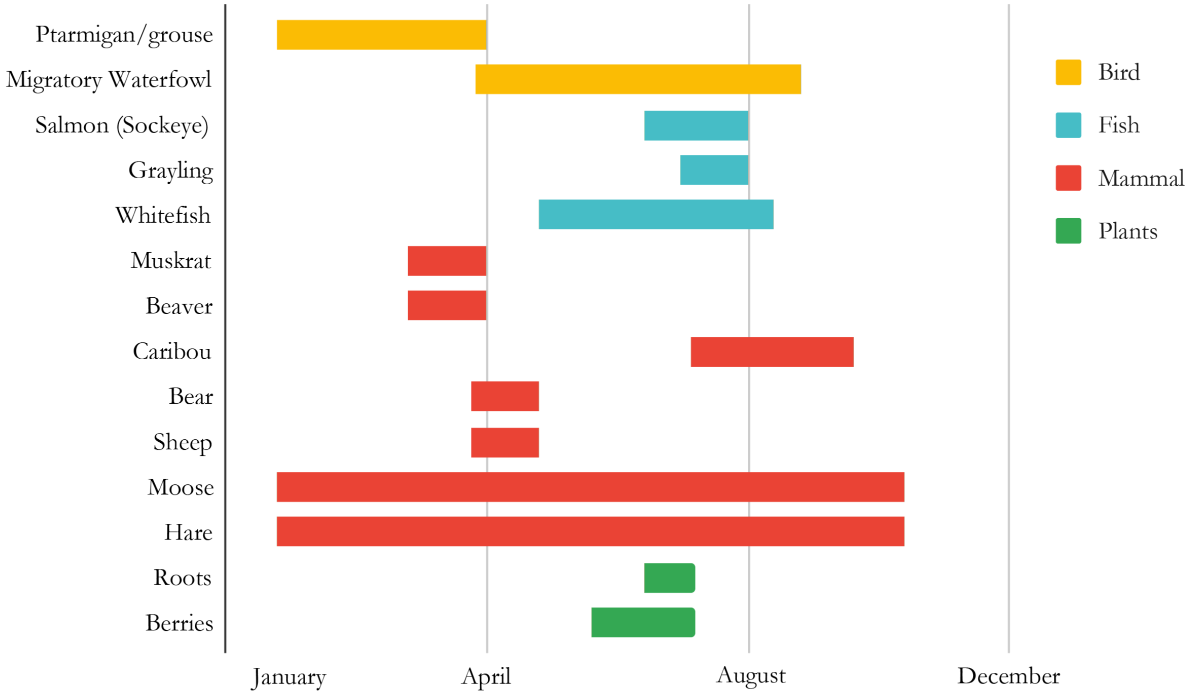


Figure 2.6 Northern Dene/Athabascan Seasonal Subsistence Strategies (from Hosley 1981:543)

Fall begins in mid-August and signals the end of the short growing season. Several species of berry are still abundant, and mushrooms burst from the underbrush during this period. Many small plants yellow and die early in the fall and trees shed their leaves in the beginning of September. Migratory waterfowl are typically long gone when the first frost takes hold in mid-September. Fish are typically less active as their metabolisms slow with decreasing temperatures, but they can continue to spawn through September. During these increasingly dark and cold months, most mammals are focused on finding mates before winter takes hold. Bull moose attract clutches of females by creating smelly wallows and caribou begin to aggregate in medium to large herds of cows led by bulls in mid-August. High in the uplands, Dall sheep become preoccupied by the rut as rams endeavor to guard their ewes from other rams. Medium and large mammals are the most active species during fall months when other animals and plants slowly fade with rapidly decreasing temperatures and daylight.

Daily Variation

Central Alaska and Yukon experience a great deal of fluctuation on a day-to-day basis, beginning with the weather. Major storms are relatively infrequent in this region as it is protected by mountain ranges, but these topographic features tend to prolong weather patterns that would dissipate quickly otherwise. In the winter months, it is not uncommon for temperatures to drop below -40ºC for weeks at a time as cold weather systems are held in place by neighboring mountain ranges (Wendler and Shulski 2009). Conversely, in the summer months, temperatures can exceed 28ºC for weeks before returning to more moderate temperatures. Isolated thunder showers are typical during these warm spells and frequently start forest fires in areas that have been dried in warmer weather (Bachelet et al. 2005). Predicting the duration or magnitude of these hot or cold spells is difficult, even with computerized forecasting models (Mölders et al. 2008). Colloquially, clear skies typically portend extreme temperature swings, resulting in either very hot or cold temperatures in summer and winter, respectively; cloudy skies signal a return to more moderate temperatures. Beyond that, predicting day-to-day weather by reading the clouds requires an expert's eye and failure to prepare for inclement weather can have devastating consequences, particularly during the winter.

Fluctuations in daylight also affect day-to-day activity in the region. During December, the darkest month of the year, the sun appears at the horizon for just three to five hours of twilight, depending on latitude. This provides a very short window of time for daytime activities. A full moon can illuminate snowy terrain nearly as effectively as a low sun when skies are clear, but animals are typically far less active after the sun has set. In contrast, June is characterized by 24 hours of sunlight and twilight. Certain animals, such as moose and waterfowl, remain active through the summer night. Oral histories and traditional knowledge indicate that summer days were long, sleepless, and busy with resource harvesting and preparation, while winter days were filled with sleep and story-telling (De Laguna 1995).

The consistent rhythms of daily and inter-annual environmental oscillation provide a rough backdrop for thousands of years of human history in central Alaska and Yukon. Resource density and diversity is undeniably lower at these Subarctic latitudes. However, predictable fluctuations serve to replenish the environment at many time scales. Importantly, these drastic intra- and inter-annual environmental extremes stand in stark contrast to a cultural tradition that remained consistent for millennia until the Northern Dene/Athabascan transition, which is recorded in the material remains, oral histories, and ethnographic accounts reviewed in the next section.

Northern Dene/Athabascan Ecologies

To situate the reader within the vast landscape of Subarctic human-environment interaction and adaptation, it is necessary to understand the way Northern Dene/Athabascans used this landscape in the past. Northern Dene/Athabascans almost exclusively selected open air sites with impressive views of prominent landmarks. Moreover, archaeologists have found only limited evidence for the serial reoccupation of sites from the late Pleistocene through the Holocene. At nearly all well-stratified deposits, archaeological assemblages are separated by hundreds or thousands of years, implying that Northern Dene/Athabascans had no particular tie to specific campsites. Cultural preferences and the vast nature of the landscape, low population density, and oscillating seasonal shifts likely led to an immense knowledge of the landscape and loose affiliation with specific sites for subsistence pursuits, similar to land use documented ethnographically among Denésuliné Dene/Athabascans in the central Canadian Subarctic (Sharp and Sharp 2015:113). Additionally, Northern Dene/Athabascans have a strong distaste for messy camps that could lead to spoilage during food preparation (Sharp and Sharp 2015:33), indicating a potential aversion for using obviously pre-occupied sites and perhaps complicating archaeologists' attempts to recover solid material evidence of site use. Combined, these data indicate that past Northern Dene/Athabascans applied their extensive knowledge of the landscape fluidly and flexibly.

Here, I will consider the complex interplay of social and natural systems throughout the Holocene as a way of foregrounding the theoretical discussion in the next chapter. Anthropologists have reconstructed the myriad subsistence strategies that Northern Dene/Athabascans honed over the course of their millennia in this dynamic Subarctic region through material, linguistic, genetic, and geochemical evidence (Potter 2016). The Northern Archaic tradition, defined primarily by a prominent style of lithic technology, represents the material remains of a highly mobile upland subsistence system based on communal caribou hunting (Esdale 2008). Following this period, the Northern Dene/Athabascan tradition signifies a period of increased diet breadth, use of lowland resources, decreased mobility, and the use of bone and metal tools. While many details of Holocene Dene/Athabascan culture and behavior remain vague, it is possible to synthesize Northern Dene/Athabascan history and life thanks to decades of painstaking governmental, academic, and private archaeological research.

Northern Archaic

Archaeological data indicate that the Northern Archaic tradition began between 8,000–6,000 years ago, around the time that forests spread throughout the region (Mason and Bigelow 2008). The Northern Archaic has been defined primarily stylistically and is based on the abundance of notched projectile points found across the region (Esdale 2008). As such, the Northern Archaic primarily represents a technological tradition that may also represent a cultural tradition, though the link between Northern Archaic typologies, Northern Dene/Athabascan identity, and regional culture remains in question (Davis 1981; Kari and Potter 2010). Very few comprehensive examinations of Northern Archaic-type occupations have taken place, particularly in Alaska, for two primary reasons. First, poor preservation associated with limited soil formation in remote upland ecological zones has resulted in the recovery of relatively few mid-Holocene faunal assemblages (Esdale 2008:16). Second, disciplinary focus on late Pleistocene assemblages has led to reduced data collection and/or interpretation of mid-Holocene components at deeply stratified sites, as discussed in Chapter 1. Few mid-Holocene assemblages have been treated with the same intellectual verve as those dating to the late Pleistocene and early Holocene. Nonetheless, regional archaeologists argue that Northern Archaic notched projectile points are associated with a highly mobile group of Northern Dene/Athabascan caribou hunters adapted to upland subsistence pursuits.

Technological data indicate that mid-Holocene Northern Dene/Athabascans associated with the Northern Archaic tradition used a generalized toolkit that included bifacial knives and points, unifacial scrapers, and bone needles (Potter 2016). Northern Archaic-type notched points could be hafted to wooden darts, which archaeologists argue were used to hunt caribou and moose on the basis of ice patch finds (Hare et al. 2012). Obsidian from Northern Archaic assemblages suggests long-distance movement of this resource likely through extended trade networks (Reuther et al. 2011). Bone tools are rare from this period, though this may be due to preservation issues noted above. However, bone needles have been found in association with mid-Holocene and earlier periods indicating that Northern Dene/Athabascans wore tailored clothing.

Faunal data indicate that diet breadth among mid-Holocene Northern Dene/Athabascans associated with the Northern Archaic was narrow and focused on seasonal caribou migrations. This interpretation is based on traditional faunal analyses, the presence of caribou drive lines, and settlement patterning information (Potter 2016). Drive lines aimed to funnel caribou into a concentrated mass to facilitate capture and were constructed using a variety of methods and with various catchments. Many were constructed with stone lines that channeled caribou into snares, lakes, or other areas where hunters could easily dispatch them in great numbers in a short period of time (Wilson and Rasic 2008; Friesen 2013). A commitment of physical resources and time are implicitly represented by these communal hunting monuments (Stewart et al. 2004). As such, these drive lines highlight an adaptive commitment to caribou hunting among associated mid-Holocene Northern Dene/Athabascan communities. Additionally, physical faunal remains from 25 mid-Holocene archaeological components indicate a concentration on caribou (Potter 2008a), a sample which may not accurately represent the full scope of subsistence behavior spanning this large region over 4,000 years (Esdale 2008). Yet, these faunal remains correspond with increased use of upland ecological zones and evidence for the use of drive lines along seasonal caribou migration routes from at least 5,200 cal B.P (Ackerman 2004; Wilson and Rasic 2008). Drive lines and faunal assemblages dominated by caribou remains indicate that Northern Dene/Athabascans were maintained a caribou-centered subsistence system throughout the mid-Holocene and spanning the Northern Archaic tradition.

Site use and site patterning data form the basis of archaeological interpretations for mobility associated with the Northern Archaic tradition during the mid-Holocene (Potter 2008a). Occupations during this time are notably small and ephemeral with little evidence for serial reoccupation. Therefore, these occupations likely represent short-term residential camps (Esdale 2008). No storage features, semi-permanent dwellings, or ceramics have been recovered before 2,500 cal BP (Potter 2016, Holmes 2008). Archaeologists have pointed to the absence of these characteristic features of sedentism as indirect evidence for high mobility among mid-Holocene Northern Dene/Athabascans. Again, given the limited nature of the evidence in question, additional research pertaining to this period may reveal such manifestations of sedentism. It is especially worth considering how a highly mobile group of foragers without storage traditions or site reoccupation could have integrated the caribou seasonally captured *en masse* into their annual subsistence round. Nevertheless, regional archaeologists maintain that a strategy of high mobility persisted until around 3,000–1,000 years ago.

The distribution of notched points that are characteristic of the Northern Archaic tradition extend beyond the limits of the current study area and late Dene/Athabscan territory (Esdale 2008; Krauss et al. 2011), suggesting that Dene/Athabscan territories may have been broader during the mid-Holocene than later Northern Dene/Athabascan territories. Archaeologists have recovered notched points within central Alaska and Yukon, throughout the Brooks Range, along the Kenai Peninsula, and along the Southeast Coast of Alaska (Esdale 2008). Many of these diagnostic points cannot be securely dated due to soil deflation and lack of associated dateable carbon and it is possible that these points were traded outside of traditional Dene/Athabascan territory. Therefore, it is unclear if Dene/Athabascans who made these points occupied a larger region during the Northern Archaic tradition than subsequent periods or if the wide distribution of these points is simply the result of a broad regional trade network. Yet, it is clear from these data that the Northern Archaic tradition had an expansive social impact on the region.

Athabascan Transition

Archaeologists have argued that several important changes to subsistence, technology, and mobility occurred during the late Holocene that represent a Northern Dene/Athabascan cultural transition. Most anthropologists refer to this transition and the subsequent period as "Athabascan," even though oral histories, linguistic evidence, and place name data all indicate that Northern Dene/Athabascan speakers inhabited the region for thousands of years before the transition took place (Ives 1990; Kari and Potter 2010; see Holmes 2008 for other terminology). Excavated remains and artifacts recovered from melting ice patches provide the basis for this transition. A combination of archaeological remains and ethnographic data establish Northern Dene/Athabascan cultural practices following this transition, all of which indicate that significant shifts in mobility, subsistence, and technology took place between 3,000–1,000 years ago. However, previous research has only drawn vague conclusions related to the specific timing, regional extent, and interrelatedness of these changes.

Faunal data from the late Holocene are more abundant than those from archaeological sites associated with the mid-Holocene Northern Archaic Tradition, and these data imply that diet breadth increased after the mid-Holocene. Previous syntheses suggest that Alaskan archaeologists have recovered and analyzed at least 40 faunal components from 2,000 years cal BP through the protohistoric period (Potter 2008a). These data indicate that late Holocene

Dene/Athabascans relied upon a much broader range of resources by 1,000 years cal BP, including hare, fish, and waterfowl, in addition to caribou and moose (Holmes 2008; Potter 2008a; Shinkwin 1979). Indeed, by the protohistoric and post-colonial periods, small game and fish were very important to Northern Dene/Athabascan subsistence economies (Osgood 1937; De Laguna 1995; Hosley 1981:543). On the basis of these data, archaeologists have concluded that Northern Dene/Athabascan subsistence strategies became less focused on caribou and broadened to include previously ignored resources such as fish and small game at some point during the late Holocene and certainly by 1,000 cal BP.

Aside from this dietary shift, a significant decrease in mobility is intimated by four central lines of archaeological and ethnographic evidence related to technology and settlement patterning. First, the earliest birch-lined storage pits date to ca. 2,000–1,500 cal BP in the region and are associated with long term storage of caribou remains based on the presence of articulated caribou bones within these birch-lined pit features (De Laguna 1947; Shinkwin 1979). Second, the first semi-permanent dwellings and cultural depressions related to semi-permanent settlement also date to this period (Holmes 2008; Potter 2008a; Thomas 2003). Third, the earliest strategically positioned seasonal hunting or fishing camps with definitive evidence for serial reoccupation also date to this time (Potter 2016; Holmes 1986; Shinkwin 1979). Finally, the earliest ceramic and metal tools also date to ca. 1,500–500 cal BP and are frequently found in association with larger seasonal encampments that have been interpreted as early village sites (De Laguna 1947; Rainey 1940; Plaskett 1977). Both ceramic technology and metalworking evidence from the archaeological record are frequently linked to increased sedentism (Harry and Frink 2009, Arnold 1985). These technologies, settlement shifts, and resource use strategies are all representative of an increasingly sedentary subsistence strategy that corresponds to ethnohistoric accounts of Northern Dene/Athabascan culture (Osgood 1937; MacNeish 1956).

Other technological trends coincide with shifts in mobility and subsistence represented by archaeological materials predominantly found in ice patches. Based on ice patch finds from a small area in the southern Yukon, some archaeologists have argued that the bow and arrow replaced dart and atlatl technology, particularly microblade-inset darts, during the late Holocene (Hare et al. 2012, Holmes 2008). Yet, archaeologists have failed to recover conclusive evidence for bow and arrow technology in stratified contexts and continued use of microblades through the protohistoric period is indicated by cumulative evidence from the Swan Point, US Creek, Dixthada, and other later Holocene sites (Shinkwin 1979; Rainey 1940; Holmes 2008; Proue et al. 2011; Fafard 1999; Esdale 2007). Additionally, ice patch surveys have resulted in more bone tools from late Holocene assemblages, leading archaeologists to argue that bone technology replaced stone tool technology after 1,000 years ago. However, results from excavated village sites in central Alaska present a challenge to this argument (Holmes 2008; Shinkwin 1979; Plaskett 1977). Moreover, taphonomic issues and preservation bias may affect archaeologists' ability to recover identifiable bone technology at earlier times. Nevertheless, the introduction of copper and ceramic technology discussed above along with potential shifts in projectile technologies indicated by ice patch finds suggests broad changes to subsistence technologies that archaeologists have associated with the Northern Dene/Athabascan transition.

In terms of sociopolitical structure during the late Holocene, Alaskan anthropologists have argued that central Northern Dene/Athabascans had hostile relations with other regional groups. Many oral histories document repeated episodes of conflict between Inuit, Ahtna, Gwich'in, and central Northern Dene/Athabascans (Krech 1978:715; Burch 2012). Despite the arguably low population density of the region, at least at contact, it appears that territorial concerns frequently lead to intergroup warfare. Echoes of these historical tensions have persisted throughout the Euro-colonial period and are reflected in present day interactions, underscoring the gravity of these past conflicts (Burch 1979:140).

Northern Dene/Athabascan Migration

Linguistic and genetic data provide a basis for the general timing, origin, and direction of the Dene/Athabascan migration during the late Holocene. Linguists have employed comparative analyses of Northern and Southern Dene languages to argue that the *urheimat*, or Dene/Athabascan linguistic homeland and origin of the migration, lies either somewhere within the central Alaska/Yukon borderlands (Davis 1981:68), in central Alaska (Kari 1996:464), or in western central Alaska (Wilson 2011:276). The first explanation asserts the more easterly location based on the absence of Yup'ik loan words within Southern Dene languages. The second argument is based on the directionality of the region's hydrological place names (Kari 1996), and the third argues for more westerly origin on the basis of technological terminology and connections to Asia (Wilson 2019), where Dene-speakers emigrated from initially. These differing arguments have archaeological implications, particularly as they pertain to the White River Ash deposits that blanket the central Alaska-Yukon borderlands. Indeed, it is on the basis of an Alaska/Yukon borderlands homeland that Workman (1979:352) initially hypothesized that the White River Ash caused the Dene migration south. However, if the *urheimat* is in fact located in central or west-central Alaska, this would indicate that volcanic activity had only a possible indirect effect on Northern Dene/Athabascans and the subsequent southward migration. Existing genetic data document a bottleneck in Southern Dene populations consistent with a migration south but are otherwise not refined enough to distinguish between these two potential migration origins within the broader Northern Dene region (Erickson 1999:156). Genetic testing is limited among North American Indigenous communities in general, and specifically among Southern Dene because they do not support genetic research in their community for reasons related to the colonial enterprise (TallBear 2013).

In terms of timing, linguistic data again offer the clearest picture of the Dene/Athabascan migration south. Technological terms related to novel technologies such as the bow and arrow, ceramics, and copper are consistent between Northern and Southern Dene, indicating that Dene developed these technologies prior to their partial southward migration (Wilson 2019). Oral histories that link the discovery of copper with volcanic activity intimate that either the White River Ash north or east, both dated to the late Holocene, may reflect the trigger and thus a chronological link for the Athabascan migration south (Moodie et al. 1992; Phyllis Ann Fast 2008). Again, this link hinges upon a Dene/Athabascan homeland in the central Alaska-Yukon borderlands, which linguists have recently called into question. Genetic data indicate that the bottleneck was relatively recent but have limited chronological resolution based on currently available data (Erickson 1999:156). Therefore, the best chronological indicators derived from linguistic data indicate that the oldest ceramic, copper, and bow and arrow technology establish a *terminus post quem* for the Dene/Athabascan migration. Archaeological data indicate that this likely occurred after 1,300–1,100 cal BP (Potter 2008a; Hare et al. 2012), though archaeological research has focused mostly on the central Alaska-Yukon borderlands (e.g., Hare et al. 2012) and may not provide the most accurate basis for estimating the introduction of these technologies and the associated migration if this specific sub-region does not accurately reflect the Dene/Athabascan *urheimat*.

The directionality of Dene population movement is the least contentious topic within the broader anthropological debate surrounding the migration. Substantial genetic and linguistic evidence conclusively show that Southern Dene populations emigrated from the north (Erickson 1999; Davis 1981). Genetic bottlenecks evidenced by several genetic diseases unique to Southern Dene/Athabascans show that a small, isolated part of the Athabascan population moved southward, though it is unclear whether Southern Athabascans in present-day Washington or California were part of the same migration process as the Southern Dene/Athabascan ancestors of the Navajo and Apache (Erickson 1999). Further, linguistic morphological differences between Northern and Southern Dene/Athabascan dialects have directional connotations that conclusively demonstrate a partial southward move. These data imply that Dene/Athabascans moved south in relatively small groups, though it is unclear if Dene/Athabascans moved south in one or multiple migration waves.

Conclusions from linguistic and genetic data provide a framework for archaeologically evaluating the cause(s) and timing of the Dene/Athabascan migration and correlated Northern Athabascan transition. Particularly because these conclusions depend on technological terminologies, archaeological data are uniquely situated to inform these multifaceted debates and shed new light on the dynamic process of migration from central Alaska and Yukon during the late Holocene. The unique and varied geography of the Dene/Athabascan Subarctic homeland provides additional correlates and inherent predictions for different circumstances of behavioral adaptation that can be considered with material evidence. Further, evaluating archaeological data at a regional scale commensurate with linguistic and genetic data can establish new connections across the discipline of anthropology.

The geographic context of the Dene/Athabascan transition and migration is important to understand because it establishes the gravity of the factor(s) that drove these expert Subarctic denizens to make significant changes to their behavior and culture, and then depart from this region entirely. At some point, the conservative subsistence, mobility, and technology strategies that Dene/Athabascans perfected over millennia in this highly variable environment and associated with the Northern Archaic tradition became less attractive than a novel system that was firmly established by Euromerican colonization. Climatic, ecological, and even topographic variability reveal the resilience of Dene/Athabascans as well as the severity of the situation that invoked the adaptive process of migration. Reconstructing the natural and social setting of the region's geography provides a window into this decision-making process with several related material correlates.

Chapter 3 A Model of Dene/Athabascan Adaptation and Resilience

Introduction

The process of adaptive change that culminates in human migration is modeled in this chapter using theoretical paradigms from human behavioral ecology, landscape archaeology, and evolutionary ecology. Here, I consider human migration as a cultural process of iterated decisions and behavioral changes or adaptations that ultimately culminates in the permanent relocation of one or more people to a new environment. Considering migration as a cultural process opens it up for predictive theoretical modeling at multiple scales and permits migration processes to be compared cross-culturally. Factors that influence migrations represent the complex interplay of a changed social and natural environment. Archaeologists can untangle the process of migration by interpreting material correlates related to specific aspects of the social and natural landscape of pre-migrant groups, such as Subarctic Dene/Athabascans around 1,000 years ago.

In this chapter, I will situate the process of adaptive decision-making within the complex geographic context of Subarctic Northern Dene/Athabascans discussed in the previous chapter. First, I will discuss how anthropologists have conceived of the process of adaptive decision-making among hunting and gatherers and other small-scale societies to highlight the differences in social and natural environmental explanations and the tendency among archaeologists to ignore the historical context of these groups when modeling their decision-making process. Next, I will outline how archaeologists have applied human behavioral ecology and ethnographic analogy to understand changed resource availability related to volcanic events and population pressure in their causal models of cultural and behavioral change among hunter-gatherers and other small-scale societies. Finally, I will present a synthetic model that builds on the theoretical perspectives offered in previous scholarship to provide material correlates for volcanic and demographic explanations of the Dene/Athabascan transition and migration. This model has utility beyond this example because it draws upon inferential categories that are universal to human culture in the past and present. Thus, it presents a testable model of migration that I will consider in light of the material data presented here.

Cultural Change as Cavitation

Throughout, I have conceived of the Dene/Athabascan migration as a dynamic process related to the Northern Dene/Athabascan transition documented archaeologically through material shifts in subsistence, technology, and mobility. All living organisms have a number of adaptive pathways to better situate themselves within an environmental niche. Many of these are phenotypic, embedded in genetic data, and relatively constant during an organism's lifetime. It is certainly beyond an organism's ability to choose to employ any epigenetic adaptive strategies to survive in changing environments. However, organisms, including humans, can also draw upon a suite of behavioral adaptations permitted by their environment and their own physical limitations. Scholars have referred to these behavioral options as a third helix in reference to the double helix that holds our genetic information (Lewontin 2001). Humans are unique for their behavioral flexibility and for culture, a system that graduates beyond behavior, or individual actions in response to stimuli. It is not simply genetics or behavior but culture, the historically-situated system of beliefs that structures human action, decision-making, and interaction, that has promoted our species' successful colonization of every continent on Earth (Gamble 2013).

Geneticists have taken great pains to explain pathways to variation and adaptation in our DNA. This adaptive process is complex, multivariate, and frequently happens simply by chance. However, a record of genetic adaptation is accessible within DNA that structures our understanding of that adaptation as heritable. Whether population-level changes in DNA occur by natural selection, mutation, gene flow (migration), or genetic drift, there is a regular process by which it can occur that is relatively well understood. Behavioral adaptation, in contrast, remains problematic for social and natural scientists alike because it does not occur in a constrained, predictable way. Further, behavioral adaptation involves decision-making and agency. Therefore, attempts to model behavioral adaptation and cultural change as a genetic process fall short when they go beyond a simple analogical comparison, as I will argue in more depth in the next section (Mithen 1989). Genetic and cultural adaptive processes should be viewed separately, even though they are intimately related. After all, one's behaviors are dictated by physical capacity encoded within genetic data. Similarly, epigenetic and genetic drift can occur following behavioral adaptation and cultural changes. Nonetheless, the manner in which these adaptive processes manifest is distinct in several key ways that have implications for our ability to reconstruct and explain behavioral and biological adaptation in the past.

If genetic or biological adaptation provides a poor direct model but a good analogy for behavioral adaptation, how should social scientists consider the behavioral adaptive process that culminates in significant cultural shifts? Behavioral adaptations, like genetic adaptations, are changes over time. Several theoretical paradigms from complex systems theory and biology provide frameworks for understanding these changes in the social sciences, such as chaos theory

(Krasner 1990). Open, dynamic, and nonlinear systems are subject to internal and external sources of chaos, or random but deterministically-driven forces (Thietart and Forgues 1995). This is a helpful paradigm for exploring many aspects of natural and social sciences but still does not provide the structural window into the process of behavioral adaptation that is necessary to understand and explain the process of migration.

Colson (1979:19) presented shifts in decision making as responses to significant internal and external pressures, and as "adaptive and recurrent strategies." This is a useful paradigm for understanding behavioral adaptation because it emphasizes the iterative process of decision-making in the face of uncertainty but with some prior knowledge of variability. Further, this iterative decision-making process can be viewed as a type of behavioral cavitation. Cavitation is a hydrodynamic and chaotic process, that is, a process that predictably occurs among bounded water molecules subject to internal and external pressures. Essentially, water molecules moving together at high velocity produce tiny vacuum bubbles when they intersect with any irregularities in the surface of the channel they flow through (Fedarko 2014:211). Each small bubble on its own produces a small implosion and tiny shockwaves that radiate outward. In a large moving body of water, the cumulative effect of each of these tiny implosions and radiating shockwaves generates a shocking impact. One tiny divot on a smooth surface can cause water flowing over it to cavitate or generate successively larger shockwaves that produce extensive force that can permanently alter the surface and cause a chain reaction of successively more massive and greater hydrodynamic forces. On a wild river, this hydrodynamic process is what forms unpredictable and violent rapids. In a closed channel, this process can trigger a downstream chain reaction that can begin with a divot as small as a quarter and result in the destruction of the entire system. A similar process nearly destroyed the Glen Canyon Dam on the Colorado River in 1963 and left successively larger divots within the dam's channels (Fedarko 2014:212). Here, I suggest that a process akin to cavitation triggers small decisions that ultimately culminate in adaptive behavioral strategies. Individuals, like bounded water molecules, create small ripples in the behavioral system that can radiate outward and affect others, leaving traces of their effects along the way, similar to the idea of affordances proposed by Keane (2016). As the course of time moves forward, like a body of water moving at high velocity, these individual creative ripples will yield significant evidence across human culture, such as language, material culture, and land use. This process is chaotic, in that an unimaginable number of internal and external influences can direct the course of individual movements. However, when individuals are faced with a great enough influence, their culture will successively shift in ways that are predictable based on the temporal and spatial scale of the causal effect.

Adaptation, Resilience, and History

Anthropology has long been concerned with documenting and, increasingly, explaining diachronic change, comprising cultural, behavioral, and natural evolution at various times and places throughout human history (Trigger 1989:315–6). Global issues of environmental change and sustainability have led anthropologists to reframe disciplinary interests in adaptation from merely observation to application. A new wave of so-called "disaster scholarship" seeks to improve adaptive responses to catastrophe through preemptive action that serves to reduce risk (Barrios 2016). Understanding how past human-environment relationships functioned and changed represents a central premise of said research and as such integrates traditional ecological knowledge, material history, and archaeological perspectives. Further, considering how this relationship was iterated and reiterated through behavioral adaptation provides great insight into human history and culture.

The diachronic scale of archaeological data provides a clear window into the development of human-environmental relationships through time and across diverse ecological settings that results in unique cultural frames. Many recent archaeological studies have offered traditional ecological perspectives that pertain to past adaptive strategies that may be applied in the present to promote more sustainable environmental systems. Such studies have offered insights into managing fisheries, agriculture, and forestry resource management in the present. While many of these applications are inherently location-specific and cannot be extended to settings beyond the study region, the frameworks that underpin these traditional ecological systems can be generalized to improve our understanding of human-environment interaction more broadly. Archaeology's theoretical strength is a facility for generalization at diverse temporal and regional scales by aggregating material cultural data. These data can be mobilized to refine environmental management strategies and improve our understanding of culture interaction, and decision-making.

Archaeologists frequently ascribe cultural change to variables of the natural environment that limit or promote foraging activities to provide a, "sexy explanation for changes in human society" (Fagan 2004:334). Critics have noted how the environmental focus of many hunter-gatherer studies produces a lopsided interpretation of both human history and coupled human-environment systems, in which the environment is often granted too much explanatory power (Gamble 2005). If you only look at environmental data, you will only be able to explain human culture in terms of the environment. Data collection and differential preservation or taphonomy further privilege past environmental data. There are many more environmental scientists than there are archaeologists, and environmental data arguably withstand taphonomic forces more consistently than material culture. There is simply more available data on past environmental shifts than past social dynamics: pollen and isotopic records reflect past vegetation regimes, genetics can track prey population changes, and volcanic tephra record punctuated episodes of potential environmental disruption (Witt 2002; Bunting et al. 2013; Heintzman et al. 2006; Blockley et al. 2008). These environmental data are further favored due to their hard-scientific association, an attribution inherently linked with increased credibility among hunter-gatherer archaeologists. Comparatively, social variables, such as inter-group relations, cohesion, and identity, leave few preserved traces that archaeologists can account for through excavation alone, nor do international teams of interdisciplinary researchers frequently synthesize major finds on hunter-gatherer social dynamics in high profile scientific journals as they do for environmental research. Moreover, many scientifically oriented archaeologists eschew such humanistic angles of human behavior (Binford 1987; Earle et al. 1987). Despite advances in our ability to identify the social dynamics of past hunter-gatherers through novel techniques such as material sourcing, isotopic mobility reconstruction, and population genetics, past social interaction remains an undertheorized aspect of hunter-gatherer histories that has resulted in tacit environmental determinism across the discipline.

A focus on environmental factors is frequently premised upon an assumption of the fragility of hunter-gatherer existence, particularly in environments that are considered to be marginal or inhospitable (Sahlins 1968:85; Porter and Marlowe 2007). Hunter-gatherers occupy these unwelcoming regions both in the past and the present, and archaeological and ethnographic data tend to suggest episodes of starvation and long-term abandonment associated with resource stress, particularly in high latitude hunter-gatherer populations (Smith and Smith 1994; Kelly

2013:188). However, researchers have consistently called into question the alleged marginality of high latitude environments, the argument that foragers tend to live in more marginal environments, assumptions of food stress, and the frequency of starvation episodes in the past (Krech 1978; Cunningham et al. 2019; Holly 2019; Cordain et al. 1999; Berbesque et al. 2014). Moreover, many environments that hunter-gatherers successfully occupy today are prohibitive of other subsistence modes, such as agriculture, further illustrating the inherent incongruity of archaeologists' emphasis on the natural environmental and environmental change in reconstructions of hunter-gatherer history. Foraging lifestyles are inherently flexible and certainly less sensitive to environmental perturbation than horticultural or agricultural groups that rely on intensified food sources linked to favorable and stable climates (Colson 1979:22; Sheets 2001:73). Hunter-gatherer fragility cannot be assumed, even in marginal environments, nor do hunter-gatherers tend to occupy marginal environments at higher rates than peoples who employ other subsistence strategies . Thus, hunter-gatherer archaeologists do the discipline a disservice by considering environmental factors to the exclusion of social variables that may have equal or even greater weight in adaptive decision-making among hunter-gatherers (Gamble 2005:93).

In addition to the problematic disciplinary assumptions that underlie arguments of hunter-gatherer adaptation, research that evaluates past hunter-gatherer responses to climatic events frequently depends on a correlative framework that does not specify expectations based on theoretical predictions. When only environmental factors are considered as explanatory mechanisms, the results can only be described in terms of the environment. The comparative impacts of environmental and social variables are rarely considered in hunter-gatherer archaeology, potentially due to a disciplinary assumption that social factors cannot shape the behaviors of the members of small-scale societies in meaningful ways (Burch 1979:123), or perhaps owing to the enigmatic nature of sociality within hunter-gatherer material culture discussed above. Nevertheless, oral and ethnohistories preserve the complex social networks that served as overarching adaptive frameworks for hunter-gatherers likely spanning human history (Whallon 2011). Changes in these social networks via conflict, alliance, marital structure, demographic change etc., perturb hunter-gatherer behavior, decision-making, and culture in meaningful ways (Duke and Wilson 1995). Many scholars have introduced theoretical models that incorporate such social variables in hunter-gatherer research during recent decades and this research shows the potential to contextualize hunter-gatherer culture within distinct historical trajectories (Sassaman and Holly Jr. 2011).

It is important to distinguish the Dene/Athabascan transition and migration as aspects of Dene history because this establishes a unique series of events that culminated in a distinct Northern Dene/Athabascan identity, in contrast to a uniform progression implied by neoevolutionary frameworks (Trigger 1989:386). Neoevolutionary frameworks that assume a stepwise progression towards complexity further strip hunter-gatherers of their sociality by relying almost exclusively on extrinsic environmental variables as causal mechanisms (Meggers 1960; Hodder 1994). New Archaeologists of the late 20th century held up this progressivist paradigm to explain patterns in material culture related to state formation in particular (Flannery 1968). Neoevolutionary perspectives search for the emergence of complex cultural aspects such as intensification, structural inequality, and large-scale settlements (Binford 1965). However, complexity becomes inevitable when it is framed as *emergent*. Put another way, the details and timing may differ, but the result will always be the same. This scheme of "General Evolution" provides a single track along which all cultures must run, rejecting historical particularism in the name of positivism (Trigger 1989:387–388) and in many ways reverting to the unilineal framework of cultural evolution envisioned by Morgan (1877). Many scholars have argued that an adaptationist perspective cannot reconcile the progressivist underpinnings of the neoevolutionary framework (Trigger 1989:445). If cultures represent adaptations to local conditions, culture cannot also be a universal trajectory towards complexity given enough time and resources. By presuming general evolution, neoevolutionary frameworks do not accommodate the social histories of simple foraging groups. Moreover, neoevolutionary frameworks excuse the erasure of historicity from hunter-gatherer pasts.

To consider history in causal explanations is to acknowledge the potential for cultural divergence. I acknowledge the distinct natural and social variables that created a unique adaptive setting and the historical trajectory of Dene/Athabascan culture rather than assume that Dene/Athabascans were on track to incipient complexity, sedentism, and horticulture provided certain external stimuli. Therefore, I refer to the Dene/Athabascan past as history to distinguish a unique process of identity formation. Behaviors and decisions are iterated through this historical trajectory, connoting the singularity and the richness of the human experience and culminating in the culture that results in the materials we, as archaeologists, analyze (Rowley-Conwy 2001). Moreover, I consider Dene/Athabascan history through oral historic accounts and ancestral ways of knowing in addition to material correlates to incorporate Dene/Athabascan identity into the research presented here. Their history is the context for the behaviors that I reconstruct and the thread that ties these behaviors to Dene/Athabascan culture. To consider history, environmental variables are not enough. The archaeologically- and linguistically-visible decisions made at multiple scales in the Dene/Athabascan past is the result of the entanglement of a vibrant social landscape and ecological stochasticity (Stewart et al. 2004). North American archaeologists have established the viability of this paradigm in studies of so-called “complex” hunter-gatherers (Sassaman 2004) and many researchers have fruitfully explored identity structuration and historical particularity in explanations of all hunter-gatherers (Holly 2019; see Ives 1990 for an early Subarctic example). Archaeologists can only hope to fully understand past human culture, behavior, and decision-making if they acknowledge adaptation from the perspective of entangled historical contexts.

The historical perspective on the Dene/Athabascan transition and migration that I present here allows for a better reconstruction of coupled human-environmental systems by explicitly involving the social processes that shaped those systems. Moreover, this framework acknowledges Northern Dene/Athabascan resilience as masters of the Subarctic environment and opens up the possibility of appreciating Dene/Athabascan culture beyond the domain of the environment. Such perspectives are necessary to improve archaeological models of hunter-gatherer behavior in response to disasters, climatic change, and environmental perturbations. If anthropologists intend to inform current debates surrounding human-affected climate change and sustainability, there is no excuse for ignoring potential variables that may have affected humans’ relations with their environment or privileging environmental determinism in causal models. To ignore these factors and to bias conclusions by doing so results in scholarship that has the potential to misdirect efforts to understand human culture at a fundamental crossroads in human-environment relations.

Athabascan Ecological and Social Organization

Resource availability is among the central constraints that shape human decisions and behavior. Thus, a careful evaluation of subsistence resources and the subsistence economy provides one part of a larger analysis of any cultural process. Human behavioral ecology draws on optimization and game theoretic models to build predictions about the fitness-related trade-offs that individuals face in variable environmental and social circumstances (Winterhalder and Smith 1992; Bird and Codding 2008). Within this paradigm, optimal foraging theory offers the diet breadth model to predict subsistence decisions under shifting resource availability (Bettinger et al. 2015). The diet breadth model in particular provides a framework for predicting the adaptive response of foragers to changed resource availability because it ranks resources based on their utility yield (typically weight or calories) per unit search and handling time. In this rational model, foragers broaden their diet to include lower-ranked resources that were previously ignored when higher-ranked resources are no longer available (Winterhalder et al. 1999). Moose are the top ranked resource in the interior Subarctic, whereas caribou are lower ranked but still an important resource (Tremayne and Winterhalder 2017). The same diet breadth model of Subarctic fauna indicates that salmonids and other fish are so low ranked that foragers will not pursue them when encountered because of their higher processing time-to-biomass ratio. However, changes in resource availability, technology, settlement organization, and mobility can change the calculus of the diet breadth model by reducing the search and/or handling time of lower ranked resources.

Intensification represents one process that can lead to increased diet breadth by increasing the yield of lower ranked resources per unit time. Following Morrison (1994:115), intensification typically refers to an increase in the productive output per unit of land among hunter-gatherers through technological or organizational innovation. Thus, intensifying a low-ranked resource results in a decrease of search and/or processing time by organizing people or technologies in ways that decreases the time needed to find and/or process that resource. Similarly, the disappearance of a high ranked resource can necessitate shifts in mobility that alter resource search times, again augmenting the return rates of low-ranked resources and increasing their attractiveness to foragers. Therefore, the diet breadth model shows how generalized subsistence strategies, which include many different resources but primarily depends on the highest ranked resources, can ultimately result in wider diet breadth and the increased use of low-ranked resources through intensified resource use. Foragers may initially pursue those low-ranked resources for very different reasons that can be reconstructed through a multiscalar analysis of archaeological remains.

After an increase in diet breadth is detected in the archaeological record, archaeologists can study patterns in mobility, settlement, and technology from multiple scales to determine whether this shift in resource use resulted from a shift to a generalized subsistence strategy or the intensification of lower ranked resources. Thus, technology and mobility in a generalized system are oriented around obtaining the highest ranked resources with the flexibility to procure all high-ranked resources through generalized tool kits and small, highly mobile groups. In contrast, an intensified subsistence system relies on increasing the yield of a given landscape, potentially through specialized use of lower-ranked resources, which results in associated technological and mobility systems oriented around those specific resources. In central Alaska and Yukon, Dene/Athabascan groups could have intensified both caribou and salmon within upland and lowland locales within their territories through larger groups that facilitated intensive communal foraging and technological specialization. Numerous ethnographic and archaeological examples from across North America show evidence for intensified caribou hunting, represented by specialized technologies and communalized foraging, and salmon fishing (Partlow 2000; Friesen 2013; Morgan 2015; Graesch 2007; Betts and Friesen 2004). Therefore, technology and settlement patterning data can help to explain the documented increase in diet breadth that occurred during the Dene/Athabascan transition.

Economic and ecological models also offer predictions for land use decisions based on resource availability that can be used to explain subsistence and mobility changes associated with the Northern Dene/Athabascan transition (Dyson-Hudson and Smith 1978; Nonaka and Holme 2007). Specifically, agent-based and ecological models suggest that foragers pursue a strategy of high mobility when resources are sparse and unpredictable. Conversely, foragers pursue a territorial strategy of lessened mobility when resources are dense in predictable patches that can be intensively exploited. The cost of defending predictable resources that are intensively pursued from other foragers is thereby outweighed by the benefits of controlling them. This economic interpretation accords with ethnographic models of forager behavior (Colson 1979; Dyson-Hudson and Smith 1978) and provides a useful dichotomy for understanding conditions that would yield either intensified resource use or a strategy of generalized subsistence among Dene/Athabascans in the Subarctic, as well as certain material correlates that might be associated with different resource environments.

Territoriality is one correlate of a rich resource environment documented ethnographically, archaeologically, and through human behavioral ecology models. The study region is vast and features low resource abundance compared to more southerly ecosystems, making a territorial system somewhat difficult to envisage. However, this Subarctic ecosystem presents a unique resource scheduling conflict among two predictable and dense resources, salmon and caribou, which are both available for only a few weeks in the late summer and early fall at predictable lowland and upland locations, respectively (see Chapter 2, Figure 2.6). Additionally, evidence for Northern Dene/Athabascan territoriality in both the protohistoric period and the ethnographic present support territoriality associated with this resource scheduling conflict between fish camps and caribou drive lines and/or fences, navigated through a gendered division of labor (Burch 1974; Sharp and Sharp 2015; Blong 2016). Perimeter defense was likely impossible on this vast landscape. Yet, hunter-gatherers can still regulate physical access to lands through social access that reflects the trade-off involved in allowing resource use in exchange for the benefit of reciprocal resource use in the future (Dyson-Hudson and Smith 1978:26; Kelly 2013:164). Dene/Athabascans in the ethnographic present established control of the most productive sites on this heterogenous landscape by aggregating women at lowland fishing sites and men at upland hunting camps (Burch 1974).

Volcanism and Human History

Volcanoes have played an important role in shaping our planet's geology and influenced human behavior directly and indirectly since the beginning of our species' history. The extent to which humans are resilient to sudden volcanic episodes remains a subject of great debate among archaeologists and historians (Small and Naumann 2001). Volcanic activity is relatively easy to identify in the past and yet the scale of environmental change associated with volcanic events covers a broad range from minor to complete regional devastation, thus yielding variable downline effects on plants, animals, and humans in their aftermath (Mulliken et al. 2018; Dale et al. 2005). Subarctic archaeologists have invoked the White River Ash eruption(s) almost exclusively in their explanation of the Dene/Athabascan transition and migration. Considering comparative examples of volcanic impacts in Arctic and non-Arctic populations throughout human history provides an overview of archaeological interpretations of volcanism and its influence on human decision-making that sheds light on the explanatory validity of the White River Ash event(s).

Archaeologists' focus on volcanic activity as a driver of human behavior and cultural change may be linked to its high visibility in the archaeological record. Volcanic activity results in lenses of tephra that provide a key signature of specific volcanic eruptions and a relative date that can be used to consider impacts across broad regions (Grattan and Torrence 2016:4). Other natural disturbances to ecological systems such as temperature and precipitation fluctuations are identifiable through a comprehensive analysis of various isotopic, pollen, and various other ecological markers that generally provide only coarse chronological markers (Witt 2002; Bunting et al. 2013; Heintzman et al. 2006; Blockley et al. 2008). Social pressures such as conflict are even more difficult to conclusively identify and date. In contrast to these other potential natural and social influences on human behavior and culture, volcanism is uniquely identifiable chronologically and spatially and thus may be overrepresented in archaeological explanations of the past.

Volcanism represents a unique kind of catastrophe due to the widespread, unpredictable, diverse, and rapid nature of eruptions. Though volcanic eruption extents are quite variable, large scale eruptions occur with surprising regularity (Deligne et al. 2010). The destruction that occurs in the wake of a volcanic eruption can take place in a matter of minutes, leaving little time for adaptive decision-making, and may impact local ecologies for decades or even centuries (Crisafulli et al. 2018; Dale et al. 2005). Moreover, the varied extent and effects of volcanic eruptions remain highly unpredictable to this day. Perhaps because of these unique qualities, volcanoes are frequently referenced in oral histories around the globe (Moodie et al. 1992; Lowe et al. 2002; Németh and Cronin 2009). Moreover, the specific catastrophic qualities associated with volcanic events combined with their high visibility in the archaeological record have led to extensive research by archaeologists around the world.

Identifying an temporal association between tephra and specific episodes of cultural change does not necessarily reflect a causal relationship (Grattan and Torrence 2016:2). Central to volcano-based explanations of human history are links between volcanic activity and ecological disruption that in turn affect human decision-making and material culture. Certainly, the experience of enduring a volcanic eruption, including the noise, ashfall, and blackout conditions is unsettling and a common trope in oral histories (Blong 1982). These sensory impacts do not necessarily result in archaeologically-visible changes to material culture, however. Volcanoes can result directly in population decline, as was famously recorded at Pompeii. However, volcanic eruptions range in their local and regional severity. Many volcanic eruptions have subtle and indirect effects on human activity that must be traced through proxy ecological evidence and combined with theoretical predictions. Additionally, spatial research on Holocene settlement placement has shown that population density decreases with distance from active volcanoes, potentially due to the benefits of highly fertile volcanic soils (Small and Naumann 2001). The variable nature of volcanic activity complicates archaeologists' ability to assess and assert volcanic models of the past.

Archaeologists' consideration of volcanic eruptions as explanations for behavioral and cultural change reveals the variability of human responses to volcanism in the Subarctic and beyond. Research in the Eastern Aleutians showed that several sites were buried by volcanic tephra ca. 9,000 cal BP, leading several archaeologists to suggest a causal connection between the abandonment and volcanic activity (Dumond and Knecht 2001). However, subsequent research has established the continuous occupation of the region in the centuries following the ashfall event (Davis and Knecht 2010). On the Kuril and Rat Islands of the Western Aleutians, volcanic activity appears to have had limited impacts on residents over millennia (Fitzhugh et al.

2019). Continuous occupations show that the inhabitants of these islands endured a highly volcanic landscape. Yet, site placement away from the highest areas of volcanic activity indicates that volcanism informed land-use strategies in these Subarctic islands and likely played a role in the broader cosmological orientation. In contrast, the eruption of Aniakchak on the central Alaskan Peninsula ca. 3,400 BP may have motivated regional abandonment according to archaeological evidence (VanderHoek and Nelson 2007). This research suggests that a massive summertime volcanic eruption pushed the region's inhabitants into neighboring territories for nearly 1,000 years before the abandoned area was reoccupied. Moreover, the paucity of radiocarbon dates from the central Alaskan peninsula contrasts with neighboring regions and suggests that volcanism may have prevented settlement of the Alaskan Peninsula until ca. 2,200 years ago (VanderHoek and Nelson 2007). The disparate respective outcomes in the Eastern Aleutians and the central Alaska Peninsula indicate that volcanism had variable effects on the lives of coastal Alaskans.

Archaeological research beyond the western Subarctic suggests past volcanic activity may have triggered important changes in the behavior of inland hunter-gatherers. Archaeologists have argued that the Laacher See volcanic eruption in Northern Europe ca. 12,800 BP can be linked to an *in situ* cultural change and demographic patterning (Riede 2017). These results are based primarily on the extent of the volcanic ashfall event, summed probability distributions of radiocarbon dates, and a divergence in material culture and potential cultural isolation co-incident with the event in question (Riede 2017:18–19). While the research on the Laacher See eruption lacks theoretical depth and some archaeologists have criticized the correlation based on a paucity of evidence and rapid recolonization of the affected region (Sørensen 2010), this research nevertheless suggests the broad regional effects of volcanic activity on past peoples, particularly on inland hunter-gatherers.

Looking even further back, the Campanian Ignimbrite (CI) eruption ca. 39,000 cal BP in Mediterranean Europe has also been linked to the Upper Paleolithic transition among inland hunter-gatherers (Hoffecker et al. 2008). Volcanologists argue that the CI eruption was the largest in the Greater Mediterranean in 200,000 years (Barberi et al. 1978) and archaeologists have posited that this massive eruption may have caused century or millennial scale ecological changes that resulted in both the Middle to Upper Paleolithic transition as well as the abandonment of southern Italy (Fedele et al. 2002, 2008). However, archaeologists have subsequently disputed the correlation between the CI ashfall and the Upper Paleolithic by establishing that the Middle to Upper Paleolithic transition in North Africa and Europe began before the CI eruption (Lowe et al. 2012). These results, derived from microscopic tephra, suggest that a much smaller region was potentially affected by the CI ashfall. Interestingly, both of these arguments rely on circumstantial lines of evidence that offer few or no predictions for human behavior or social organization based on assumptions of the volcano's impact. Nevertheless, this CI ashfall event and its argued effects on human history offer an insightful comparative example for the White River Ash associated with the Northern Dene/Athabascan transition.

Volcanic explanations of hunter-gatherer behavior have provided critical insights into human decision-making around the world. Volcanism yields highly variable responses among humans, even those who live in similar regions. In some cases, humans adapted to volcanic activity and were able to permanently inhabit very active volcanic regions such as the Western Aleutians. In other regions, such as Northern Europe, the Mediterranean, and the Eastern

Aleutians, volcanic activity arguably lead to widescale cultural changes, including abandonment, altered trade routes, and major shifts in subsistence and mobility. The severity and frequency of volcanism undoubtedly played a role in these varied trajectories, but differences in subsistence base, mobility, social networks, territoriality, and exchange may have also contributed to these dissimilar results. For example, studies of central and South American archaeological records indicate that egalitarian societies, including hunter-gatherers, were much less susceptible to downline effects associated with volcanic eruptions than hierarchical societies (Sheets 2001). Of the studies that link specific volcanic eruptions to cultural change in hunter-gatherers, very few provide a theoretical model of set of behavioral predictions associated with volcanic activity, other than the *ad hoc* argument that volcanic eruptions are negatively impact local ecologies and produce abrupt limits on resource acquisition. Additional data may shed more light on the differentiating variables in each of these situations and each of these cases highlights the importance of providing a theoretical framework that incorporates specific predictions for human behavior based on distinct circumstances.

Demographic Change and Human History

Demographic change has proven a difficult nut to crack in hunter-gatherer archaeology. Observing demographic change itself has been broadly limited to overall population increase and decrease due to the ephemeral nature of mobile hunter-gatherer material culture. Cross-culturally, hunter-gatherers tend not to bury their dead. Archaeologists typically recover evidence for life expectancy, health, maturation rates, intergroup violence, and other demographic variables from human remains. Yet, mortuary data are rare for past hunter-gatherer groups, at least in part because subterranean burial is relatively infrequent among highly mobile hunter-gatherers and many ethnographic hunter-gatherers have strong taboos associated with death and the deceased or a mistrust of archaeologists that make research on human remains unacceptable. Given the dearth of hunter-gatherer mortuary data, radiocarbon data that serve as a proxy for population size is employed in discussions of past hunter-gatherer demography, though this endeavor is further complicated by the inherent complexities of extrapolating population size from the number of archaeological occupations. Nevertheless, a great deal of archaeological discussion revolves around hunter-gatherer population size from the deep past through the present.

Archaeologists frequently evaluate demographic changes as possible correlates or, somewhat problematically, causes of changes to subsistence, mobility, and technology (Hassan 1978). Studies of hunter-gatherer population increases or decreases are often based on summed probability distributions, or temporal frequencies of radiocarbon-dated archaeological occupations, provide the primary basis for discussions of demographic change (Surovell and Brantingham 2007). Such estimates lend themselves to use in explanatory frameworks because they can accommodate both the timing and pace of population changes. Moreover, population size provides a key correlate for resource demand, a critical variable in human behavioral ecology frameworks frequently applied in evolutionary archaeological research. Demographic changes and population increases or decreases in particular are the subject of a great deal of archaeological attention because they are relatively easy to identify and integrate within dominant theoretical paradigms.

Importantly, anthropologists have established correlations between population growth and increased artifact class richness, or the number of different tools used and maintained at archaeological occupations. Note that richness, or the number of different taxa or types, is distinguished from the concept of diversity, a term borrowed from ecology that denotes both evenness, or the degree of variation between taxa or types, and richness (Leonard and Jones 1989). Archaeologists have positively correlated population size and technological richness in several cases spanning human history (Premo and Kuhn 2010; Powell et al. 2009; Mackay et al. 2014; Shennan 2001). Cultural transmission theory explains these increases in toolkit richness as a function of the number of teachers and learners involved in conveying stylistic and technological innovation, also known as dual inheritance because it signifies both cultural and genetic evolutionary processes (Richerson and Boyd 1992). As populations grow, more room for variability is introduced in the system and results in a greater deviation of tool forms. Conversely, when populations decline, richness is lost and results in smaller and less rich toolkits (Henrich 2004). Though there are other potentially parsimonious explanations for positive correlations between population size and toolkit richness, this adaptive framework corresponds to the potential demographic and technological shifts that occur in Northern Dene/Athabascan populations during the late Holocene.

Some archaeologists have proposed that environmental decline and intertwined increases in risk of failure are better indicators of toolkit richness than population growth (Collard et al. 2013; Buchanan et al. 2016; Read 2008). However, these studies are typically based on quantified ethnographic data and are therefore synchronic in nature. The manner in which environmental and toolkit variables are quantified in this research varies: environmental risk is ambiguously using global temperature data, and stylistic differentiation is problematically equated with toolkit richness. Additionally, researchers place risk at odds with population growth, which is problematic because population increases inherently augment the risk and effects of subsistence failure. From several perspectives, then, research that indicates toolkit richness increases with increased risk of failure remains problematic. Therefore, we will consider population size as a proxy of technological richness rather than environmental variation.

Researchers commonly interpret changes in population size, like many other correlates of hunter-gatherer culture, in terms of gradual or rapid environmental changes, such as climatic shifts or volcanism, respectively. The connection between population decline and environmental deterioration is commonly invoked within adaptive frameworks that explore changes in mobility based on declines in resource availability. For example, ecologists have argued that the Younger Dryas cooling event at the end of the Pleistocene resulted in an ecological downturn that archaeologists have used to explain several important cultural changes observed across the globe (Moore and Hillman 1992; Abell and Plug 2000; Anderson et al. 2011; Smallwood et al. 2015). As global temperatures fell during this ca. 1,000-year period at the beginning of the early Holocene, pollen data suggest that forests returned to grassland or steppe tundra with decreased ecological productivity that led to many disruptions in settlement, mobility, and other behaviors around the world. Population decreases, decreased mobility, and decreased toolkit richness are predominant trends that are consistent with correlations between population and toolkit richness considered above. The Younger Dryas provides a concrete framework to consider gradual and severe ecological degradation that can be used as a model for the WRA east, thought to have wreaked similarly extensive ecological havoc in central Alaska and Yukon.

In contrast to initial expectations for site patterning following the WRA east event, ca. 1,000 years ago, however, radiocarbon data show a significant relative increase in the number of occupations ca. 2,000 cal BP that is suggestive of a significant and prolonged population *increase* (see Chapter 1, Figure 1.3). The average number of radiocarbon-dated occupations nearly doubles ca. 2,000 cal BP (Potter 2008a; Graf and Bigelow 2011). While these data may signify increased residential mobility following a catastrophic environmental shift, a strategy that I will evaluate further in the next section, these radiocarbon data may also indicate that regional populations may have dramatically increased during the late Holocene. Unfortunately, archaeologists in the region have yet to tackle these settlement patterning data in their frameworks of Northern Dene/Athabascan transition, perhaps due to the inherent complexity of explaining population increases among hunter-gatherers in the absence of significant environmental change.

Researchers have provided compelling causal models for population increases based on increased resource availability. On the Northwest Coast, detailed paleoclimatic and archaeological research has led to the elaboration of mid-Holocene human-environmental relations at a remarkably fine resolution. Chatters and Prentiss (2005) demonstrate that a rapid episode of climate amelioration led to ocean warming and increased productivity of marine and terrestrial resources, which led to a rapid population increase. While this increase was ultimately reversed as population growth was evidently unsustainable in the long term, this example applies an adaptive evolutionary framework to establish the connection between climate change and population growth in terms of resource abundance and predictability rather than scarcity and unpredictability. Yet, the western Subarctic record shows no conclusive evidence for significant regional climatic change of any kind after the mid-Holocene (Kaufman et al. 2016; Anderson and Brubaker 1993), well before the increase in the number of radiocarbon-dated occupations potentially representative of increased populations. Therefore, an environmental explanation for Northern Dene/Athabascan population growth is unlikely given the environmental record of the region.

Beyond environmental explanations, hunter-gatherer demography, and particularly population growth, remain difficult to satisfactorily explain using causal models. Environmental variables track much more easily with the scale of archaeological materials related to past hunter-gatherers and are more conclusively identifiable than intangible operant social conditions. Warfare and infanticide are applied in causal models of hunter-gatherer population decline and stasis, respectively, but population growth has few socially situated explanatory mechanisms. Of these, *ex situ* population movements, or territorial expansion and in-migration of neighboring groups, and/or shifts in kinship organization that promote local group growth may explain the increase in population density suggested by the region's radiocarbon data. In-migration of neighboring territorial groups could have forced central Alaskan and Yukon populations into a smaller territory whereas shifts in kinship organization could have led to an *in situ* population increase and resulted in a similar increase in population density.

The Western Subarctic has long featured wide scale movement of people and objects across vast networks that drew upon regional groups' vast territories (Kristensen, Hare, et al. 2019; Cooper 2012; Rasic 2016). At least twice since the mid-Holocene establishment of Athabascan/Dene populations in the region, Arctic and Subarctic groups migrated and shifted their territories. Material evidence indicates that Northern Archaic tradition groups lived as far north as the Brooks range during the mid-Holocene (Esdale 2008), while Paleo-Inuit pre-Dorset, Norton and Choris traditions emerged and expanded their territory eastward around 4,000 years ago (Mason 2016:505). These groups were adapted to both coastal and maritime subsistence economies and indicates that Northern Archaic tradition groups, potentially early Dene/Athabascans, may have been forced south of the Brooks Range around this time. However, the number of radiocarbon-dated sites in central Alaska and Yukon shows only a possible decline during the mid- to late Holocene transition ca. 3,000–4,000 years ago. Subsequently, around 1,800 years ago, a maritime cultural tradition emerged around the coasts of northern Alaska, known as Early Thule, Old Bering Sea, Punuk, or Birnirk, at around the same time the Northern Dene/Athabascan transition may have begun. The full Thule emergence around 1,000 years ago was associated with a rapid territorial expansion eastward across the Arctic coastline, increased territoriality, whale hunting, use of metal tools, and competition for resources (Friesen 2016:680). This expansion happened rapidly but after the increase in population denoted by radiocarbon-dated assemblages from central Alaska and Yukon, indicating that the Thule emergence post-dates the increase in population suggested by radiocarbon-dated sites.

Changed group formation principles provides another possible explanation for the increase in radiocarbon-dated sites in the region beyond environmental and external social stimuli. Ives (1990:307) suggested that Northern Dene/Athabascan history could be better understood in light of group formation principles. Ives (1990) considered two alternative paradigms of group formation based in Dene/Athabascan Dravidian kinship structure, specific kinship terminology, and ethnographic data: local group growth vs. local group alliance. Dravidian kinship is classificatory, rather than descriptive, with kinship terminology based on alliance instead of descent (Busby 1997:25). In contrast to Seneca-Iroquois kinship systems, Dravidian systems distinguish between parallel and cross-cousins and are associated with cross-cousin marriage (Dumont 1953:35). Thus, Dravidian kinship systems structure alliances by establishing selective cousinhood, whereby parallel cousins are considered consanguineous siblings that are ineligible as marriage partners, and cross-cousins are considered eligible marriage partners.

Within the Dene/Athabascan kinship system, Ives (1990) identified two group formation principles based on ethnographic records and interpretations of Dravidian social organizations. The first is premised on *exogamous* group foundation through an opposite-sex sibling core while the second is premised on an *endogamous* group foundation through a same-sex sibling core. Within an alliance group formation, founding same sex sibling cores initially seek marriage partners outside the kin group, resulting in exogamy. In contrast, a local group growth formation is based on marriage partners selected from within the local kin group, typically cross-cousins, and is broadly endogamous (Ives 1990:212). Ives' linguistic research on Dene/Athabascan kinship terminology demonstrates that both styles of group formation are possible from a linguistic perspective. Indeed, both local group growth and local group alliance formation principles were documented ethnographically across Dene/Athabascan communities such as the Caribou Eaters, Beaver, and Western Apache (Ives 1990; Kraus and White 1956:1021). Further, novel genetic data indicate that endogamous kinship systems were more common among past hunting and gathering groups than previously assumed (Maryanski and Turner 2018; Livingstone 1969). Thus, differences in group formation in Dene/Athabascan groups may provide insights into shifts in population size in the past.

A local group growth scenario of hunter-gatherer population increase is certainly historically situated: principles present in the Northern Dene/Athabascan language necessitate various forms of social interaction that promote alliance and group growth formations (Ives 1990). Yet, this group formation dichotomy has clear explanatory utility for the Dene/Athabascan transition and migration, and potentially for other groups that exhibit local group growth formation principles linguistically or ethnohistorically. Kelly (2013:161) suggested that groups become more endogamous with increased resource predictability and density, resulting in greater territoriality. With increasing environmental stability (Kaufman et al. 2016) and/or through a shift to intensified foraging strategies (Morgan 2015), resources in central Alaska and Yukon may have become predictable and dense enough to allow a local group growth social formation. These groups of endogamous Dene/Athabascans perhaps grew until they reached a natural population density limit for their Subarctic homeland and subsequently part of these groups migrated south, pushed by both a crowded landscape and limited resources. Local group growth formations could explain *in situ* hunter-gatherer population growth that may arise in the absence of environmental amelioration, encroaching neighbors, or other external factors, though it is challenging to positively identify without further comparative research.

A Synthetic Model of the Dene/Athabascan Transition and Migration

The Northern Dene/Athabascan transition, comprising a suite of changes to mobility, subsistence and technology that occurred between 2,000–1,000 years ago, and subsequent Dene/Athabascan migration from central Alaska and Yukon to the Northwest Coast, Great Plains, and Southwest of North America ca. 1,000 years ago represent a cumulative decision-making process. The following model incorporates resource availability, structure, variability, and demand based on potential social/demographic and environmental causal models to evaluate the variables that factored into that decision-making process. To predict the specific changes in Northern Dene/Athabascan subsistence, mobility, and technology and their material correlates, I consider expectations from human behavioral ecology and economic heuristics generated through ethnographic research (Bettinger et al. 2015; Kelly 2013; Dyson-Hudson and Smith 1978; Colson 1979). This model builds on previous archaeological research in the region by adding the ability to confirm or deny causality and considering an alternative and/or complementary hypothesis to a volcanic explanation.

Predictions from archaeological data are different from many other scientific disciplines because both the starting and ending conditions are typically established; predictions, in this case, deal with the intervening conditions that correlate to ultimate or proximal causal mechanisms and must accord with what is known from the period before and after the transition takes place. The archaeological record of central Alaska and Yukon provides us with a relatively secure reconstructions of behavior and culture from before and after the Northern Dene/Athabascan transition. As I discussed in the previous chapter, archaeological data strongly suggest that Northern Dene/Athabascans were highly mobile and communal caribou hunters before the Northern Dene/Athabascan transition. Following the transition and through the protohistoric period, archaeological evidence suggests increased diet breadth, reliance on fish, and a semi-sedentary lifestyle with metal and bone tools, storage, and semi-subterranean house pits. Here, I will present predictions for what the transition itself would have looked like based on different motivating factors that I have introduced above: a volcanic eruption or population growth resulting from changes in kinship structuration, summarized in Table 3.1.

Table 3.1 Predictions for Dene/Athabascan Responses to Natural and Social Stimuli

Stimulus	Response of Dene/Athabascans and Material Correlates
WRA Event	*Dispersion and high mobility* 1. **Lithics**: Maintainable and generalized tools made from local materials, more bifaces, low artifact class richness, wide spread of exotics 2. **Fauna/Isotopes**: Generalized diet abundant in moose and salmon; site use characterized by a mix of resources 3. **Site patterning**: Overall decrease in number of sites; relative increase in number of lowland sites compared to upland sites; increase in lowland site size

Population growth	*Territorial system* 1. **Lithics**: Specialized and reliable tools, continued use of microblades, high artifact class richness, decreased spread of exotics, location-specific toolkits 2. **Fauna/Isotopes**: Intensified resource use: caribou and moose only at upland/hunting sites, salmon only at lowland/fishing camps; increased evidence for bone boiling and marrow extraction, evidence of food storage 3. **Site patterning**: Equal increase in number of sites in both uplands and lowlands; overall increase in site size

Environmental Degradation and Dispersion

Approximately 1,150 cal BP, the Mount Churchill-Bona massif in the Wrangell-St. Elias mountain range erupted and distributed ash over 600 km to the east and north, throughout present-day Canada and into central Alaska (Mulliken et al. 2018). Archaeologists have long speculated that this eruption caused downline environmental effects that resulted in significant, rapid changes to Northern Dene/Athabascan subsistence and mobility throughout central Alaska and Yukon and beyond the immediate impact zone (Workman 1979). Recently, biologists provided evidence that Yukon caribou populations experienced a bottleneck following the White River Ash east (WRA east) eruption on the basis of equivocal genetic data (Kuhn et al. 2010; Letts et al. 2012). Archaeological reconstructions of mid- and late Holocene Northern Dene/Athabascan subsistence strongly suggest that caribou were a key resource in a specialized subsistence system structured around communal hunting and facilitated by high mobility (Potter 2016). Therefore, a caribou population crash could have led to a major restructuring of the Northern Dene/Athabascan way of life across central Alaska and Yukon during the late Holocene and, archaeologists have suggested, a migration from the region as Dene/Athabascan sought a stable resource base.

In a setting of lessened resource availability and predictability following the WRA east, the diet breadth and economic defensibility models suggest that Northern Dene/Athabascan subsistence should reflect increased diet breadth via increasing subsistence generalization, with a wider array of resources pursued evenly across various ecological zones. Specifically, if caribou populations experienced a significant decline, the diet breadth model for the region suggests that Dene/Athabascans occupations should show a dramatic increase in the quantity of moose and fish in the diet. Moose were possibly more resilient to ecological shocks associated with the WRA east than caribou because they are browsers not grazers (Crisafulli et al. 2018). Similarly, aquatic habitats home to fish may have been less affected by ashfall (Blackman et al. 2018). Indeed, ethnographic records establish that fish was a common fallback food in the Subarctic and Arctic, many villages from the last millennium of Northern Dene/Athabascan history are located on lakes, and ethnographic records document the central importance of salmon to Northern Dene/Athabascans at the time of European contact (Andrews 1975; Shinkwin 1979; Hosley 1981). Fish and moose are more abundant and predictable in lowland ecological zones and a novel strategy of high residential mobility within these lowland areas would decrease the search time of these resources. Therefore, intra- and inter-site data should reflect the increased importance of lowland areas, a shift to a generalized and highly mobile subsistence strategy, and overall lower populations as a result of the ecological effects of the WRA east.

Evidence for subsistence from physical faunal remains and residue analysis of hearth features should reflect a transition from upland to lowland resources and an increase in diet breadth associated with a significant decline in caribou populations. At both upland and lowland locales, faunal assemblages should reflect a wide variety of available fauna, particularly moose, fish, and small mammals. Reorienting mobility and technology around a generalized subsistence system would decrease search times for low-ranked resources that were too costly to pursue within an upland-oriented, specialized caribou subsistence system. Within hearth cooking features, a compound-specific isotopic analysis of fatty acid methyl esters should demonstrate equal use of moose and fish across sites, which will be located primarily in the lowlands. If this event is correlated with the WRA east as opposed to another rapid decline in regional caribou herd size, then this increase in diet breadth should occur after this event ca. 1,150 cal BP. Combined, physical faunal data and isotopic data should reflect dietary diversity and generalization following the WRA east with a paucity of caribou remains if this volcanic event caused this transition.

Technological data should similarly reflect both subsistence and demographic changes associated with the WRA east (Premo and Kuhn 2010). Based on synthetic technological research of central Alaska, Subarctic archaeologists argue that microblade technology was primarily used for caribou hunting in upland ecological zones (Wygal 2010; Potter 2008a). It must be noted that these findings are preliminary at best. However, if taken at face value, these tentative results indicate that a transition to a lowland subsistence base would result in the loss of microblade technology in favor of bifacial technology used for moose hunting and associated with general foraging pursuits (Osgood 1933:703). Additionally, population declines typically result in a loss of specialized technology with complex reduction sequences (Premo and Kuhn 2010), indicating that the complex sequence entailed in microblade reduction would be lost, particularly if upland caribou hunting ceased and this technology was associated exclusively with that activity. Indeed, archaeologists have argued that microblade technology disappears in Yukon following the WRA east event based on evidence from ice patch finds (Hare et al. 2012). Therefore, a population decrease and transition to lowland subsistence resources could explain the apparent loss of microblade technology that archaeologists have previously associated with the WRA east volcanic event. Finally, resource unpredictability should result in increased dependence on regional ties reflected by the increased use of exotic raw materials such as copper and obsidian. Within lithic assemblages, the WRA east should yield increased bifacial production, which archaeologists have also associated with moose hunting, to the exclusion of evidence for microblade reduction. Lithic assemblages should be small but diverse lithic assemblages associated with high mobility, and increased abundance of exotic materials signifying increased reliance on regional trade networks.

Associated with these technological and subsistence changes, the WRA east should result in a reorganization of settlement patterning if this or a comparable event caused the Northern Dene/Athabascan transition. A shift to generalized resource use focused in the lowlands should feature an increase in the number of sites in the lowlands proportional to upland sites as subsistence pursuits shifted to these lowland areas. Additionally, average site size should decrease as mobility increases to accommodate an unpredictable and resource-poor environment following the WRA east, and low site size variability would indicate short occupations overall. Presumably, the large extent of the WRA east should yield a broader cultural change across the Northern Dene/Athabascan-speaking region, though the effects may be more pronounced in Yukon settlement patterning following the eruption.

The predictive framework laid out here explicitly considers the timing of these changes in terms of the WRA east event. However, if significant changes in lithic assemblages, subsistence, and settlement patterning predicted by this model occur prior to 1,150 cal BP, it may be that the Northern Dene/Athabascan transition was triggered by an earlier caribou bottleneck and/or other rapid environmental disaster that led to a prompt decline in resource availability and predictability. The strength of this predictive framework lies in its ability to discern the nature of these changes without necessitating an explicitly identified trigger, such as a volcanic event. If this unified suite of changes to subsistence, technology, and mobility occurs prior to the WRA east, it would be possible to argue that another catastrophic environmental effect produced these changes. Future research could then ascertain the specific environmental trigger for these changes. However, the results that I will present in the next chapters will show that the WRA east and similar rapid environmental triggers do not provide adequate cause for the Dene/Athabascan transition and migration.

Regional Population Increase

Radiocarbon data from occupations across central Alaska and Yukon indicate another possible explanation of the Northern Dene/Athabascan transition: these data suggest a dramatic increase in population size around 2,000 years ago. Together with site size, evaluated in Chapter 6, these data provide a compelling explanation for both the Northern Dene/Athabascan transition and the associated partial Dene/Athabascan migration. Where climatic stability may have yielded a predictable and relatively densely resourced environment, a gradual population increase may have resulted in a shift in resource access. Ethnographically, predictable and dense resources as well as increased population density frequently leads to increased territoriality, decreased mobility, resource intensification, and endogamy (Dyson-Hudson and Smith 1990; Kelly 2013). While territoriality in the Subarctic rarely features perimeter defensive strategies, conflicts over the control of predictable and dense resources is common in this and other desert regions. Territoriality in these vast landscapes arises when foragers run out of resources, not when they run out of space. Further, agent-based modeling studies suggest that foragers intensify productive resources when they are predictably available (Nonaka and Holme 2007). Thus, an increase in diet breadth associated with increased population density should be reflected in several lines of material evidence that contrast with predictions for increased diet breadth in the context of environmental degradation associated with the WRA East.

Technologically, a population increase associated with intensification should produce longer occupations with increased assemblage variability, and territoriality associated with increased populations should result in the gradual increased use of local raw materials (Dyson-Hudson and Smith 1978; Ives 1990). Longer occupations associated with increased sedentism typically result in greater toolkit richness signified by a relative increase in the number of types present at a site. Additionally, increased territoriality should result in decreased use of exotics and increased use of poor-quality local materials. Reduction strategies ought to be conservative, signifying the greater cost of procuring lithic material in a system of decreased mobility and increased territoriality, though with increased population size, tools with more complex reduction sequences, such as microblades, should be conserved according to predictions from cultural transmission theory (Richerson and Boyd 1992). Lithic reduction and toolkits should be distinguishable based on ecological zone, with significant differences in assemblages recovered from upland and lowland sites. Upland toolkits should be oriented around manufacturing microblades, bifacial projectile points, unifacial scrapers, and other tools associated with caribou hunting and hide processing. Lowland toolkits should exhibit tools for capturing and processing large amounts of fish, such as bifacial knives. Many of the specialized tools used for harvesting salmon and other fish *en masse* are made from organic materials that frequently do not preserve archaeologically, like nets. Still, lithic toolkits employed in upland and lowland subsistence pursuits should exhibit significant differences within lithic reduction debris that demonstrate different tools and reduction sequences employed in these ecological zones associated with intensified use of caribou and fish. In sum, a local group growth formation should result in differences in intra- and inter-assemblage variability, toolkit richness, and continued use of microblade technology.

Subsistence patterning should also result in specific patterns distinguishing increased population size and density by differential use of residential bases and logistical camps. Communal hunting pursuits that represent intensified resource use are evinced by faunal assemblages dominated by one central subsistence target. In upland residential camps, this should be caribou and at lowland residential camps this should be fish, both resources that can be intensified with communal foraging strategies. Both physical faunal remains, quantifiable by number of species present, and relative proportions ascertainable by the compound-specific isotopic analysis of fatty acid methyl esters can indicate diet breadth at occupations. These faunal patterns should distinguish logistical and residential camps and thereby establish the effects of increased population size on resource use throughout the region.

Finally, landscape data pertaining to ecological zone and site placement should distinguish a gradual population increase from a sudden ecological crash through regional settlement patterning data. Increased population sizes and population density would be reflected in larger residential bases and more numerous logistical occupations. The number of sites and overall site size should increase in both upland and lowland ecological zones representing a committed communal subsistence strategy centered on alternatively on caribou or fish, depending on ecological zone. Additionally, ethnographic evidence and other examples from the Subarctic do suggest that one group may have maintained both hunting and fishing locales through a gendered division of labor to meet the demands of increased populations. Spatial lines of evidence would indicate a shift towards intensive use of seasonally abundant resources commensurate with supporting an increasingly large population in this unique resource environment.

This model is designed to evaluate the complex interplay between the social and natural environment of the western Subarctic at the time of the Dene/Athabascan migration. Within this predictive framework, a gradual population increase may fully explain the Dene/Athabascan transition, complement volcanic explanations, or prove to be unrelated to changes set in motion by late Holocene volcanic activity. The research that I summarize below serves to evaluate the impact of these factors on Dene/Athabascan decision-making as well as the utility of this adaptive and iterated model of migration. In the next chapters, I will present data that clearly show that gradual population growth, perhaps related to changes in group formation, lead to changes to subsistence, mobility, and technology in the region that were distinct from any shifts related to concurrent ecological degradation brought on by volcanic activity. In light of the migration model considered here, the most parsimonious explanation for the Dene/Athabascan migration should be reflected in the reason for the Northern Dene/Athabascan transition. Small decisions culminated in archaeologically documented shifts to subsistence, mobility, and technology that Northern Dene/Athabascans undertook to improve their resource environment. Migration was another part of this broader cultural transition, as a large number of Dene/Athabascans moved south to pursue improved resource access.

Chapter 4 Late Northern Dene/Athabascan Technology

Introduction

Targeted excavations were conducted at four late Northern Dene/Athabascan occupations comprising a total of five archaeological components in two broad ecological settings to synthesize technology production and use through the Northern Dene/Athabascan transition (Figure 4.1). This chapter presents excavation methods and summaries of excavation results, a description of analytical methods applied to technology and associated production debris recovered during excavations, and the results of this technological analysis. Drawing upon thousands of excavated remains from five occupations radiocarbon-dated to the Northern Dene/Athabascan transition, the results of these analytical efforts show that technology becomes increasingly specialized by ecological zone, with significant increases in toolkit richness and distinct upland and lowland technological curation strategies pertaining to reduction sequence and raw material use. Combined, these results establish that the Northern Dene/Athabascan transition was associated with a gradual shift to a more specialized technological system. Further, these results are consistent with technological predictions associated with a gradual population increase.

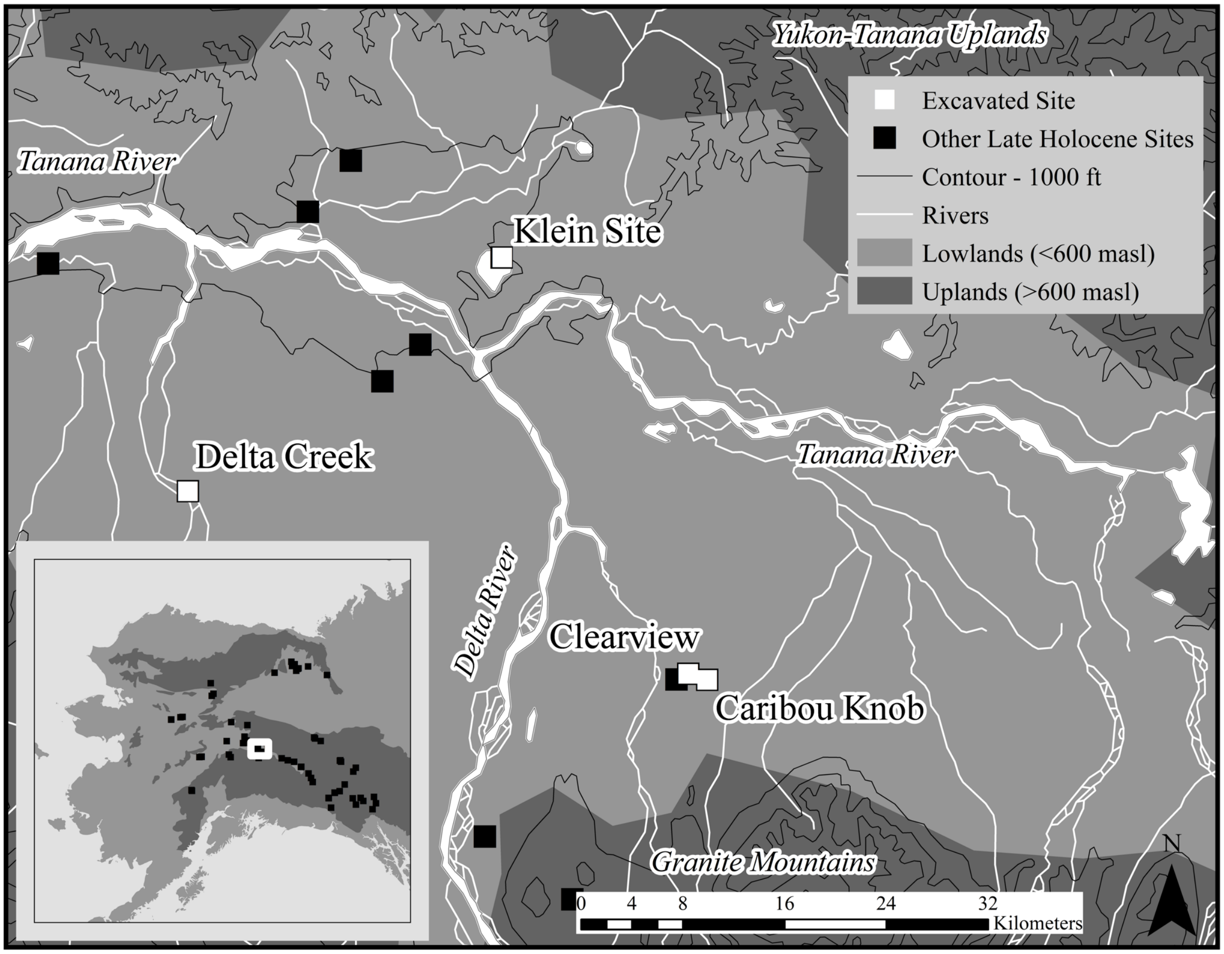


Figure 4.1 Location of Excavated Sites in Central Alaska

Excavations

Four sites in central Alaska were targeted for excavations as part of this research based on their ecological zone, proximity to the White River Ash (WRA) east and north events, and potential to yield novel information regarding the technological aspect of the Northern Dene/Athabascan transition. Clearview, a site located within an upland ecological zone with shrub-tundra vegetation, caribou, and moose, was selected because previous testing had revealed an extensive technological workshop comprising numerous formal tools and multiple raw materials. The Delta Creek Site, also located in a shrub-tundra upland ecological zone, was selected because it offered promising evidence of lithic production and because of its close proximity to Delta Creek, a salmon-bearing stream. Caribou Knob, located next to a small pond in a lowland forest, was selected because previous research yielded evidence for cooking, represented by hearth remains and animal bone fragments, and technology production. Similarly, two components at the Klein Site's upper and lower loci were targeted for further study because preliminary excavations of the two late Holocene occupations at the site on Quartz Lake provided evidence of food processing as well as lithic production in two distinct archaeological components. While these four sites are all located in the same geographic region and were likely occupied during the late summer or early fall based on faunal material, they comprise upland and lowland ecological zones as well as material traces of myriad activities that span the possible range of the Northern Dene/Athabascan transition (ca. 2,000–500 cal BP; Table 4.1). Therefore, these sites reflect a range of Northern Dene/Athabascan technology over a long time span relevant to reconstructing the Northern Dene/Athabascan transition.

Table 4.1 Calibrated Radiocarbon Dates from Excavated Archaeological Components

Component	AHRS No.	Ecological Context	Radiocarbon Years BP (2 σ)	Calibrated Years BP (2 σ)*	Lab	Lab #
Caribou Knob	XMH-917	Lowland	1420 ± 40	1280–1390	Beta Analytic	Beta-271226
Clearview	XMH-1303	Upland	1540 ± 30	1370–1520	NOSAMS	OS- 130785
Delta Creek	XBD-110	Upland	1560 ± 60	1400–1530	NOSAMS	OS-140923
Klein Site, Upper Locus	XBD-362	Lowland	1256 ± 38	1170– 1280 (*p*=0.78); 1080–1160 (*p*=0.22)	University of Arizona	AA88629
Klein Site, Lower Locus	XBD-362	Lowland	560 ± 20	520–560 (*p* = 0.52); 600–630 (*p* = 0.48)	Beta Analytic	Beta-40143

**Calibrated with Calib 7.1 (Stuiver et al. 2019; Stuiver and Reimer 1993; Stuiver and Polach 1977)*

Notably, none of these sites have visible tephra associated with either late Holocene WRA event. Past researchers have suggested that the volcanic eruption associated with these tephra led to the Northern Dene/Athabascan transition witnessed across central Alaska and

Yukon and beyond the area directly impacted by the volcanic eruption (Mulliken et al. 2018). Therefore, the sites' location outside the immediate area of volcanic impact, as indicated by the absence of tephra, serves to test the proposed hypothesis that one or both of the WRA events impacted the broader region beyond the extent of the tephra itself (Potter 2008a). Moreover, these sites are within 100 km of both ashfall events (Figure 4.2), and thus representative of the WRA impacts in the area most likely to be affected outside of the ashfall (Dale et al. 2005). The Northern Dene/Athabascan transition, represented in technology, subsistence, and mobility, occurs beyond the ashfall extent of both events. Therefore, if a volcanic event suddenly led to these broader regional changes, they should be identifiable beyond the ashfall extent and certainly within areas immediately adjacent to the ashfall.

Excavation methodologies remained consistent during four seasons of excavation completed between 2016-2019 at each of the four sites considered. At each site, previous research determined the overall site size through systematic shovel testing at 10 m intervals (Robertson et al. 2013; Reuther 2013). I considered excavation data presented in reports and centered excavation blocks on activity areas identified through initial shovel testing. Within each block, every 1 x 1 m unit was excavated in arbitrary 5 cm levels and by 50 x 50 cm quadrants. Through this strategy, approximately 10% of the total site area was excavated at each site. Diagnostic materials and materials larger than 1 cm^2 in any dimension were three-point provenienced. All excavated material was screened through 1/8th inch hardware cloth and identifiable cultural material, such as bone, stone tools or debris, and metal, were recovered from the screen and catalogued by excavated level and 50 x 50 cm quadrant. During excavations, wood charcoal samples affiliated with cultural remains and/or paleosols were collected for additional chronological control. Additionally, detailed stratigraphic maps were recorded at the conclusion of excavations to contextualize archaeological occupations within soil development episodes. Carbon sampled during excavations was submitted to the National Ocean Sciences Accelerator Mass Spectrometry lab for AMS radiocarbon dating, unless otherwise noted. Resulting dates were calibrated to 2σ using Calib 7.1 and reported following standard conventions (Table 4.1; Stuiver et al. 2019; Stuiver and Reimer 1993; Stuiver and Polach 1977). Stratigraphic maps were digitized in Adobe Illustrator and are presented with chronological results. Artifacts were catalogued according to University of Alaska Fairbanks Museum of the North guidelines either at an archaeological lab on Fort Wainwright, Alaska or at the University of Michigan Museum of Anthropological Archaeology in Ann Arbor, Michigan.

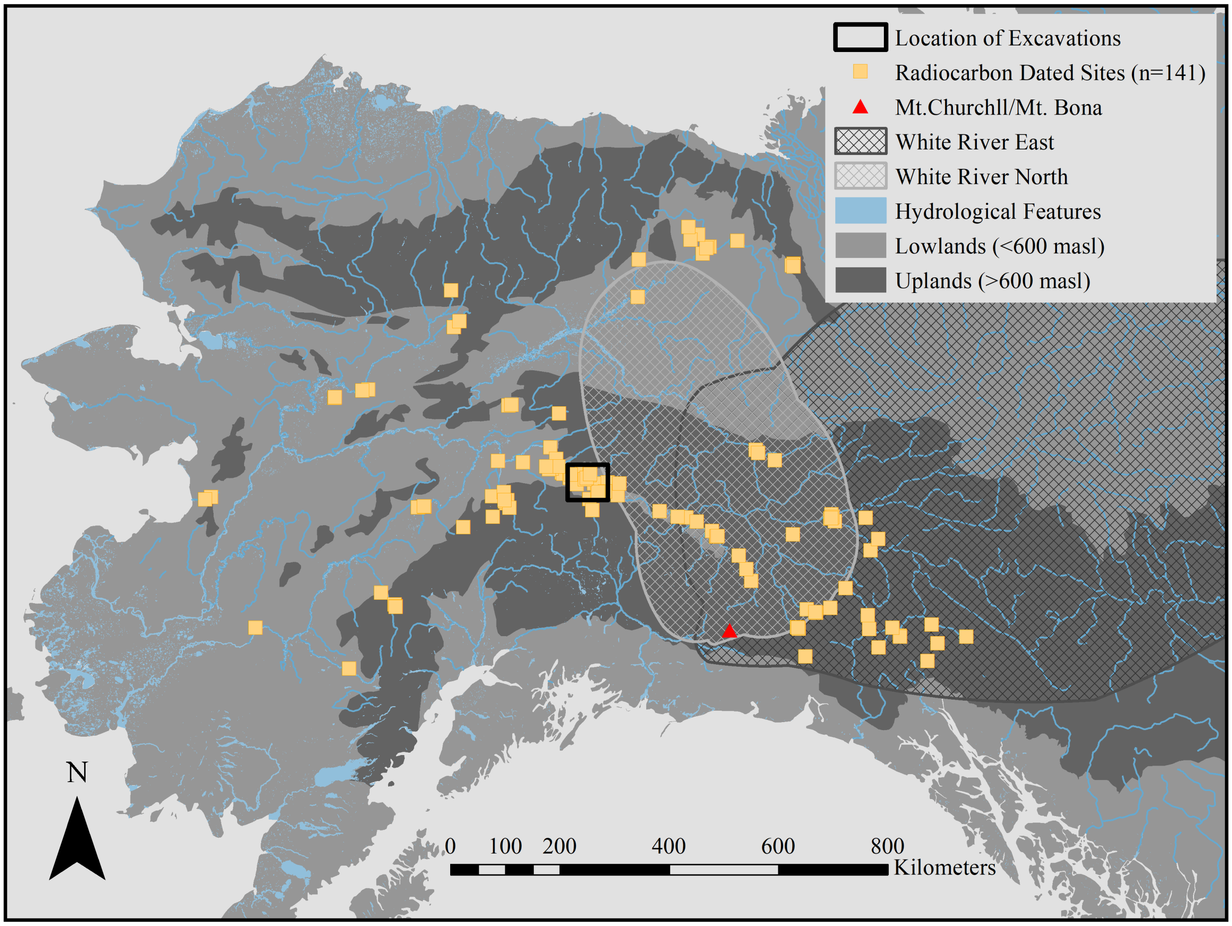


Figure 4.2 Location of excavations and distribution of the White River Ash North and East (Mulliken et al. 2018)

Clearview

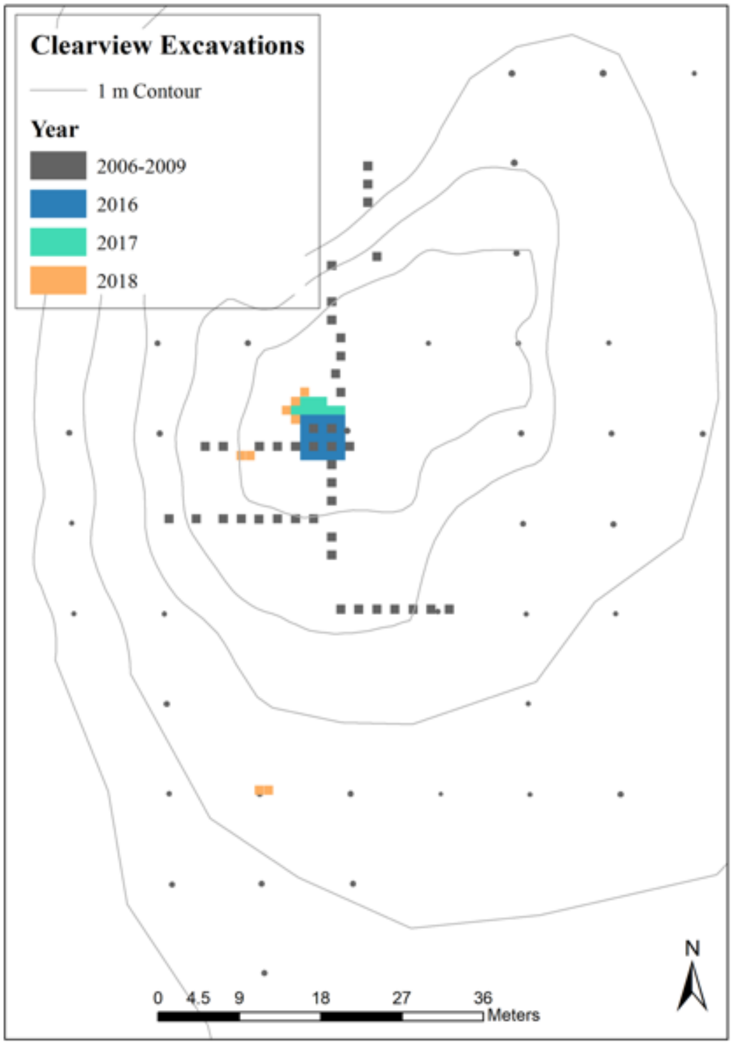


Figure 4.3 Overview of Excavated Areas at Clearview, 2006-2018

Clearview is located at an elevation of 460 masl on a small rise and so-named because of the site's exceptional 360º view of the Tanana Valley and Donnelly Dome to the south and west, the Granites to the Southeast, and the Yukon-Tanana Uplands to the Northeast. Banjo Lake and a small, unnamed lake lie to the north and south of the site, respectively. During excavations, moose (*Alces alces*) were frequently observed from the site, as were a variety of species of small game, such as hare (*Lepus americanus*), ptarmigan (*Lagopus* spp.), and ravens (*Corvus corax*). The site is currently cleared of vegetation for use as a military firing point, but a mixed spruce forest covered the landform prior to brush cutting operations. The site is on the perimeter of productive upland and lowland areas that offer a diverse array of resources from a unique vantage point.

Archaeologists affiliated with Colorado State University's Center for Environmental Management of Military Lands (CEMML) first identified Clearview in 2006 and recovered around 60 artifacts (UA2011-401), including 54 pieces of lithic debitage from three shovel test pits and four from the surface (Robertson et al. 2013). In 2009, CEMML archaeologists from excavated forty 1 m x 1 m test units to determine the site's extent (

Figure 4.3; Robertson et al. 2013). This additional testing resulted in the recovery of 649 lithic artifacts, including 24 diagnostic tools or tool fragments (UA2011-309). In 2016, I led a team of contract archaeologists who returned to Clearview to conduct additional testing as part of mitigation. These excavations expanded a previously excavated 1 m x 1 m test unit into a 5 m x 5 m block, based on artifact concentration. These excavations recovered 2,494 additional artifacts (UA2016-136), including numerous diagnostic tools and tool fragments and a thin charcoal lens that provided a secure radiocarbon date for the site's occupation (Table 4.2). Moreover, spatial distribution of artifacts recovered during these excavations provided clear evidence for separate lithic production areas within the central activity area, which guided the excavation strategy in subsequent years.

Table 4.2 Radiocarbon Chronology at Clearview

NOSAMS Lab No.	Northing	Easting	Depth Below Surface (cm)	^{14}C Age	Error	cal Years BP (2-sigma)
OS-130783	497.828	97.29	25	1250	40	1168 - 1278
OS-130784	501.467	97.015	15	1720	40	1545 - 1715
OS-130785	501.323	97.323	15	1540	30	1365 - 1524

OS-130786	501.37	97.268	15	1550	30	1377 - 1527

Excavations that I directed in 2017 and 2018 expanded upon the 5 m x 5 m central block excavation and increased testing at promising areas off the central activity area of the site. In 2017, excavations expanded on the area with highest lithic and charcoal concentration to map the shape of the lithic production area and resulted in the recovery of 1174 artifacts (UA2017-92). In 2018, excavations focused on areas away from the 5 x 5 m block to evaluate other potential loci of importance and resulted in lithic materials that contextualize previously excavated materials. These excavations recovered 167 additional artifacts (UA2018-71).

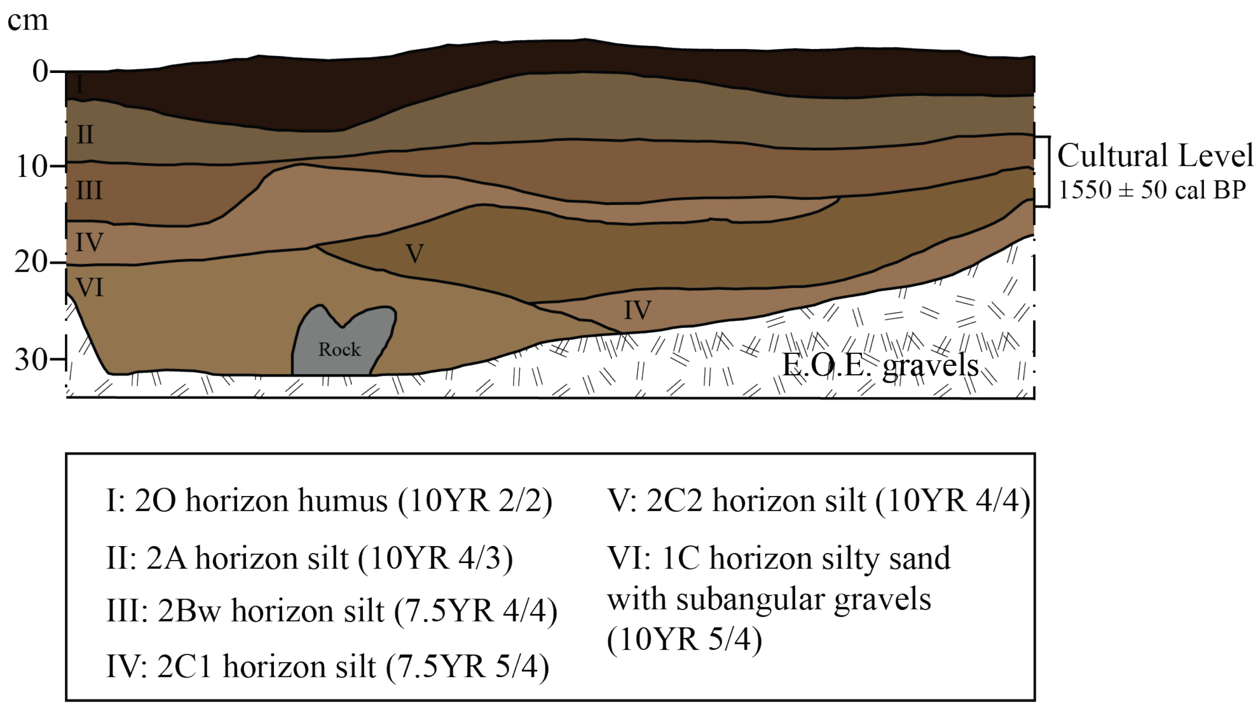


Figure 4.4 Stratigraphic Profile of Clearview N 502 E 98 N Wall

Macromorphological indicators suggest that Pleistocene glacial processes and Holocene aeolian activity shaped the parent material at the Clearview site. The sediments at Clearview can be organized into three primary stratigraphic units: glacial outwash, silts with evidence for at least two episodes of soil formation, and the organic humic mat (Figure 4.4). The deepest stratigraphic unit is comprised of poorly sorted glacial outwash, likely derived from subglacial eskers and kames (Reger et al. 2008). In 2009, excavations recovered no archaeological materials in this stratum and all subsequent excavations were terminated at contact with this stratigraphic unit, approximately 20–40 cm below surface.

Above the glacial deposit, a thick layer of silt is further divided into four horizons based on color with evidence of soil development, likely related to the succession of several coniferous boreal forests throughout the Holocene (Ping et al. 2008). Cultural materials primarily appeared in a weak B horizon (Bw) 10–20 cm below surface in the upper silt. Finally, Stratum I represents the humic mat of the organic horizon. Although some vertical mixing of artifacts may have occurred, disturbance to the stratigraphic integrity of the site appears minimal due to the vertical concentration of lithic material (Figure 4.5) and its association with a faint charcoal lens and/or paleosol ca. 10–15 cm below surface.

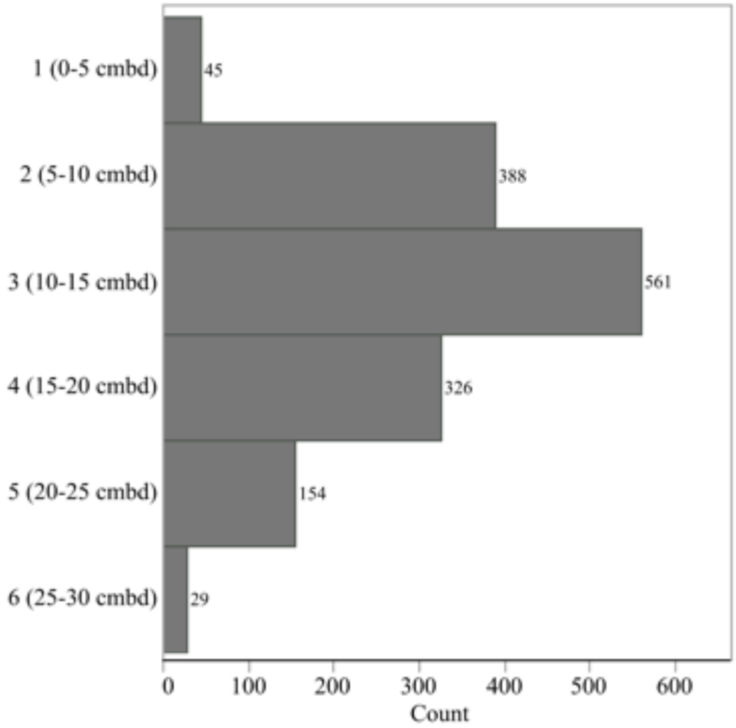


Figure 4.5 Vertical Distribution of Complete Flakes at Clearview

Delta Creek

The Delta Creek site is located on a large, steep, west-facing bluff approximately 25 m above the Delta Creek to the south of the middle Tanana River Valley at the foot of the Alaska Range. Summer Lake, a large, marshy lake on top of the bluff, is located 300 m east of the site. Vegetation at the site consists of several old growth needle (*Picea glauca*) and broadleaf species (*Populus balsmifera*, *Alnus* spp.) with a brushy understory of willow (*Salix* spp.), rose (*Rosa acicularis*), dogwood (*Cornus × unalaschkensis*), fireweed (*Chamaenerion augustifolium*), and delphinium (*Delphinium glauca*). Caribou (*Rangifer tarandus*) were frequently seen along the Delta Creek during excavations. Hares (*Lepus americanus*), birds of prey (e.g., *Falco peregrinus*), songbirds (e.g., *Poecile atricapillus*), and red squirrels (*Tamiasciurus hudsonicus*) were also regularly present, and migratory waterfowl such as swans (*Cygnus buccinator*) were often seen or heard on Summer Lake. Additionally, researchers collected several samples of fine-grained black and purple chert cobbles from the creek bed in 2018.

Several archaeologists have visited the Delta Creek site since it was initially identified by C. Holmes in 1978, who observed lithic and faunal material eroding out of the bluff face at approximately 1.15 m below surface (Holmes 1979:25; Bacon and Holmes 1980:64–71). During this visit, artifacts were collected from three exposed loci along the bluff face (UA78-476, UA79-479) and are documented in associated photographs, but no subsurface excavations were carried out. The site was revisited by B. Potter in 1998 and additional photos were taken documenting erosion of the bluff face (Higgs et al. 1999). No subsurface testing took place during this visit nor any artifact collection during this visit.

The first subsurface testing of the site took place in 2012, when archaeologists from CEMML visited the site to relocate the site's loci, determine the site's extent, evaluate the site for the National Register of Historic Places, and determine any potential impacts of a proposed winter road (Esdale 2012). Only two of the three loci originally described by C. Holmes were re-identified during this visit, though the third may be within a marmot or fox burrow complex meters to the northwest of Locus II (Figure 4.7). Nineteen shovel test pits were excavated at these two loci in 2012, resulting in four positive shovel tests along the bluff edge. Many of the shovel tests further from the edge were terminated at less than 50 cm below due to permafrost. One test unit was excavated to 100 cm below surface and yielded numerous flakes, and carbon was sampled from strata present in the exposed bluff face (UA2012-87).

In 2017, I directed the first full scale excavations at Delta Creek with a team of contract archaeologists. Excavation methods remained consistent during excavations in 2017 and 2018. In 2017, five north-south oriented 1 x 1 m test units were placed along the bluff edge at Locus II

(Figure 4.6). I centered these units in high probability areas based on previous site testing and profiles visible on the bluff edge, though the first cultural materials at the site are recovered more than 50 cm below surface and initial shovel tests may have terminated prior to this level, potentially affecting interpretations of activity concentrations across the bluff. After positively re-identifying Holmes' (1979) profile tests at Loci II and III, and tentatively identifying Locus I, tests were conducted primarily at Locus II in 2017-2018, with one additional unit placed at Locus III in 2018. All units were placed near exposed profiles that Holmes (1979) had sampled during the original identification of the site. All nine units excavated between 2017-2018 were positive. Five tools, 5431 pieces of lithic debitage, 757 faunal fragments, 33 carbon samples, two pieces of ochre, two tephra samples, and one piece of fire cracked rock were collected from four radiocarbon-dated components (UA2017-91, UA2018-70). At Locus II, all units were excavated to bedrock except most westerly test unit (Test 4), which terminated at 130 cm below surface in 2017. This unit contained a large krotovina or intrusive burrow and was not completed in 2018. The test unit at Locus III terminated at 85 cm below surface due to time constraints but charcoal was recovered in association with cultural material for future radiocarbon dating. In 2018, three additional 1 x 1 m units were added to Test Units 2, 3, and 5, and a 1 x 1 m test unit was established at Locus III. All units were excavated by 50 x 50 cm quad in 5 cm levels with a trowel when cultural material was present and 10 cm levels with a shovel between cultural components.

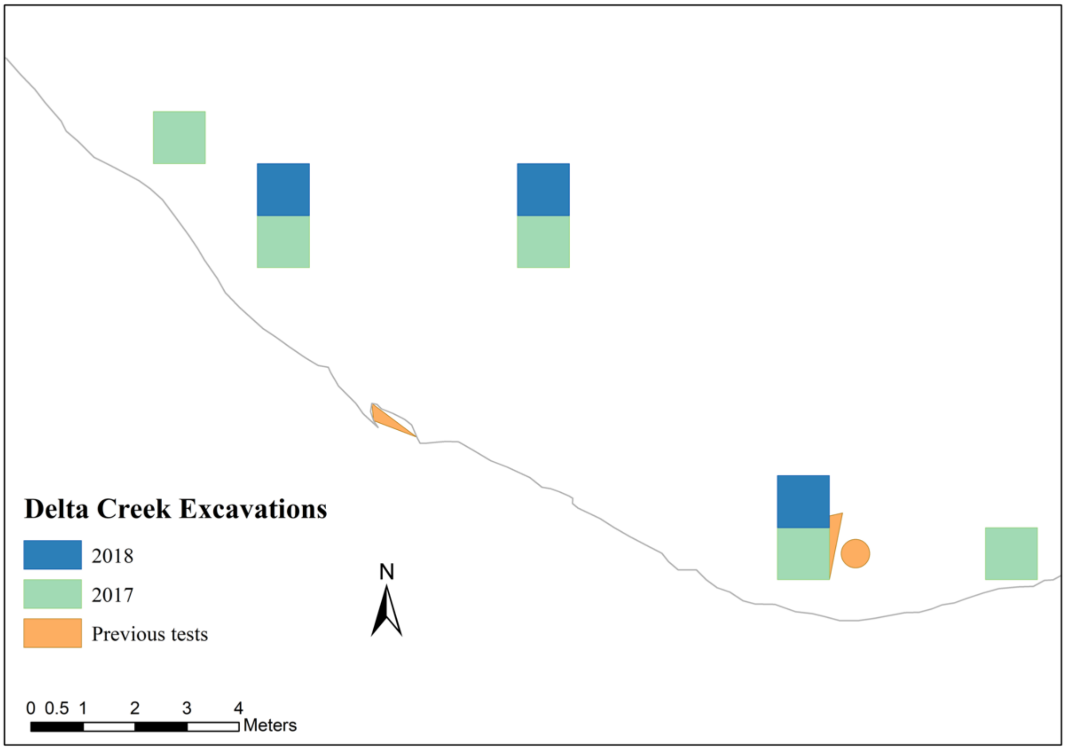


Figure 4.6 Overview of Excavated Area at Delta Creek, Locus II

According to the association between cultural materials and radiocarbon-dated charcoal, Delta Creek was occupied at least four times in the past (Table 4.3). Sampled radiocarbon suggests a terminal Pleistocene component dating approximately to 11,800 cal BP, an early Holocene component that dates to 9,300 cal BP, a mid-Holocene component that dates to 3,800 cal BP, and finally, a late Holocene component that dates to 1,900–1,500 cal BP. This last component will be the sole component considered here. All components contained both lithic and faunal materials at varying levels of preservation, faunal integrity decreasing with depth below surface. The late Pleistocene and early Holocene components have a diffuse boundary that was difficult to distinguish in the field but clearly delineated within three-point provenience information. Two later Holocene components were stratigraphically separated and clearly identified during excavations.

Table 4.3 Radiocarbon Dating Results from Locus II, Delta Creek

NOSAMS Sample ID	Northing	Easting	Depth Below Datum (m)	Unit Level	14C Age	Age Error	Calibrated Years BP (2-sigma)	Median Probability	Component
OS-140923	503.877	145.759	99.718	5	1560	25	1396-1526	1468	LH
OS-140924	497.188	150.156	99.231	6	1980	20	1884-1987	1927	LH
OS-140925	497.988	150.834	98.121	9	3520	30	3702-3876	3785	MH
OS-140900	497.09	150.228	98.568	11	8360	45	9273-9482	9384	EH
OS-144348	503.605	145.49	98.678	17	9970	80	11233-11756	11457	LP
OS-144346	498.866	150.429	98.53	16	10150	140	11268-12378	11784	LP
OS-144490	497.266	150.282	98.332	18	10200	45	11719-12095	11901	LP
OS-144349	497.088	150.405	98.333	18	10300	55	11831-12388	12098	LP

The deep loess deposits at Delta Creek are relatively consistent across three loci of the site with limited disturbance due to cryoturbation but significant bioturbation at certain localities. Macromorphological indicators suggest that late Pleistocene and Holocene aeolian activity shaped the parent material at the site. The sediments at Delta Creek can be organized into four primary stratigraphic units: decomposing bedrock, aeolian sands, loess with evidence for several episodes of soil formation, and humic mat (Figure 4.7). The deepest stratigraphic unit is a decomposing granulite bedrock. Above this bedrock layer lie approximately 30 cm of aeolian sands. The third stratigraphic unit consists of approximately 160–170 centimeters of loess with several episodes of petrogenesis (soil development) represented by stark color changes. Cultural materials are found throughout this unit. The late Pleistocene and early Holocene components are associated with buried forest soils. The mid-Holocene and late Holocene components are both associated with diffuse A/B horizons. Finally, a thick humic mat ranging from 5-15 cm in depth caps the stratigraphic sequence.

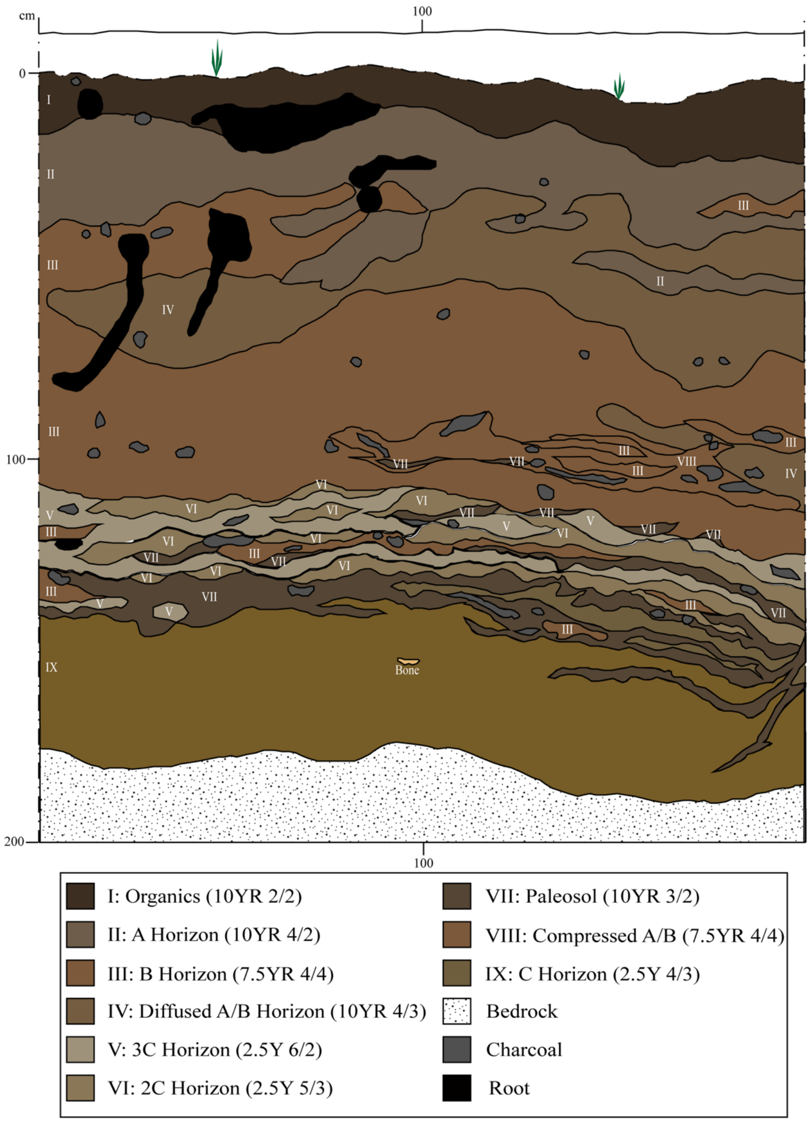


Figure 4.7 Stratigraphic Profile of Delta Creek N 504 E 140 East Wall

Caribou Knob

Caribou Knob sits on a finger ridge that overlooks a small marshy pond. The site is densely covered in a mixed spruce forest that moose (*Alces alces*), ptarmigan (*Lagopus* spp.), and hare (*Lepus americanus*) frequent. Waterfowl were also heard calling from the marsh below the lake. Caribou Knob was identified by contract archaeologists in June 2002 based on the recovery of two lithic flakes from the surface of the site(Hedman et al. 2003). Between 2008-

2009, contract archaeologists conducted subsurface testing at the site to determine the size and location of primary activity area(s) at the site. This entailed the excavation of 23 shovel test pits, each approximately 30–50 cm in diameter, and six 1 x 1 m test excavations (Figure 4.8). Only one shovel test and three of the test units produced archaeological remains, including a hearth and a dense concentration of lithic material identified in one test unit (Robertson et al. 2013). Over 2,600 bone fragments and 330 lithic tools and debris were collected during these excavations (UA2011-297).

In 2016, I led a team of contract archaeologists in the recovery of additional archaeological material from the central hearth area at Caribou Knob. During these excavations, three additional 1 x 1 m tests resulted in an additional 917 pieces of lithic debris (UA2016-137). No additional hearth material was recovered during these excavations. In 2017, five additional 1 x 1 m units were excavated to produce a 3 x 3 m grid around the hearth recovered from the site. These units produced an additional 461 lithic artifacts (UA2017-093).

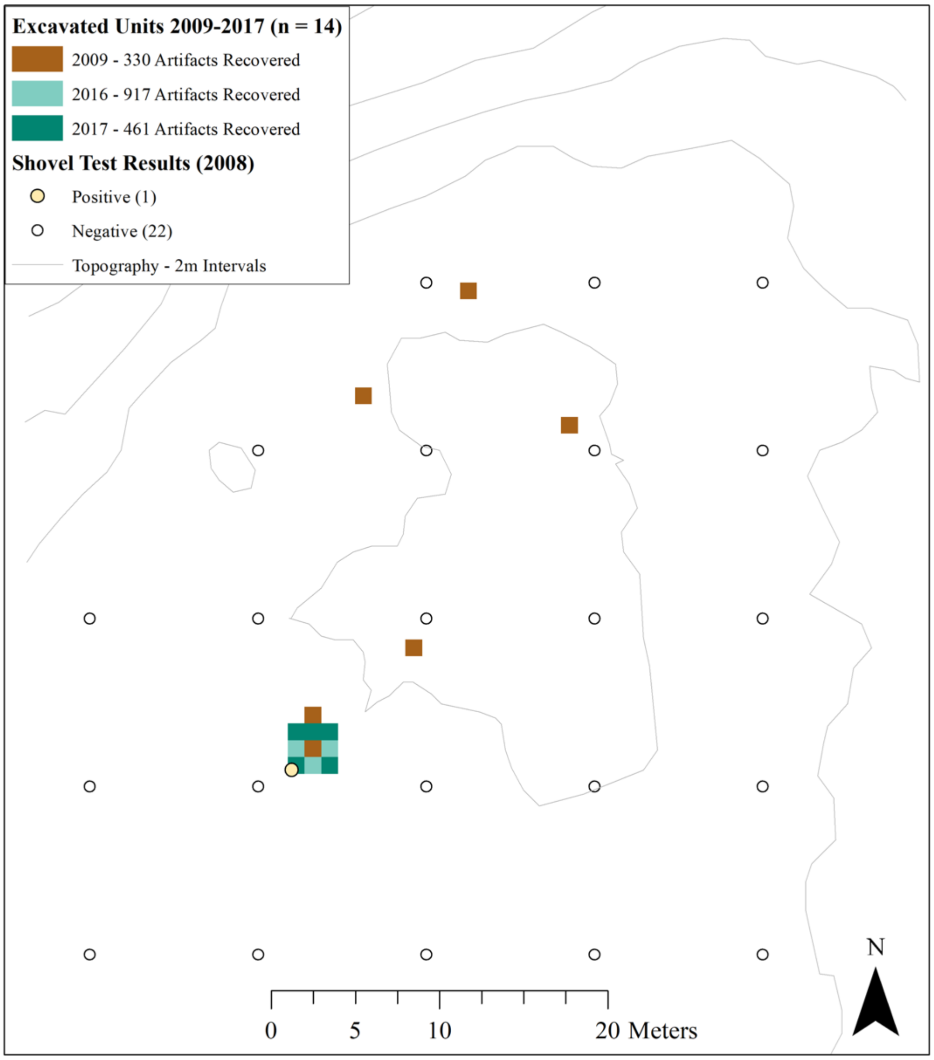


Figure 4.8 Overview of Excavations at Caribou Knob (2008-2017)

Macromorphological indicators suggest that Holocene aeolian activity as well as Pleistocene glaciations shaped the parent material at Caribou Knob. Further, its stratigraphic context is very similar to the neighboring Clearview and Banjo Lake sites (Esdale et al. 2015; Figure 4.9). The sediments at Caribou Knob can be organized into three primary stratigraphic units: glacial outwash, silts with evidence for several episodes of soil formation, and humic mat. The deepest stratigraphic unit ranged in depth from 20 to 60 cm below surface within the 3 x 3 m central excavation block and was comprised of poorly sorted glacial outwash, likely derived from subglacial eskers and kames (Reger et al. 2008). In 2009, excavations recovered no archaeological materials in this stratum and all subsequent excavations were terminated at contact with this stratigraphic unit. Above this glacial deposit lies a thick layer of silt that is further divided into four horizons with varying evidence of soil development based on color. This stratigraphic unit likely represents the succession of several coniferous boreal forests throughout Holocene (Ping et al. 2008). Cultural materials appeared within these silts, and primarily in a strong B horizon 5-10 cm below surface. Finally, Stratum I represents the humic mat. The stratigraphic integrity of the cultural materials recovered from this site is such that some vertical mixing of materials may have occurred.

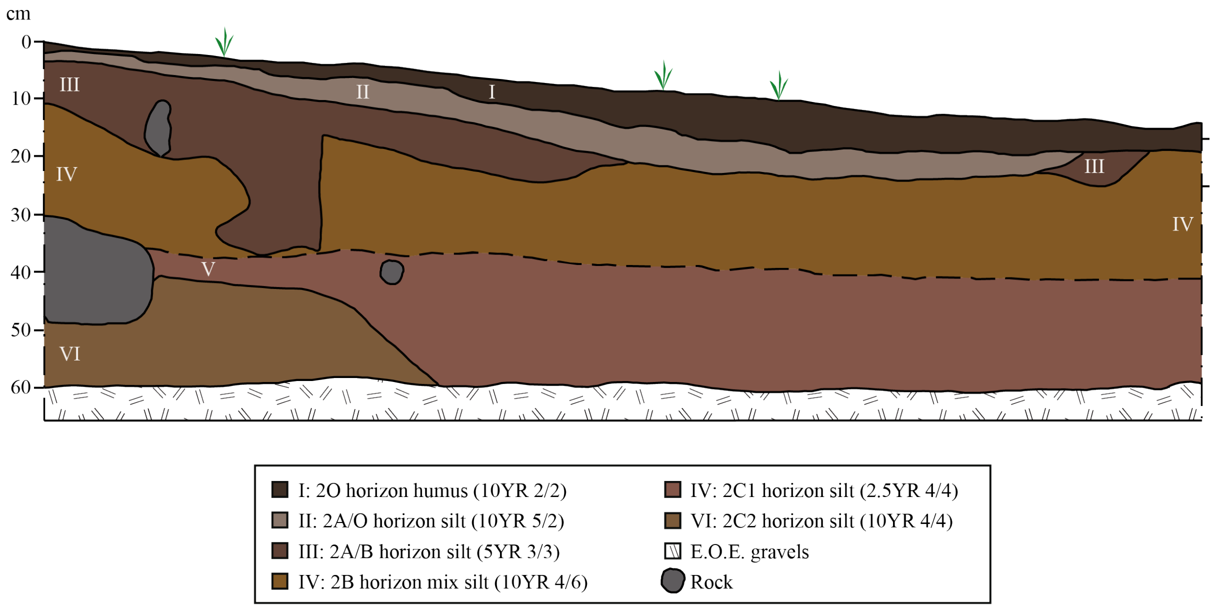


Figure 4.9 Stratigraphic Profile of Caribou Knob N 492 E 92 West Wall

Klein Site Upper and Lower Loci

The Klein Site is located on the northern shore of Quartz Lake on a prominent, southern-facing sand dune approximately 5 m above the lake shore and currently 100 m away from the lake edge, which is rapidly receding. Quartz Lake was likely fed by Shaw Creek or the flooding of the Tanana River on the western edge of the lake at various times in the past (Reuther 2013).

The Alaska Range is visible from the northern shore of the lake, as are the Yukon-Tanana Uplands. The northern shore of the lake is densely forested with a mix of white spruce (*Picea glauca*), black spruce (*Picea mariana*), quaking aspen (*Populus tremuloides*), and birch (*Betula papyrifera*), and an understory of soap berry (*Shepherdia canadensis*), artemisia (*Artemisia alaskana*), and wild rose (*Rosa acicularis*). Until the 1970s, when the lake was poisoned with rotenone to eradicate that lake's pike and foster a better environment for lake trout (Harvey 2009), Quartz Lake contained several species of fish, including northern pike (*Esox lucius*), sheefish (*Stenodus neima*), burbot (*Lota lota*), salmon (*Oncorhynchus* spp.), and whitefish (*Coregonus nelsonii*). As a consequence, current lake ecology is likely significantly different from historic conditions. Nevertheless, moose (*Alces alces*) and several species of migratory ducks (*Anas platyrhynchos*), geese (*Branta canadensis*), and swans (*Cygnus buccinator*) frequent the lake from the spring to late fall. In addition to moose, terrestrial fauna include black bear (*Ursus americanus*), grouse (*Falcipennis canadensis*), hare (*Lepus americanus*), and porcupine (*Erethizon dorsatum*). The lake's name derives from abundant milky quartz cobbles of various sizes found on the lake's western shores, and the Middle Tanana Dene name, Ttheech'el Menn', means "broken rock."

The Klein Site spans approximately 100 m in length and features two primary loci, Klein and Eicken, that have distinct stratigraphic sequences and occupations. The Klein locus at the Klein Site features two further sub-loci, distinguished as "upper" and "lower". These loci comprise at least three buried soils associated with several archaeological components (Reuther 2013: 352, 380). The upper locus is located further west on the dune and, as the name implies, is 5 m higher than the lower locus, located 50 m to the east. These loci feature similar soil development, with the exception of a large sand unit ca. 30 cm below surface at the upper locus, but radiocarbon dates associated with excavated cultural material suggest they were occupied at two different times during the late Holocene: the upper locus was occupied ca. 1,200 years ago and the lower locus was occupied ca. 600 years ago (Table 4.4).

Table 4.4 Radiocarbon Chronology of the Klein and Eiken Loci, Klein Site

Lab	**Lab #**	**Locus**	**Depth Below Surface (cm)**	**^{14}C Age (years B.P.)**	**Error**	**Cal BP (2 sigma)**
UGA	UAGMS#40143	Lower	10	560	20	520 – 560 ($p = 0.52$) 600 – 630 ($p = 0.48$)
UGA	UAGMS#20533	Lower	20	2200	30	2140–2315
Arizona	AA88631	Lower	40	2607	50	2500–2840
Arizona	AA88633	Lower	55	2933	40	2960–3240
Beta	Beta-283203	Lower	58	3460	40	3630–3840
Arizona	AA88630	Lower	73	3505	50	3640–3900
Arizona	AA88632	Lower	60	4122	40	4530–4820
UGA	UGAMS#12234	Lower	27	4500	25	5050–5290
Arizona	AA105233	Lower	60	7950	40	8650–8980
Arizona	AA88628	Upper	30	975	45	785–960
Beta	Beta-284830	Upper	65	1030*	40	800–1050
Arizona	AA88629	Upper	25	1256	40	1080–1280
Beta	Beta-283204	Upper	35	3390	40	3480–3820
Arizona	AA87561	Upper	50	3462	60	3570–3890
Arizona	AA87560	Upper	74	3930	70	4150–4570

*Chronological reversal associated with a vertical piece of preserved charcoal interpreted as a post

In 2008, Carol Gelvin-Reymiller identified the Klein Site through test excavations conducted with permission of the then-owner, David Klein (Gelvin-Reymiller 2011). From 2009-2012, Gelvin-Reymiller conducted additional testing at the site, including a line of shovel tests, with University of Alaska Fairbanks affiliates (Figure 4.10). Positive shovel tests were expanded into 1 x 1 m units and these tests established the occupational history of the upper and lower loci at the Klein Locus. In subsequent years, test units at the upper (2016, 2017) and lower locus (2014) were expanded to full scale excavation directed by Joshua Reuther at the University of Alaska Fairbanks. During these excavations, units were excavated by 50 x 50 cm quad in arbitrary 5 cm levels below surface with a trowel. Diagnostic material and material larger than 1 x 1 cm^2 were three point provenienced using a South Instrument Total Station.

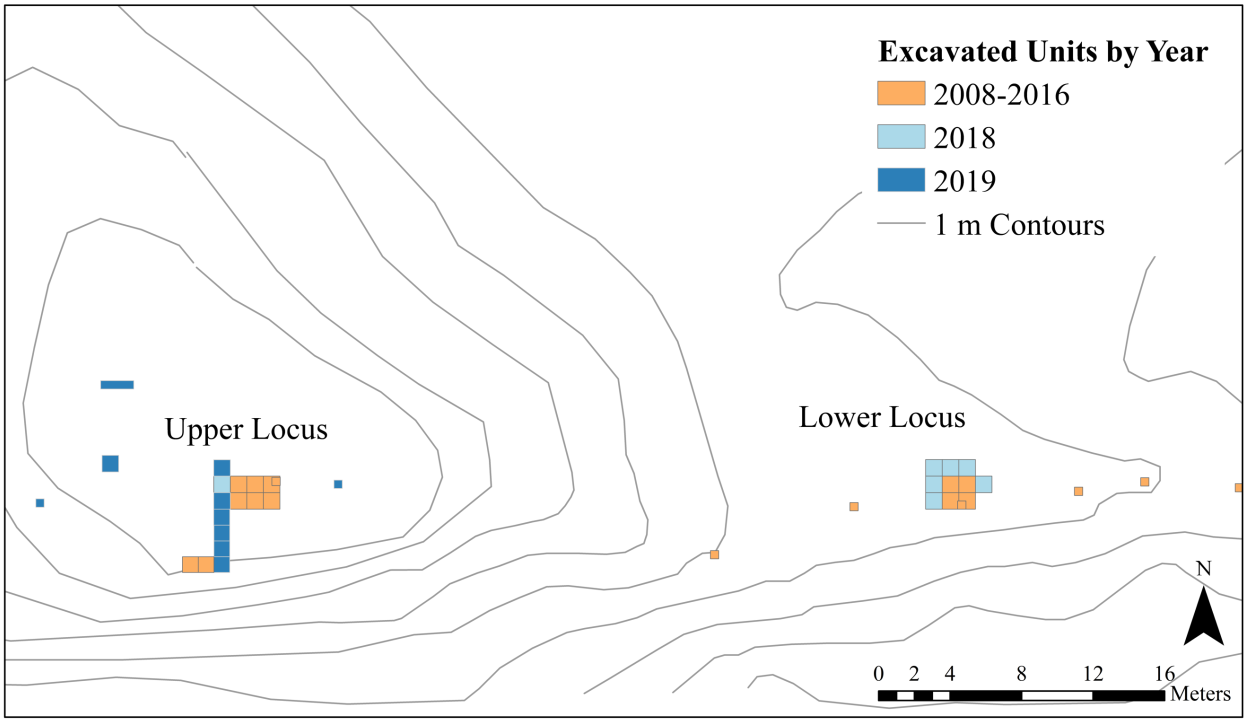


Figure 4.10 Overview of Excavations at the Klein Locus, Klein Site (2008-2019)

In 2018, I directed excavations at the lower locus of the Klein locus at the Klein Site to expand the excavation area and continue excavations of a hearth cooking feature (F2014-2) with University of Alaska Museum of the North affiliates and two undergraduate students from the University of Michigan. We expanded the excavated area to a 3 x 3 m block with a 1 x 1 m expansion from the cooking feature (F2014-1) and conducted additional testing at the upper locus to recover hearth materials associated with a feature recovered in 2017, subsequently named F2018-5. In 2019, I returned to the Klein locus to expand excavations at the upper locus with a team of researchers from Simon Fraser University, the University of Michigan, and the

University of Tübingen. We added a north-south 1 x 5 m trench onto the previously excavated 2 x 3 m block and excavated these units to the first layer of sterile sand that separates the late Holocene and mid-Holocene deposits (Reuther 2013: 374).

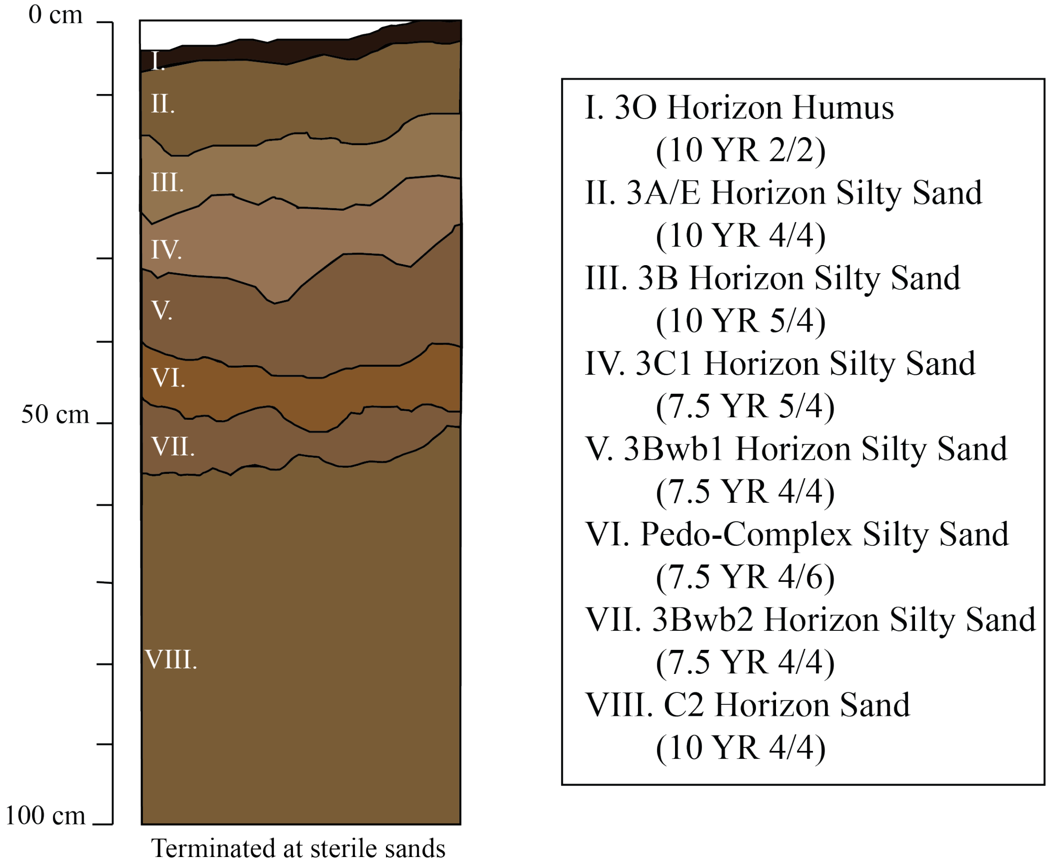
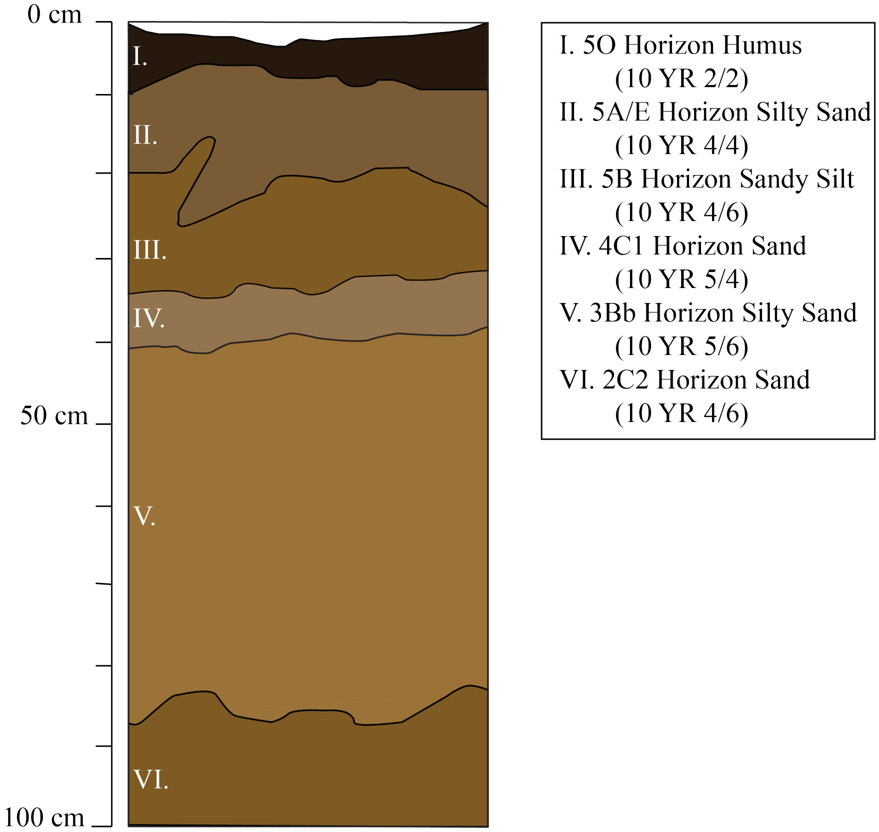


Figure 4.11 Stratigraphic Profile of Lower Locus, Klein Site N 500 E502 N Wall

The sediments at the Klein Site can be categorized into three lithostratigraphic units at the lower locus and five units at the upper locus (Figure 4.11, Figure 4.12; Reuther 2013: 377-8). At both loci, Unit I is composed of colluvium and bedrock an underlies Unit II, which consists of fine to medium sands that extend from the base of the sand dune to 60–90 cmbs. Unit III covers Unit II and consists of pedostratified loess that caps the dune sand (Reuther 2013: 376-378). Unit III features seven pedostratigraphic layers, including three buried soils. At the upper locus, a thin sand bed comprises Unit IV and is overlain by another loess layer, Unit V, and this sand bed was likely deposited between 2,500 and 1,280 cal BP (Reuther 2013: 381). Unit III and Unit V both feature one buried soil (Reuther 2013: 380).



Terminated at 240 cm below surface

Figure 4.12 Stratigraphic Profile of the Upper Klein Loci, Klein Site N 500 E 460 N Wall

Methods of Technological Analysis

Lithic Analysis

All excavated materials were analyzed at the University of Michigan Museum of Anthropological Archaeology following widely practiced identification methods (Andrefsky 2005, 2001; Esdale 2009). Tools and debitage were analyzed separately. All tools and tool fragments were weighed, and material type was assessed through comparison to tool stone types found in local drainages (e.g., Delta Creek). Finally, tools and tool fragments were analyzed in comparison to known tool types from central Alaska and distinguished into six broad technological categories: uniface, biface, burin, blade, microblade, and expedient tool (Potter 2016; Coutouly 2012; Holmes 2008; Shinkwin 1979).

The analysis of lithic debitage took place in three general phases. First, materials were counted, weighed, and cleaned with a soft brush when necessary. The raw material of each piece was identified through a visual analysis. Second, lithic pieces with an intact bulb of percussion, platform, and terminating edge were classified as complete, counted, and separated for further analysis. These complete pieces of debitage were individually weighed and assigned a size class on a base two scale, beginning at 1 cm^2. Next, these pieces were assessed individually for presence of cortex, heat treatment, and use-wear. Finally, each piece was assigned to one of thirteen production phase categories following Andrefsky (2001). General production phase categories distinguished between early reduction, bifacial reduction, unifacial reduction, and microblade reduction debitage. Early reduction flakes were further separated into primary decortication (> 50% cortex), secondary decortication (10–50% cortex), and interior flakes (0–10% cortex). Debitage related to bifacial reduction was separated into early thinning, late thinning, alternate, edge preparation, and bifacial pressure flakes based on morphometric attributes common to these diagnostic types. Similarly, microblade reduction debitage were distinguished into core face rejuvenation flakes, platform rejuvenation flakes, microblades, and core tablets.

Following this visual analysis of lithic materials, the results were compared using statistical methods to understand the variation between components regarding material type, tool type, and phase of production. Statistical comparisons were made using a Fisher's exact chi-squared test. This test offers a more robust assessment of significance than a standard chi-squared test of significance because it better accommodates comparisons between results with small sample sizes common to archaeological assemblages. Results with $p < 0.05$ are considered significant here.

Spatial Patterning

Following an analysis of the overall lithic assemblage, spatial data associated with the recovered artifacts from late Holocene assemblages with sufficiently large contiguous excavation areas (over 9 m^2) were considered in the horizontal plane. This analysis revealed the boundaries of artifact clusters, specific areas of activity across the site, and spatial relationships between raw materials and tool types. Two-dimensional spatial data was input into ArcGIS Desktop 10.6 as raster and point data. Raster data comprised lithic debitage, and point data comprised individual diagnostic tools and tool fragments. Artifact distribution was assessed based on raw material type, debitage category, and presence of cortex.

The results of this debitage analysis were further considered for spatial relationships between tool and raw material types present in the assemblage to determine clustering and activity areas. To identify underlying patterns in tool manufacture and use, debitage recovered from the central activity area was considered in two phases following methods standard in geospatial statistical analysis and artifact patterning (Flenniken 1978; Wandsnider 1996). First, two distinct activity areas, or centers of debitage production, were spatially designated through a *k*-means cluster analysis and debitage results were either attributed to one of these two spatial clusters or excluded from the analysis if they were outside these central activity areas. A *k*-means cluster analysis is limited because the user inputs the desired number of clusters, which introduces bias into the analysis. Therefore, results were compared across several analyses to identify the most relevant number of clusters for a given sample. Second, Fisher's exact tests were applied to assess differences in lithic production based on debitage type, phase, and raw material between these two activity areas.

XRF Analysis

Non-destructive x-ray fluorescence (XRF) analyses were conducted at the National Park Service Fairbanks Administrative Facility by Dr. Jeffrey Rasic using a portable Bruker Tracer III-V portable XRF analyzer (serial #510) equipped with a rhodium tube and a SiPIN detector with a resolution of ca. 170 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area of 7 mm^2. Methods follow those described by Phillips and Speakman (2009). Analyses were conducted at 40 keV, 15 µA, using a 0.076-mm copper filter and 0.0305 aluminum filter in the X-ray path for a 200 second live-time count. Ten elements were measured: Potassium (K), Manganese (Mn), Iron (Fe), Gallium (Ga), Thorium (Th), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), and Niobium (Nb). Peak intensities for these elements were calculated as ratios to the Compton peak of rhodium and converted to elemental concentrations using linear regressions derived from the analysis of 15 well-characterized obsidian samples analyzed by NAA and/or XRF and are reported in parts-per-million (ppm). Source assignments were made by comparing the composition of analyzed samples to a catalog of source samples. Correlations between artifacts and source signatures were considered meaningful when key elements fell within two standard deviations of mean source values (Hughes 1998).

Results

Excavations at the late Holocene components from Clearview, Caribou Knob, Delta Creek and Quartz Lake recovered over 5,000 artifacts related to technological production, including at least 8 tool types, over 3,000 pieces of identifiable debitage, at least 15 lithic raw materials, and three pieces of worked copper (Table 4.5, Figure 4.13, Appendix B). These results represented two ecological zones and span the Northern Dene/Athabascan transition, with material that dates to the period before and after the WRA east tephra that archaeologists have associated with a major shift in technological organization.

Table 4.5 Debitage Phase and Raw Material Counts by Site and Ecological Setting

Site/Locus	**Ecological Setting**	**Core Preparation**	**Early Bifacial**	**Late Bifacial**	**Microblade Reduction**	**Unifacial Reduction**	**Exotic Material**	**Local Material**	**Total**
Caribou Knob	Lowland	45	161	355	2	3	16	434	566
Klein Site, lower	Lowland	15	8	16	3	2	5	33	44
Klein Site, upper	Lowland	34	44	109	16	0	7	192	203
Clearview	Upland	144	520	662	85	11	8	1312	1422
Delta Creek	Upland	2	12	13	0	0	1	24	27

Two components from sites located in upland ecological zones were evaluated here: Clearview (XMH-1303) and Delta Creek (XBD-110). A technological analysis of Clearview, calibrated to 1,370 – 1,520 cal BP, yielded 1,477 diagnostic lithic artifacts, including 55 tools, tool fragments, and cores, made on at least 13 raw material types. Delta Creek, calibrated to 1,400 – 1,530 cal BP, yielded 27 diagnostic lithic artifacts made on at least four raw material types. Calibrated radiocarbon dates indicate that both of these sites pre-date the WRA east event. Faunal remains were limited from these sites, potentially due to poor preservation associated with boreal soils (Ping et al. 2008), and no bone technology was definitively identified among the faunal assemblages from these sites.

Figure 4.13 Representative Tools Recovered During Excavations of the Clearview (*) and Klein Sites (**)
Includes bifacial technology (a.-e.), copper scrap and awl (f., g.**), unifacial scrapers (h.**, i.-k.*, l.**), microblade cores (m.*, n.**, o.*), microblades (p.*), and expedient tools (q., r.**); Clearview artifact photos courtesy of Whitney McLaren.*

Three components from two sites located in lowland ecological zones were also evaluated: Caribou Knob (XMH-917) and both the upper and lower loci at the Klein Site (XBD-362). Caribou Knob, calibrated to 1,280 – 1,390 cal BP, yielded 568 diagnostic lithic artifacts made on at least seven raw materials, including one expedient scraper and one unifacial scraper fragment. The upper locus of the Klein Site has a calibrated age of 1,080 – 1,160 cal BP (p = 0.22) and 1,170 – 1,280 cal BP (p = 0.78; Reuther 2013) and yielded 209 diagnostic artifacts, including a copper awl, three expedient tools, two unifacial scraper fragments, and at least 11 raw materials. The lower locus of the Klein Site has a calibrated age of 520 – 560 cal BP (p = 0.52) and 600 – 630 cal BP (p = 0.48), and yielded 44 diagnostic artifacts, including one microblade core fragment, one unifacial scraper, one expedient flake knife, and at least six raw materials. According to the calibrated radiocarbon dates presented above, Caribou Knob and likely the Klein Site upper locus pre-date the WRA east event, while the Klein Site lower locus post-dates this event. Though faunal material was present in all three assemblages, no evidence for osseous technology was recovered, contrasting results of previous excavations at lowland sites (e.g. Dixthada) that recovered osseous technology (Shinkwin 1979).

Clearview

The assemblage from the upland Clearview site contains 55 tools, tool fragments, and cores. Both expedient and formal tools are present in the assemblage, including retouched flakes, projectile points, burins, microblades, blades, and unifacial scrapers. Over half of these are complete tools (56.4%), including expedient flake tools, burins, blades, and bifacial points and knives. The other items present in the assemblage are bifacial fragments (e.g. projectile point bases, tips) or microblade cores. The assemblage also contains 155 microblades, or linear flakes with dorsal arrises and/or use wear (Sollberger and Patterson 1983). Over 4,400 pieces of debitage were recovered during excavations at the Clearview site. Debitage, including both complete flakes and shatter or incomplete debitage, represents 86% of the total artifact assemblage. Pieces of debitage with intact platforms and identifiable bulbs of percussion, or complete flakes, represent 34% of the total flake assemblage (*n* = 1503).

Size and weight

Diagnostic debitage from Clearview's single occupation are small on average, with a mean weight of 0.71 g. Over three-quarters of complete debitage are smaller than 1 cm^2 (*n* = 1,177; 78.3%) and these have an average weight of 0.18 g. Artifacts measuring up to 2 cm^2 had an average weight of 1.42 g and comprised 20.1% of the total debitage assemblage (*n* = 302). Finally, artifacts measuring up to 4 cm^2 had an average weight of 18.39 g and comprised 1.6% of the assemblage (*n* = 24). In general, this assemblage was primarily comprised of small, thin pieces of debitage with a small number of large, thick pieces of debitage.

Raw materials

A visual analysis of color, grain size, and luster revealed at least 13 individual cobbles or material types used at this site. Of these, there were seven subcategories of semi-sedimentary chert or chalcedony, three subcategories of volcanic material, and two subcategories of metamorphic rock (Table 4.6). Within these subcategories, any additional variations in color and texture were determined to be too minimal to warrant additional meaningful subdivision. Additionally, only three artifacts in the assemblage demonstrated possible evidence of heat treatment, including coloration, heat fracture, or pot-lidding (Domanski and Webb 1992). This, combined with the absence of hearths at the site, indicates that these artifacts may have been heat treated offsite. The assemblage at Clearview shows that its inhabitants transported and used a diverse array of raw materials.

Table 4.6 Debitage Types at Clearview Sorted by Raw Material

Raw Material	Initial Core Reduction					Microblade Reduction				
	primary decortication	secondary decortication	interior flake	*n*	%	core face rejuvenation	platform rejuvenation	micro-blade	*n*	%
andesite	4	9	8	21	45.7			1	1	2.2
banded grey chert	1	1	3	5	11.4			9	9	20.5
black chert	4	13	34	51	8.3	1	3	80	84	13.6
brown chert								1	1	6.7
chalcedony		1	4	5	5.1	1	1	2	4	4.0
grey chert	9	7	25	41	7.9	1	2	29	32	6.2
obsidian								16	16	69.6
red chert			1	1	4.0					
rhyolite	1	3	14	18	2.4	2	1	17	20	2.6
quartz		1	1	2	28.6					
quartzite										
white chert										
Total	**19**	**35**	**90**	**144**	**6.6**	**5**	**7**	**155**	**167**	**7.7**

Raw Material	Bifacial Reduction							Unifacial Reduction		Total
	early thinning	late thinning	edge preparation	alternate	bifacial pressure	*n*	%	unifacial pressure	%	*n*
andesite	10	7	7			24	52.2			46
banded grey chert	15	7	1	1	5	29	65.9	1	2.3	44
black chert	218	129	78	20	31	476	77.0	7	1.1	618
brown chert	8	3	3			14	93.3			15
chalcedony	27	31	17	5	9	89	89.9	1	1.0	99
grey chert	123	160	69	34	57	443	85.5	2	0.4	518
obsidian	3	2			2	7	30.4			23
red chert	6	9	2	2	5	24	96.0			25
rhyolite	103	308	113	83	112	719	95.0			757
quartz	1	2	2			5	71.4			7
quartzite	2	1	1			4	100.0			4
white chert	4	3	2		1	10	100.0			10
Total	**520**	**662**	**295**	**145**	**222**	**1844**	**85.1**	**11**		**2166**

Local materials dominated the lithic assemblage from Clearview. Black chert, grey chert, and rhyolite comprised 85% of the assemblage. A short survey of Jarvis Creek, 2 km west of the site, resulted in the recovery of large cobbles of each of these materials. Previous material surveys suggest that these materials are also easily found in eroding glacial kames throughout the area. These sources are well within 20 km of the site, or a day's walk, and meet conventional definitions of local tool stone (Surovell 2009:78). Cortex present on primary reduction debitage appears to be cobble cortex, further indicating that these materials were collected from riverbeds rather than mined from geological sources. Based on the results of a comparative visual analysis, the overwhelming majority of raw materials used at Clearview are locally abundant.

Table 4.7 Results of pXRF Obsidian Sourcing

AOD Number	**AHRS No. (UA2016-136)**	**Element**											**Source**	**QA***
		K	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb		
11209	0513	71044	463	5567	23	20	27	177	5	35	83	19	Batza Tena	No
11210	0624	65125	491	5922	21	20	28	194	5	35	89	20	Batza Tena	No
11211	0625	55454	478	5773	40	21	28	189	4	36	80	19	Batza Tena	No
11212	0626	52604	247	7747	16	15	13	100	86	19	136	8	Wiki Peak	Yes
11213	0627	54826	427	6230	31	20	28	174	10	38	96	18	Batza Tena	No
11214	0644	58482	438	5969	37	19	26	179	10	33	91	17	Batza Tena	No
11215	0661	54662	559	6214	32	21	30	192	4	34	87	20	Batza Tena	No

*QA = Quantitative Assessment

The assemblage contains at least one raw material derived from a non-local source: obsidian. One obsidian microblade was conclusively sourced to Wiki Peak, located over 300 km to the southeast in the Wrangell-St. Elias Mountain range (Table 4.7). Seven additional microblade fragments were geochemically-sourced to Batza Tena, though these were all too thin for a confident quantitative sourcing assessment. Nevertheless, it is clear from these data that occupants of Clearview used obsidian from at least one distant source. Aside from obsidian, exotic or non-local materials within the assemblage could not be assessed with certainty. Other potential non-local materials include fine-grained red and white chert, chalcedony and jasper (Esdale et al. 2015).

Early stage core reduction

Early reduction debitage, identified by the presence of cortex on individual pieces, flake scars, and overall size, represented only 9.3% of the total assemblage. Only cobble cortex was identified in the assemblage, indicating that no materials were quarried from bedrock outcrops. None of these pieces were produced on exotic raw materials, and 80.7% were produced on rhyolite, black chert, or grey chert. Further, no cobble cores or tested cobbles were recovered during excavations at Clearview. Overall, early reduction debitage comprise a small part of the overall assemblage and these debitage were produced from local raw materials.

Bifacial technology

Bifacial knives, projectile points, and projectile point fragments represent approximately a third of the tools within the Clearview assemblage (32.7%). Over half of the bifacial technology in the assemblage is fragmentary, with only five complete bifaces (Appendix Figure A.1). Nevertheless, fragmentary and complete bifacial technology in the assemblage indicates that at least three styles of bifacial technology were used at the site: bifacial knives, lanceolate projectile points, and straight-based projectile points. Only two of the 18 bifaces or biface fragments were made on a potentially non-local chert. While the overall number of bifaces and biface fragments is relatively small compared to the overall assemblage, these data suggest that bifaces were made in a variety of forms using local materials.

In contrast, nearly three-quarters of intact debitage (74.8%) is related to the reduction of large flakes or blanks into bifaces, reflecting the importance of intermediate bifacial reduction at the site. However, bifacial pressure flakes, typically removed with soft percussion to sharpen or re-sharpen the edge of a biface were not common, represent only 12.0% of bifacial debitage. Additionally, the assemblage contains only one biface blank and no bifacial cores associated with early bifacial production. The lack of blanks and bifacial pressure flakes is surprising given the quantity of finished bifaces and biface fragments at the site and extensive evidence for intermediate bifacial reduction in the debitage assemblage. Finally, very few pieces of intact bifacial reduction debitage are of a non-local material (6.0%) in contrast to microblades and related debitage (see below), reflecting general trends for raw material use observed in bifacial tool fragments recovered from the site. In sum, the evidence from bifacial tools and debitage suggests that the intermediate bifacial reduction of local materials was the primary activity undertaken at Clearview.

Blade technology

Three microblade cores or core fragments, three blade fragments, and 155 microblades are present in the assemblage from Clearview (Appendix Figure A.2). However, no microblade core tablets or blade cores were recovered. The three microblade cores recovered at Clearview are all consistent with a wedge-shaped style that is common in Alaskan assemblages from the mid- to late Holocene (Coutouly 2012). Two cores were made on biface fragments and one was made on a large flake, suggesting that the use life of raw materials at Clearview was extended by converting spent bifaces into microblade cores. Further, several crested blades in the assemblage provide additional evidence that microblades were commonly made on expended bifaces or biface fragments (Appendix Figure A.2). This style is common in the small number of Alaskan assemblages containing microblades that have been dated to the late Holocene (Holmes 2008). While incomplete, evidence of the microblade reduction sequence appears permissive of prolonged tool stone use and is particularly well-suited to conserving rare or non-local raw materials.

Raw material use, indicated by the microblades, blades, and cores in the assemblage, further indicates that microblade production served to conserve rare raw materials. Two of the three microblade cores are made from potentially non-local or locally rare red chert and agate, and the third is made of rhyolite. Three blade fragments were recovered from Clearview, two of which refit and have evidence of retouching. These blades are nearly 2 cm wide and significantly larger than the microblades in the assemblage, and no cores or core fragments were recovered, suggesting that these finished blades were brought to the site. All three fragments are made from chert, though the two refitting and retouched fragments are the only examples of dark red fine-grained chert in the assemblage. This indicates that this material may be locally rare or exotic.

Microblades and debitage related to microblade production were present but not abundant in the overall assemblage (11.0%). This may indicate that bifacial production was significantly more important than microblade production. However, smaller microblades and microblade fragments may have been lost in the 1/8th inch screen that was employed during excavations, and thus the excavated lithic assemblage may underestimate the relative importance of microblade technology to Clearview's occupants. Further, debitage related to microblade production contains many exotic pieces (12.1%) including fifteen pieces of obsidian, one of which was confidently sourced to Wiki Peak. The results of a Fisher's exact test that compared the use of exotic and local materials in the production of bifacial and microblade technology was significant ($p = 0.01$), indicating that the difference between the use of these raw materials varied significantly between biface and microblade reduction. Further, the presence of several crested blades and two cores made on biface fragments suggest that microblades were made on expended bifaces or biface fragments. Combined, raw material and morphological evidence from the assemblage indicates that microblade production served to increase the use-life of rare tool stone.

Other technologies

Unifacial scrapers and fragments represent 20% of the overall tool assemblage. Of these, all but two of these appear to be used primarily as end scrapers, with two expedient scrapers, one of which has cortex (Appendix Figure A.3). Unifacial technology at Clearview exhibits a great degree of flexibility, with both formal and informal reduction sequences. Additionally, two unifacial tools appear to be a composite end scraper and shaft straightener (Appendix Figure A.3). Locally available raw materials such as grey and black cherts form the overwhelming majority of unifacial technology at Clearview, though there are two complete chalcedony end scrapers present in the assemblage as well. This indicates that bifacial technology and unifacial technology raw material use strategies were approximately equivalent at Clearview.

Complete pieces of debitage linked to unifacial production represented a very small part of the overall debitage assemblage (0.7%) in contrast to the number of unifacial tools and tool fragments recovered (n = 11) during excavations at Clearview. The low number of intact debitage related to unifacial production may relate to the difficulty of distinguishing between bifacial and unifacial debitage, particularly pressure flakes, and the short reduction sequence of unifacial tool technology (Esdale 2009). However, this may also indicate that unifacial tools were used at Clearview but not produced on the same scale as bifacial or microblade technology.

The assemblage contains three transverse burins and five burin spalls that were most likely generated through burination. While all three burins were made from locally abundant raw materials, the burin spalls comprised red and white cherts that may be less abundant or exotic to the region. With such a small sample, it is not possible to determine whether this difference in raw materials represents a significant difference in material use between different technologies. However, burin production certainly employed a variety of raw materials.

Finally, utilized and retouched flakes likely used as expedient tools, represent 23.6% of the tools at Clearview. These may have been used as flake knives during the occupation of the site, and all were made on locally available raw materials, including rhyolite, black chert, and grey chert. Utilized flakes are typically made from larger waste flakes generated through bifacial and core reduction and it not surprising that they would be made from more abundant local materials.

Spatial distribution

The spatial relationship between artifacts was considered in two phases after data was compiled in ArcGIS Desktop 10.6. First, activity areas were established using a cluster analysis, and second, significant differences between these activity areas were analyzed through a series of Fisher's exact tests. A series of *k*-means cluster analyses of tools, raw materials, and complete debitage conducted in R Studio showed two likely activity areas (Figure 4.14). This indicates that one or several individuals produced tools in these locations during the occupation of the site around 1,500 years ago.

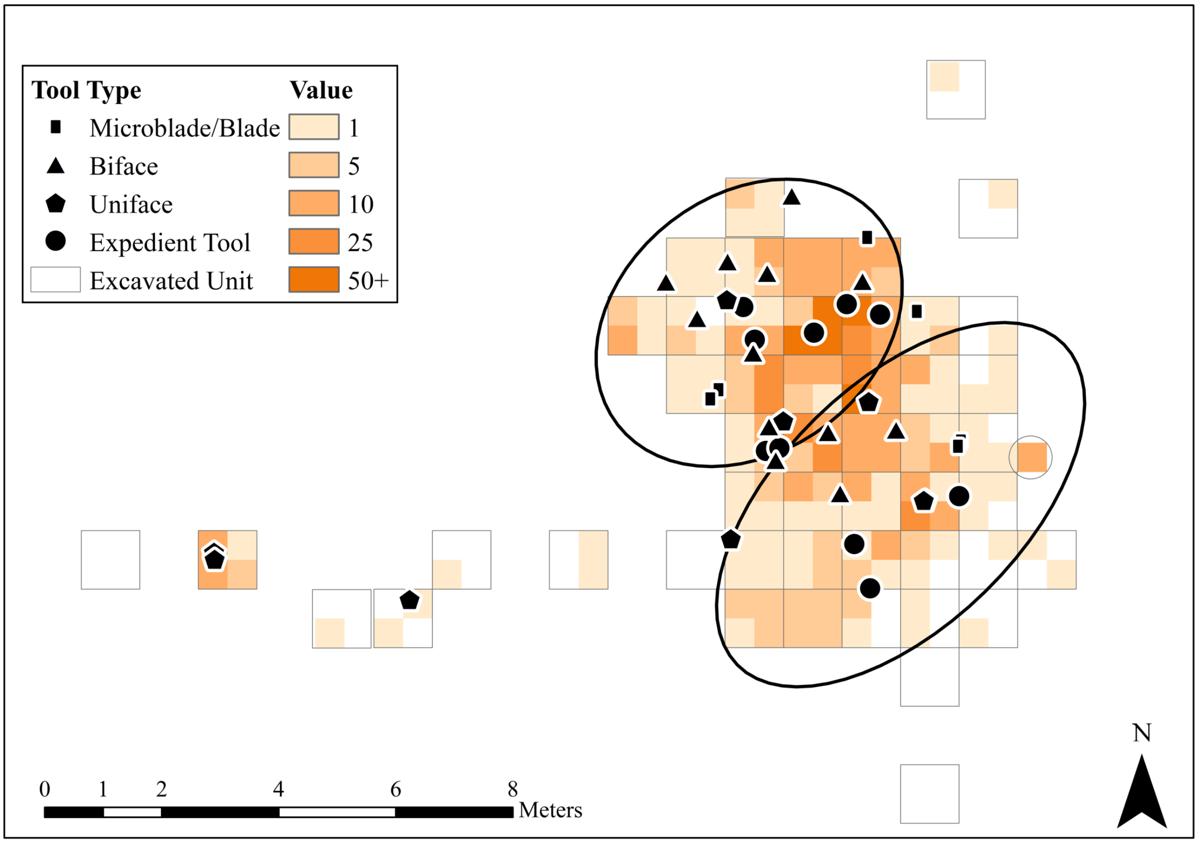


Figure 4.14 Artifact Distribution and Clusters within Central Activity Area at Clearview

Comparisons between prevalent raw material and tool types were considered in these two activity areas to determine whether any significant differences in tool production existed between them. The quantities of microblade and bifacial debitage in the two areas are not significantly different ($p = 0.49$) indicating that both tool types were produced in similar frequencies in both areas (Figure 4.15). Further, early and intermediate bifacial reduction also appear to take place in both areas ($p = 0.55$). However, early and late bifacial reduction occurred in different rates in the two clusters ($p = 0.044$) with slightly higher rates of late bifacial reduction in the smaller southern cluster. Nevertheless, these results indicate that reduction strategies were diverse and broadly similar in both activity clusters.

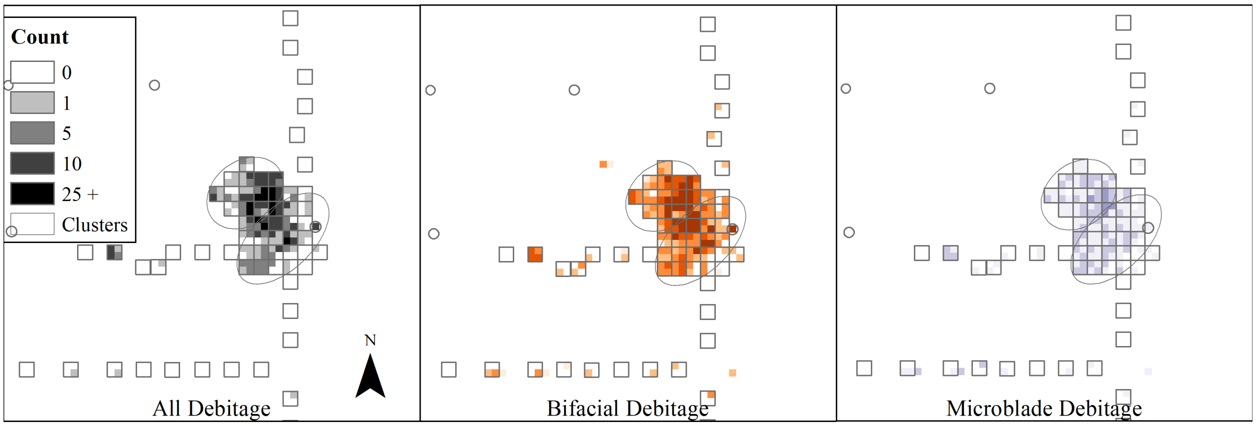


Figure 4.15 Distribution of Bifacial and Microblade Debitage at Clearview

In contrast to technological organization, raw material use varied significantly between the two areas. Black chert and rhyolite appeared in significantly different quantities in the two areas ($p < 0.001$), and black chert and grey chert were also spatially distinct ($p < 0.001$; Figure 4.16). Interestingly, local and non-local materials were not significantly spatially segregated ($p = 0.09$) indicating that non-local materials were processed in both areas. These results suggest that tool production at Clearview was not structured by tool type, and activity areas varied far more by local raw material used. The variability in raw material use also reinforces the clusters analyzed in this sample. A diverse array of stone tools was produced at both loci within the central activity area with the material that inhabitants had on hand for stone tool production.

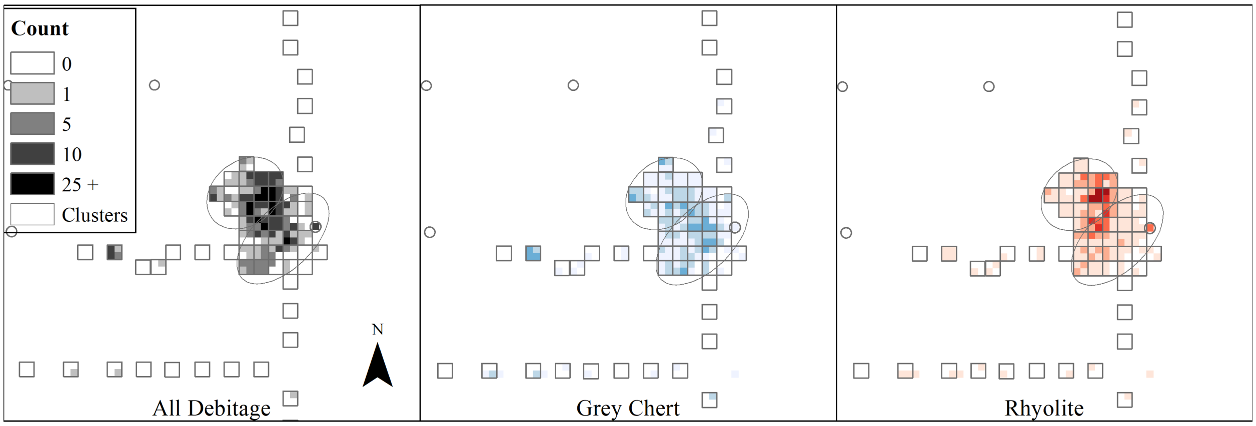


Figure 4.16 Distribution of Grey Chert and Rhyolite Debitage at Clearview

Delta Creek

The Delta Creek assemblage is small but suggestive of trends in upland technology curation and use. In terms of formal technology, only one microblade was recovered during excavations of the late Holocene component of the upland Delta Creek site (occupied ca. 1,900–1,500 cal BP). However, 27 complete pieces of diagnostic debitage were subjected to diagnostic analysis and provide additional evidence for potential use of exotic materials (chalcedony, red chert), for bifacial manufacture, and for early reduction and core preparation (Table 4.8). Debitage related to bifacial reduction represents the majority of lithic materials from this component (81.4%) and debitage related to early reduction comprises the remaining 18.6%. Only 27 pieces of diagnostic debitage were recovered from the late Holocene component at Delta Creek, compared with 617 diagnostic pieces from the early Holocene component, indicating that the last occupation of Delta Creek was likely associated with short-term use related to bifacial manufacture and retouch.

Size and weight

Diagnostic debitage from Delta Creek's late Holocene occupation are small on average, with a mean weight of 0.43 g. Nearly 90% of complete debitage are smaller than 1 cm^2 (n = 22; 89%) and these have an average weight of 0.28 g. Of all evaluated assemblages, this was the highest average weight for the first size class (<1 cm^2). Artifacts measuring up to 2 cm^2 had an average weight of 1.52 g and comprised 7.4% of the total debitage assemblage (n = 2). Finally, only one piece of diagnostic debitage was larger than 4 cm^2 and this piece weighed 1.96 g. This small assemblage features predominantly small, thick pieces of diagnostic debitage.

Raw materials

A visual analysis of color, grain size, and luster revealed at least four individual cobbles or material types used at the late Holocene component at Delta Creek. All were categorized as sedimentary cherts. Black chert comprises the overwhelming majority of lithic raw materials from this component (70.3%), followed by chalcedony (18.5%). Only two pieces of diagnostic debitage made on grey chert and only one piece of diagnostic debitage made on red chert were recovered during excavations. Three local raw materials and one possible exotic raw material are present in the late Holocene assemblage. Grey chert and black chert were likely both locally sourced, as these materials are abundant within the Delta Creek drainage that runs along the southern edge of the site. However, archaeologists and geologists have failed to find red chert and chalcedony in neighboring drainages, suggesting that these materials were procured from exotic locales through long distance movement or trade. Indeed, chalcedony is only represented in one other component at Delta Creek (early Holocene) by one diagnostic flake, and no red chert was recovered from any of the other three components at Delta Creek. This suggests at the very least that these raw materials were locally rare if not exotic to the area. Notably, the component most abundant in exotics from the Delta Creek site is the late Holocene component.

Table 4.8 Late Holocene Debitage Types at Delta Creek Sorted by Raw Material

	Early Reduction					**Bifacial Reduction**							
Raw Material	primary decort.	secondary decort.	interior	*n*	%	early thin.	late thin.	alternate	edge prep.	bifacial pressure	*n*	%	**Total**
black chert			2	2	40.0	1	6	5	4	1	17	77.2	**19**
chalcedony				0	0					2	2	0.9	**2**
grey chert		1	1	2	40.0		2		1		3	13.6	**5**
red chert		1		1	20.0						0	0	**1**
Total	**0**	**2**	**3**	**5**	**18.5**	**1**	**8**	**5**	**5**	**3**	**22**	**81.4**	**27**

Early stage core reduction

Early reduction debitage, including primary decortication, secondary decortication, or interior cobble flaking, represents 18.5% of the total debitage assemblage. Cobble cortex was only identified on two secondary decortication pieces, suggesting that the inhabitants of Delta Creek gathered their raw materials from local glacial deposits or riverbeds, and knappable material is abundant in Delta Creek today. Further, no cobble cores or tested cobbles were recovered during excavations at the site. Based on this assemblage, early reduction was not central to lithic production at Delta Creek during the late Holocene and potentially took place in nearby cobble sources such as the Delta Creek itself.

Bifacial technology

At Delta Creek, the majority of late Holocene debitage recovered during excavations relates to bifacial reduction (81.4%), with no other diagnostic technologies identified through the typological analysis of artifacts. No complete bifaces were recovered within this component, so it is unfortunately impossible to describe trends in bifacial style. However, the majority of debitage relates to intermediate (52.9%) bifacial reduction, followed by early (31.8%) bifacial reduction. Only one piece of diagnostic debitage relates to late stage bifacial reduction, suggesting that the late Holocene inhabitants of Delta Creek focused on the reduction or preparation of biface blanks with only minor retouching performed on site. A focus on early and intermediate reduction may relate to the site's proximity to plentiful knappable sedimentary cobbles in Delta Creek.

Blade technology

One black chert microblade was recovered from the late Holocene component during excavations at Delta Creek (Appendix Figure A.4) that exhibited both a dorsal arise and usewear on its edges. No other debris related to microblade reduction was recovered during excavations that could indicate the style of microblade manufacture at the site. Additionally, it is unclear whether microblade cores were produced on biface fragments at this occupation, as they were at Clearview. However, this artifact does suggest that microblade technology was used alongside bifacial technology at this upland site during the late Holocene. Additional testing should be conducted at the site to better understand how bifacial and other technologies were used in upland locations during the late Holocene.

Caribou Knob

The lowland Caribou Knob assemblage contains one tci-tho, or expedient scraper tool, one unifacial scraper fragment, one biface fragment, three utilized flakes, one microblade, and 1695 pieces of lithic debris, including both shatter and intact debitage comprising at least seven raw material types (Appendix Figure A.5, A.6). The debitage analysis conducted on this assemblage suggests that a variety of formal tools were produced and/or utilized at the site, including unifacial tools, microblades, and extensive evidence for bifacial production. Of the lithic material present, 566 pieces were determined to be complete debitage (i.e., pieces of debris with an intact platform and identifiable bulb of percussion). The assemblage is oriented towards late stage reduction and retouch of bifacial tools with limited evidence for microblade and unifacial technology.

Size and weight

Lithic artifacts within the Caribou Knob assemblage are small on average, with a mean weight of 0.22 g, the lightest of all the late Holocene assemblages considered here. Over half of all pieces of complete debitage are smaller than 1 cm^2 (n = 358) and these have an average weight of 0.05 g. Artifacts measuring 2 cm^2 had an average weight of 0.28 g and comprised

33.0% of the total debitage assemblage. Finally, artifacts measuring larger than 4 cm^2 comprised only 3.7% of the total assemblage and weighed an average of 2.6 g. This suggests that Caribou Knob was oriented towards late stage tool production or retouch as opposed to initial reduction or the manufacture of tool blanks.

Raw materials

A visual analysis of color, grain size, and luster revealed at least seven individual cobbles or material types used at this site (Table 4.9). Of these, there were six subcategories of sedimentary chert, jasper or chalcedony, and one type of volcanic material. Of these, eight pieces of debitage made from jasper had evidence for heat treatment, such as potlidding, heat fracturing, and/or change in coloration, and an additional 119 pieces of shatter (i.e., flakes with no platform) showed demonstrable evidence for heat treatment. The close proximity of the hearth to these artifacts (ca. 50 cm) suggests that they were heat-treated on site.

Table 4.9 Debitage Types at Caribou Knob Sorted by Raw Material

Raw Material	**Early Reduction**					**Bifacial Reduction**						
	primary decortication	secondary decortication	interior	*n*	%	early thinning	late thinning	alternate	edge preparation	bifacial pressure	*n*	%
black chert	4	4	15	19	42.2	7	110	38	64	147	366	70.9
brown chert									1		1	0.2
chalcedony		3	1	4	8.9	1	2	3		1	7	1.4
grey chert		3	3	6	13.3	2	9	2	6	15	34	6.6
jasper		5	1	6	13.3	1	2	2	3	2	10	1.9
red chert		3	7	10	22.2	2	24	3	26	35	90	17.4
rhyolite							1	1	1	5	8	1.6
Total	**4**	**14**	**27**	**45**	**8.0**	**13**	**148**	**49**	**101**	**205**	**516**	**91.2**

Raw Material	**Microblade Reduction**				**Unifacial Reduction**			**Total**
	core tablet	micro-blades	*n*	%	unifacial pressure	*n*	**%**	
black chert					1	1	33.3	**386**
brown chert								**1**
chalcedony								**11**
grey chert								**40**
jasper								**10**
red chert	1	1	2	100.0	2	2	66.7	**104**
rhyolite								**8**
Total	**1**	**1**	**2**	**0.4**	**3**	**3**	**0.5**	**566**

Black chert is the dominant raw material in the assemblage and represents 68.2% of the intact debitage at Caribou Knob. Other dominant material types are red chert (18.4%) and grey chert (7.1%). Red chert was distinguished from jasper on the basis of texture and translucence, with red chert evincing a waxy, opaque texture and small grain size. Contrastingly, red or orange jasper pieces were semi-translucent with a grainy texture similar to chalcedony. The remaining raw materials (rhyolite, brown chert, jasper, and chalcedony) make up less than 10% of the debitage in the assemblage. Black chert, grey chert, and rhyolite can all be found in local drainages within 20 km of the site today and there are no definitively non-local raw materials in the Caribou Knob assemblage (Esdale et al., 2015).

Early stage core reduction

Early reduction debitage, including primary decortication, secondary decortication, or interior cobble flaking, represents only 8.0% of the total debitage assemblage. Cobble cortex was only identified on four primary and four secondary decortication pieces, suggesting that the inhabitants of Caribou Knob gathered their raw materials from local glacial deposits or riverbeds. Further, no cobble cores or tested cobbles were recovered during excavations at Caribou Knob. Based on this assemblage, early reduction was not central to lithic production at Caribou Knob and potentially took place at nearby cobble sources such as Jarvis Creek situated approximately 3 km away.

Bifacial technology

The vast majority of debitage (91.2%) is related to bifacial production. It is impossible to determine which bifacial styles were produced at Caribou Knob because no complete bifaces or biface fragments were recovered during excavations. However, bifacial reduction was primarily related to late stage reduction or re-sharpening (39.7%), followed by early (31.2%) and intermediate reduction (29.0%) of biface blanks. Given the preponderance of bifacial pressure flakes in the assemblage, it is possible that some edge preparation flakes may have been generated through the re-sharpening of existing bifaces. Additionally, late thinning flakes are much more abundant than early thinning flakes, suggesting that biface blanks were prepared elsewhere and brought on site for the final stages of preparation and use. In terms of raw materials, black chert represents the primary tool stone used in bifacial production (70.9%), followed by red chert (17.4%). Overall, data from the intact debitage in the assemblage suggests that late stage bifacial reduction on black chert blanks was the predominant lithic activity undertaken at Caribou Knob.

Other technologies

Evidence for the production of microblade and unifacial technologies was recovered during excavations. One microblade core tablet and one microblade identified during the debitage analysis indicate that microblade production occurred at the site but provides little information as to the style of microblade preparation or the use of this technology at the site. Further, two unifacial scrapers and several flakes with use wear show that hide processing may have taken place at the site, and two unifacial pressure flakes identified during analysis suggest that unifacial technologies were retouched on site. All pieces of diagnostic debitage related to formal unifacial or microblade production were made on red chert.

Debitage related to microblade and unifacial production may be limited due to collection practices or similarity to debitage produced during bifacial reduction. Both unifacial thinning flakes and microblades can be quite small and may have fallen through the 1/8th inch mesh used during excavations. Additionally, unifacial thinning flakes are very difficult to distinguish from bifacial thinning flakes in most cases (Esdale 2009), and some unifacial debitage may have been conflated with bifacial production and maintenance. Additional excavations at this site could recover further evidence for unifacial or microblade production that could enhance our understanding of the toolkit employed at Caribou Knob.

Spatial distribution

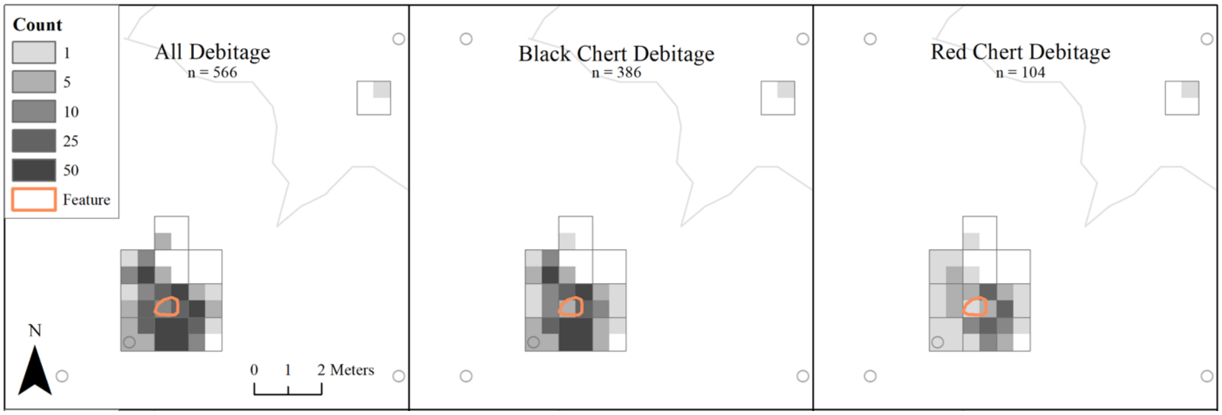


Figure 4.17 Distribution of Debitage at Caribou Knob by Material Type

The spatial relationship between raw material and debitage type produced was considered following the formal debitage analysis to identify any specific areas of tool production within the central activity area at Caribou Knob. A series of *k*-means cluster analyses were run to determine if any logical and significant patterns existed within the assemblage. However, no compelling or significant patterns appear to exist within the data: both raw materials used and tools produced exhibit a high degree of overlap within the excavated area (Figure 4.17, Figure 4.18). This is likely due to the small size of the excavation area. With additional excavations, particularly to the south and west of the main excavation area, clusters of tool production within this activity area may be visible. The current data do not indicate any spatial differentiation between tools produced or raw materials used at Caribou Knob.

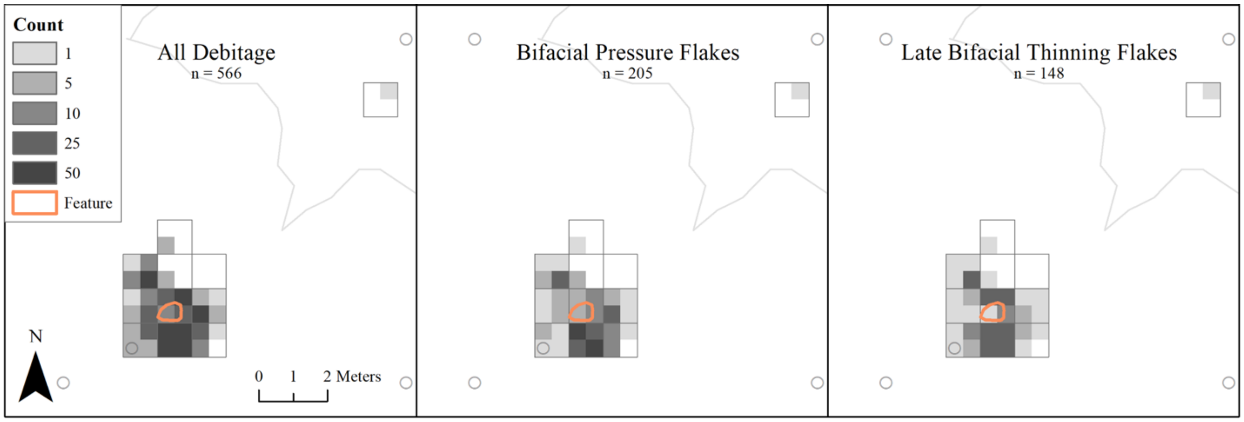


Figure 4.18 Distribution of Debitage at Caribou Knob by Tool Type

Klein Site Upper Locus

The late Holocene assemblage from the lowland Klein Site upper locus contains one copper awl, one microblade core tab with evidence of use wear, one unifacial scraper fragment, two expedient scrapers or tci-thos, two pieces of copper scrap, and 203 pieces of diagnostic lithic debitage made on at least ten local and exotic raw material types. The technological analysis conducted on this assemblage suggests that a variety of formal tools were produced and/or utilized at the site, including metal tools, unifacial tools, microblades, expedient tools, and there is extensive evidence for bifacial production. The tools, tool fragments, and production debris suggest that hide working, tool preparation, and food preparation took place at the site during the late Holocene, before the WRA east eruption.

Size and weight

Diagnostic debitage from the Klein Site's upper locus late Holocene assemblage are large on average, with a mean weight of 3.21 g, the highest of all the assemblages considered here, likely due to the presence of two expedient scraper tools in the assemblage. Over two-thirds of complete debitage are smaller than 1 cm^2 (n = 133; 65.5%) and these have an average weight of 0.08 g. Artifacts measuring up to 2 cm^2 had an average weight of 0.48 g and comprised 20.7% of the total debitage assemblage (*n* = 42). There were several large artifacts in the assemblage. Artifacts measuring up to 4 cm^2 had an average weight of 5.59 g and comprised 11.3% of the assemblage (*n* = 23), and artifacts measuring up to 8 cm^2 had an average weight of 64.41 g and comprised 2.0% of the assemblage (*n* = 4). Finally, only one piece of diagnostic debitage was larger than 8 cm^2 and this piece weighed 234.5 g. This assemblage featured a wide array of debitage, from small, thin pieces to large, thick pieces used as expedient tools.

Raw materials

A visual analysis of color, grain size, and luster revealed at least ten individual cobbles or material types used at this site (Table 4.10). Of these, there were five subcategories of sedimentary chert or chalcedony, three subcategories of metamorphic material, and two subcategories of volcanic material: obsidian and rhyolite. While dozens of pieces of heat-shattered quartz were recovered during excavation, none of the diagnostic debitage showed distinct evidence for heat treatment, such as potlidding, heat fracturing, and/or change in coloration. Grey chert is the dominant raw material in the assemblage and represents 65.5% of the intact debitage at the Klein Site upper locus late Holocene component (*n* = 133). Black chert is the next most-frequent raw material type, comprising 12.3 % of the total assemblage (*n* = 25). The remaining raw materials (rhyolite, white chert, red chert, quartz, obsidian, basalt, granite, and chalcedony) make up less than 10% of the debitage in the assemblage. Black chert, grey chert, rhyolite, quartz, basalt, and granite can all be found on the shores of Quartz Lake or in local drainages within 20 km of the site. However, obsidian and copper are definitively exotic

Table 4.10 Debitage Types at the Klein Site Upper Locus Sorted by Raw Material

Raw Material	**Early Reduction** primary decortication	secondary decortication	interior	*n*	%	**Bifacial Reduction** early thinning	late thinning	alternate	edge preparation	bifacial pressure	*n*	%
basalt	2			2	5.9							
black chert	1	2	2	5	14.7	1	3		7	6	17	11.1
chalcedony										1	1	0.7
granite	1	11	1	13	38.2			2	2	1	5	3.3
grey chert		4	5	9	26.5	3	32	4	13	63	115	75.2
obsidian							2		1	2	5	3.3
quartz		3	1	4	11.8			1	3	1	5	3.3
red chert						1					1	0.7
rhyolite		1		1	2.9	1	1		1		3	2.0
white chert									1		1	0.7
Total	**9**	**4**	**21**	**34**	**16.7**	**6**	**38**	**7**	**28**	**74**	**153**	**75.4**

Raw Material	**Microblade Reduction** core tablet	platform rejuvenation	microblade	*n*	%	**Total**
basalt						2
black chert	1	1	1	3	18.6	25
chalcedony			1	1	6.23	2
granite						18
grey chert	2	1	6	9	56.3	133
obsidian			2	2	12.5	7
quartz						9
red chert						1
rhyolite			1	1	6.3	5
white chert						1
Total	**3**	**2**	**11**	**16**	**7.9**	**203**

raw materials that the site's inhabitants either traveled hundreds of kilometers or traded to acquire. Chalcedony, white chert, and red chert may also be exotic to the region.

Early stage core reduction

Early reduction debitage, identified by the presence of cortex on individual pieces, flake scars, and overall size, represented 16.8% of the total assemblage (*n* = 34). Cobble cortex was identified on four primary and 21 secondary decortication pieces, suggesting that the late Holocene occupants of the upper locus were actively processing cobbles. Early reduction debitage was primarily on low-quality metamorphic materials such as granite (48%, *n* = 13), but there were also several pieces of grey chert early reduction debitage (33%, *n* = 9), a higher quality local raw material. No obsidian, chalcedony, white, or red chert debitage related to early stage core reduction were identified and this is consistent with interpretation that these materials are exotic to the region. Early stage core reduction debitage are not abundant within the upper locus assemblage but reveal patterns of tool reduction at this late Holocene occupation.

Bifacial technology

Most of the late Holocene debitage recovered during excavations at the upper locus of the Klein Site relates to bifacial reduction (75.4%, *n* = 153). No complete bifaces were recovered in association with this component, so it is unfortunately impossible to describe trends in bifacial style. However, late stage bifacial reduction makes up the greatest proportion of debitage (48.3%, *n* = 74), followed by early (28.7%, *n* = 44) bifacial reduction. The abundance of bifacial pressure flakes in particular suggests that late stage retouching was the focus of bifacial reduction at the upper locus during the late Holocene, though evidence for early core reduction and early stage bifacial reduction suggest that biface blanks were also prepared on site.

Microblade technology

Excavations yielded evidence for microblade reduction and core maintenance, and 7.9% of the assemblage relates to microblade production (*n* = 16). The three recovered microblade core tablets are all consistent with a wedge-shaped style that is common in Alaskan assemblages from the mid- to late Holocene (Appendix Figure A.7; Coutouly 2012). Eleven microblades were also recovered, suggesting that microblades were actively produced on site using this strategy but no crested blades were recovered. Thus, it is unclear whether microblade cores were produced on biface fragments at this occupation, as they were at Clearview. Most of the debitage related to microblade production was grey chert (56.3%, *n* = 9), and the remaining debitage was black chert, obsidian, or chalcedony, indicating that microblades were produced using local and non-local toolstone.

Other technology

One side scraper fragment and three expedient scrapers, or tci-thos, were recovered during excavations of the late Holocene component at the Klein Site Upper Locus (Appendix Figure A.8). All of these were made on locally available raw materials, either black chert or granite. No unifacial pressure flakes were identified in the assemblage. The unifacial tool assemblage from this component reflects both formal and informal scraper tool technology reduction sequences on exclusively local material.

Three copper artifacts were recovered during excavations of the late Holocene component, including one copper awl and two pieces of copper scrap (Appendix Figure A.9). One piece of copper scrap shows wear consistent with cold hammering (Franklin et al. 1981:26). The copper awl has a square profile that is similar to awls recovered from Dixthada (Shinkwin 1979) and may represent an arrow preform (Franklin et al. 1981). These copper pieces are some of the earliest intentionally worked copper recovered from the middle Tanana Valley and reflect the breadth of technologies produced during the late Holocene at the upper locus of the Klein Site.

Klein Site Lower Locus

The Klein Site lower locus late Holocene assemblage is the only assemblage considered that post-dates the WRA east event. The assemblage is small, similar to Delta Creek, but suggests several trends in lowland curation similar to those at the Klein Site upper locus and Caribou Knob. The assemblage consists of one unifacial scraper made on a microblade core tab with evidence of retouch, one unifacial scraper fragment, one flake knife, and 27 pieces of diagnostic lithic debitage made on at least six local and exotic raw material types. The technological analysis conducted on this assemblage suggests that a variety of formal tools were produced and/or utilized at the site, including unifacial tools, microblades, expedient tools, and extensive bifacial production using a range of local and exotic raw materials.

Size and weight

Diagnostic debitage from the Klein Site's lower locus late Holocene assemblage are medium sized on average. Approximately one-third of complete debitage are smaller than 1 cm^2 ($n = 17$; 38.6%) and these have an average weight of 0.14 g. Artifacts measuring up to 2 cm^2 had an average weight of 0.90 g and comprised 34.1% of the total debitage assemblage ($n = 15$). Artifacts measuring up to 4 cm^2 had an average weight of 5.90 g and comprised 20.5% of the assemblage ($n = 9$). Finally, artifacts measuring up to 8 cm^2 had an average weight of 19.13 g and comprised 6.8% of the assemblage ($n = 3$). This assemblage featured a wide array of debitage, from small, thin pieces to large, thick pieces, and was evenly distributed between four size classes.

Table 4.11 Debitage Types at the Klein Site Lower Locus Sorted by Raw Material

Raw Material	**Early Reduction** primary decortication	secondary decortication	interior	*n*	%	**Bifacial Reduction** early thinning	late thinning	alternate	edge preparation	bifacial pressure	*n*	%
black chert	3	8	2	13	86.7%	2	1	1	2	2	8	33.3
grey chert						1				4	5	20.8
obsidian		1		1	6.7%	1	1	1	1		4	16.7
quartz	1			1	6.7%							
red chert							1	1	2	1	5	20.8
rhyolite						1				1	2	8.3
Total	**4**	**9**	**2**	**15**	**34.1**	**5**	**3**	**3**	**5**	**8**	**24**	**54.5**

Raw Material	**Microblade Reduction** platform rejuvenation	micro-blade	*n*	%	**Total**
black chert	1		1	33.3	24
grey chert		1	1	33.3	5
obsidian					5
quartz					2
red chert		1	1	33.3	6
rhyolite					2
Total	**3**	**2**	**3**	**6.8**	**44**

Raw materials

A visual analysis of color, grain size, and luster revealed at least six individual cobbles or material types were used at this site (Table 4.11). Of these, there were three subcategories of sedimentary chert or chalcedony, one type of metamorphic material (quartz), and two subcategories of volcanic material: obsidian and rhyolite. None of these showed distinct evidence for heat treatment, such as pot-lidding, heat fracturing, and/or change in coloration, though dozens of pieces of heat-shattered quartz were recovered during excavations. Black chert is the dominant raw material in the assemblage and represents 55.5% of the intact debitage at the Klein Site lower locus late Holocene component (*n* = 24). Red chert is the next most-frequent raw material type, comprising 13.6 % of the total assemblage (*n* = 6). The remaining raw materials (grey chert, obsidian, rhyolite, and quartz) make up less than 12% of the debitage in the assemblage. Black chert, grey chert, rhyolite, and quartz can all be found in local drainages within 20 km of the site or along the edge of Quartz Lake. Obsidian is the only definitively exotic raw material. Chalcedony, white chert, and red chert may also be exotic to the region.

Bifacial technology

Most of the late Holocene debitage recovered during excavations at the lower locus of the Klein Site relates to bifacial reduction (54.5%, *n* = 24). No complete bifaces were recovered in association with this component, so it is unfortunately impossible to describe trends in bifacial style. However, early, intermediate, and late stage bifacial reduction each make up equal proportions of bifacial lithic reduction debitage (33.3%, *n* = 8). One-third of the bifacial reduction debitage is on black chert, and grey chert, obsidian, red chert, and rhyolite constitute the rest of the bifacial debitage. While limited, these data suggest that equal attention was paid to the entire sequence of lithic reduction during the late Holocene occupation of the lower locus, though this makes up a smaller proportion of overall debitage than the other late Holocene assemblages considered here.

Other technologies

Debitage related to microblade production and unifacial retouch are present in the late Holocene assemblage from the lower locus of the Klein Site. Two microblades and one large platform rejuvenation flake with evidence for retouch and use as a knife were recovered during excavations. The morphology of these artifacts is consistent with a wedge-shaped microblade core reduction sequence common to mid to late Holocene assemblages (Coutouly 2012). No crested blades were recovered during excavations. Of these three pieces of debitage, two are black chert and one is red chert. Additionally, one red chert unifacial thumb scraper was recovered during excavations, suggesting that formal unifaces were produced and used on site (Appendix Figure A.10). Finally, one large black chert flake knife was also recovered during these excavations. The late Holocene occupation of the lower locus at the Klein Site features a wide array of lithic technology types, including formal and informal tools, and associated reduction strategies.

Late Holocene Technology Production and Use

The four sites and five excavated components considered here span the Northern Dene/Athabascan transition and provide information critical to reconstructing the timing and cause(s) of the changes to subsistence, mobility, and technology comprised within that transition. Importantly, the late Holocene occupations investigated here span the period preceding and following the WRA east event that archaeologists have previously associated with a significant technological reorganization (Figure 4.19) as well as a period of dramatic increase in the number of sites that may be associated with an increase in the region's populations. The technological assemblages recovered from these sites serve as proxies for the broader process of adaptive decision-making that ultimately resulted in the Northern Dene/Athabascan transition and migration.

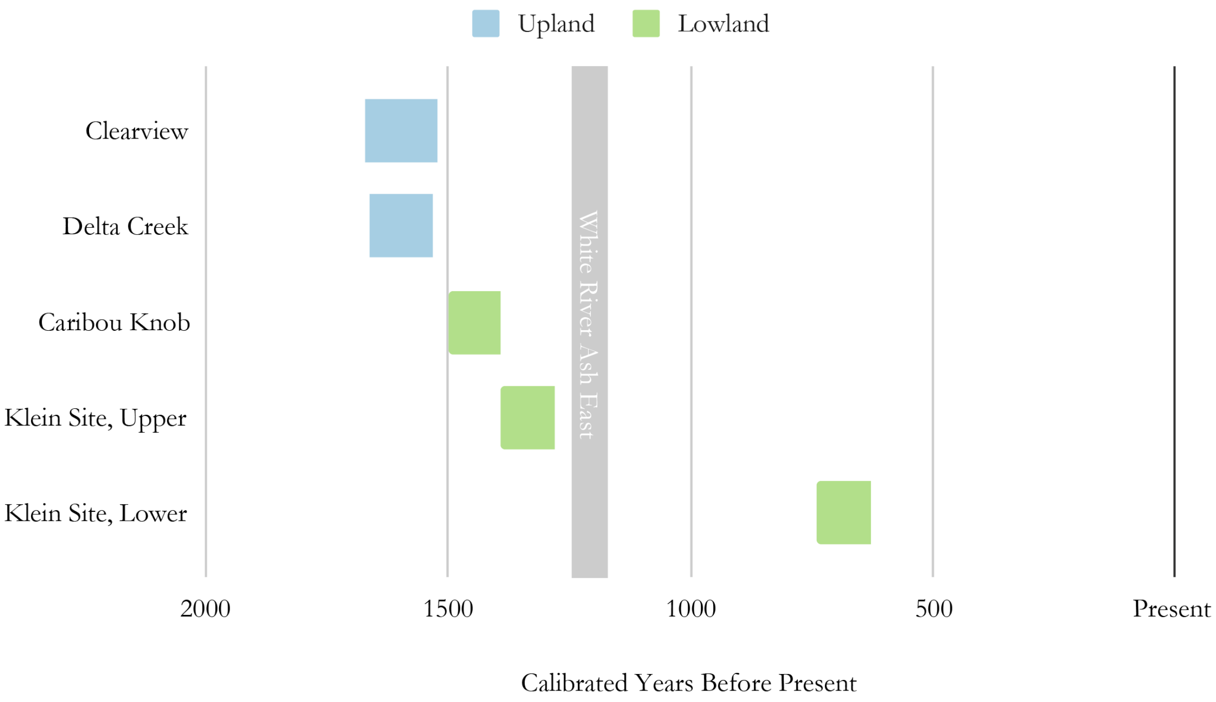


Figure 4.19 Site Occupation Date in Relation to White River Ash Events

Production Strategies and Ecological Setting

A detailed investigation of raw material use and reduction strategies involving artifacts from these five components illustrated significant differences between lithic curation in upland and lowland ecological zones during the Northern Dene/Athabascan transition (Figure 4.20). Results of a Fisher's exact test show that exotic raw materials, such as obsidian and copper, were significantly more abundant in lowland ecological zones ($p < 0.01$). Further, exotic materials were twice as abundant in overall count at lowland sites and four times as abundant by weight. Three copper artifacts were recovered during excavations at the Klein Site upper locus, including one awl and two pieces of scrap, and the delamination cracks on each of these is consistent with cold hammering (Cooper 2007:123; Franklin et al. 1981). Though exotic materials, obsidian specifically, were found in all assemblages, they were more abundant in components found in the lowland ecological zone.

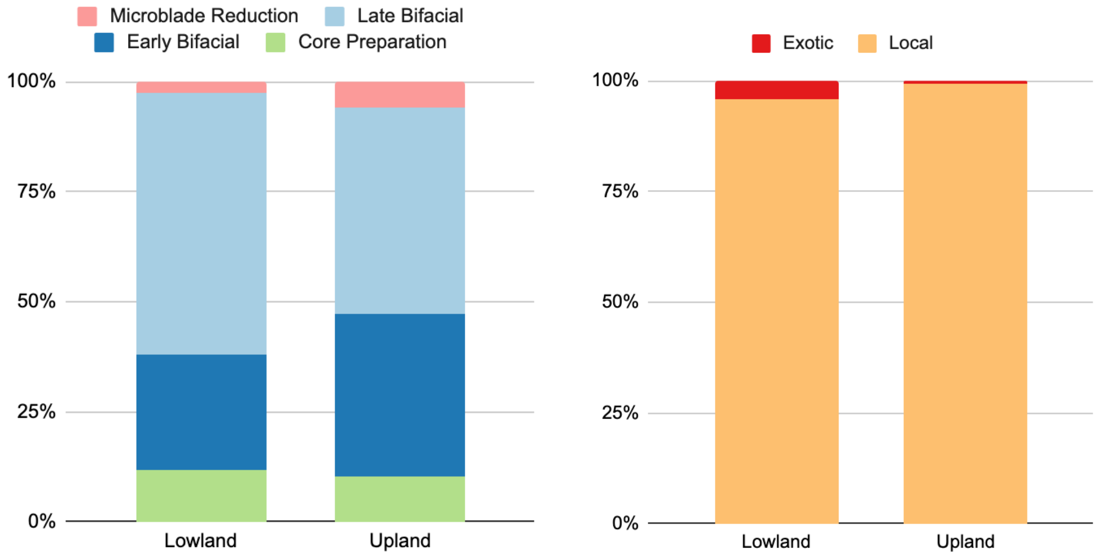


Figure 4.20 Aggregated Debitage Typologies and Materials Based on Ecological Zone

All assemblages showed evidence for initial core reduction and bifacial tool production. Moreover, unifacial, microblade, and expedient technologies were recovered from all assemblages except for Delta Creek. However, a Fisher's exact test on the overall count of artifacts related to microblade and bifacial reduction showed that microblade reduction was significantly more common in upland ecological zones ($p < 0.01$). Additionally, upland sites had significantly higher quantities of debris related to early bifacial reduction according to a Fisher's exact test ($p < 0.01$), while lowland sites had more expedient tools and debris related to initial core reduction ($p < 0.01$). While some of the assemblages considered are relatively small, these results suggest that tool production strategies were distinct in upland and lowland ecological settings at the time of the Northern Dene/Athabascan transition, though similar technologies were used across the region. Additionally, ethnographic evidence suggests that Dene/Athabascan groups maintained territories that included upland and lowland resources, and annual group fission and a gendered division of labor was a critical part of controlling these resources in the productive summer and fall months (Hosley 1981). The results suggest a different use of lithics in uplands and lowlands using data at the site level that will be evaluated further using site-level faunal data and regional settlement patterning data in the next chapters.

Gradual Shifts in Technology Production

The results of this analysis, which compared technological reduction strategies from five archaeological components spanning ca. 1,500–600 cal BP in both upland and lowland ecological zones adjacent to the area(s) affected by volcanic ash during the late Holocene, show that no abrupt changes in lithic production took place. Rather, certain technologies, such as microblades, persisted for longer than previously believed (e.g., Hare et al. 2012; Potter 2008a). The limited evidence for microblade use from the Klein Site assemblages is also reflected microblades from ca. 1,000–400 cal BP assemblages from both central Alaska (Shinkwin 1979; Holmes 2008; Proue et al. 2011; Esdale 2007) and Yukon (Fafard 1999) that indicate Northern Dene/Athabascans continued to use microblades following both the WRA east and the introduction of copper tools. Additionally, data from the Klein Site upper locus suggests that novel copper technologies were introduced earlier than previously argued (Hare et al. 2012; Cooper 2012), and before the WRA east. The chronological overlap of copper and microblade technological traditions represented by assemblages considered here and previously reported archaeological assemblages from the broader region contribute to a growing body of evidence that suggests changes to technological production and use were gradual, not punctuated, and thus more likely represent adaptations to gradual social or natural pressures. Additionally, the artifacts recovered through these novel excavations emphasize the importance of increased testing, particularly for periods that are often overlooked, such as the late Holocene in central Alaska.

The gradual changes documented in this technological analysis reflect changing strategies increasingly differentiated by ecological zone. Lowland and upland technological reduction strategies suggest several significant differences that indicate an intensified use of resources in these ecological zones, with tools related to large mammal hunting produced primarily in upland locations and tools related to butchery and fish processing in lowland locations. Formal tools with complex reduction strategies, such as bifaces and microblades, were more common in upland locations and generalized tools used for scraping, digging, or animal processing were more common in lowland locations. Additionally, lowland locations featured significantly more debris related to sharpening and tool maintenance, suggesting that formal tools were produced in the uplands and maintained during use in the lowlands, in line with ethnographic evidence that Dene/Athabascan groups moved between upland and lowland ecological zones as part of their annual subsistence round. These important differences indicate different specializations for specific upland and lowland subsistence pursuits. Interestingly, while formal tool manufacture was more common at upland locations based on the limited sample evaluated here, exotic materials were more abundant at lowland locations, suggesting these may have been loci for interregional trade. These important differences between raw material use and tool production distinguish sites in upland and lowland ecological zones and suggest a specialized use of these ecological zones consistent with changes to subsistence, mobility, and technology anticipated for increased territoriality and population size, though these data alone can only tentatively mobilize this explanation.

Summary

The material remains related to technological reduction and maintenance collected through archaeological investigations in the middle Tanana River Valley reflect a consistent strategy of increasingly specialized lithic curation. The analysis of formal tools, tool fragments, and diagnostic debitage suggest that reduction sequences were differently exercised across the landscape, with early reduction and microblade production at upland sites and expedient tool use and late stage re-sharpening and adjustments at lowland sites. Further, exotic materials were present across the sites sampled but much more abundant in lowland ecological zones, suggesting that these were closer to nodes on the trade network. No punctuated shifts in technological organization were identified in this relatively small inter-assemblage analysis and the changes are more consistent through time than they are across space, suggesting a gradual shift towards an increasingly specialized toolkit, as Northern Dene/Athabascan groups began to intensify their pursuit of both upland and lowland resources. This is consistent with ethnographic evidence that reflects a hybridized system of intensified upland and lowland resource use among distinct Northern Dene/Athabascan groups. The lithic assemblages considered tentatively indicate that this intensified, parallel use of upland and lowland resources began gradually around 2,000 years ago and could be explained by a concurrent population increase if verified with additional data from faunal and settlement patterning data.

Chapter 5 Northern Dene/Athabascan Subsistence

Introduction

Dietary reconstruction remains central to archaeological discussions of human history, particularly among hunter-gatherers. In central Alaska and Yukon, faunal remains recovered in association with lithic materials and cultural features are quite rare and the paucity of identifiable faunal remains complicates archaeologists' ability to synthesize subsistence patterns at all periods of history in the North American Subarctic (Potter 2008a; Yesner 2001). In recent decades, results from compound-specific isotope chemistry suggest that fatty acids (lipids) extracted from cultural features from Subarctic occupations have shown how this technique may augment the results of a traditional faunal analysis (Buonasera et al. 2015; Choy et al. 2016; Kedrowski et al. 2009; Heron et al. 2010). In this chapter, I will consider the merits and challenges of both of these approaches for reconstructing diet in late Holocene through a comparative analysis of faunal and chemical profiles of site subsistence from three late Holocene occupations in central Alaska.

The dietary reconstructions based on faunal and isotopic remains from these occupations also provide critical insights into diet breadth during this critical period. Specifically, the results suggest that while many resources were used, fish were the primary subsistence resource targeted in each of these occupations spanning 1,500 years cal BP to around 500 years cal BP. This suggests a specialized subsistence system oriented around predictable and abundant resources that could support growing populations rather than a generalized subsistence system oriented around maximizing unpredictable resources. Thus, the dietary reconstruction presented here further illustrates that the Northern Dene/Athabascan transition represents a suite of shifts in subsistence, mobility, and technology related to gradual *in situ* population growth rather than a rapid ecological disaster.

Faunal Remains and Analysis in the Subarctic

Archaeologists have recently presented summaries of subsistence in central Alaska and Yukon following decades of survey, excavation, and analysis across this vast region (Blong 2016; Potter 2008a, 2008b; Holmes 2008; Krasinski 2010). These assemblages are frequently small, fragmentary, or absent due to myriad processes of diagenesis and the apparent Dene/Athabascan propensity for bone grease rendering. Freeze-thaw cycles, high soil acidity, bioturbation by rodents, roots, etc., and a variety of other factors contribute to the post-depositional loss of identifiable faunal materials (Potter 2008a). Additionally, archaeologists argue that bone grease rendering via smashing and boiling bone fragments was commonly practiced across the interior Subarctic (Potter 2007). The rendered bone fragments are frequently calcined or heavily burned, further affecting their preservation and potential for positive identification. Despite these barriers to traditional faunal identification and analysis, archaeologists have successfully recovered and analyzed several numerous assemblages from several Alaskan and Yukon mid- and late Holocene contexts.

Alaskan archaeologists have recovered identifiable faunal material from approximately 50% of tested sites (Potter 2008b). Though Potter's (2008a, 2008b) study draws mostly from deeply stratified sites and lacks data from the last decade of archaeological investigation in the region and from Yukon, he summarizes a wealth of data related to securely radiocarbon-dated faunal assemblages that suggest diet breadth was greatest during the late Pleistocene and late Holocene and lowest during the early and mid-Holocene. According to Potter's (2008a, 2008b) synthetic study of central Alaska subsistence, the late Holocene features many more components with faunal material, suggesting the taphonomy played a significant role in preservation bias but also indicating that this sample may over-represent diet breadth compared to previous periods. Further, it is unclear from this study's results whether faunal preservation rates were higher during the late Holocene or whether the overall number of sites is simply greater at more recent periods in Alaska's history (Potter 2008a). Data from Yukon is not incorporated in this study, but preservation issues are thought to be just as severe if not more so in this region with many high elevation sites associated with poor soil deposition. Previous syntheses of physical faunal remains in the region suggest that the record is spotty and that many occupations with pertinent material culture lack identifiable faunal remains, prohibiting a complete picture of subsistence through time based on physical faunal identification alone.

Compound-Specific Isotope Analysis of Fatty Acid Methyl Esters

In the 20th century, isotopic chemistry revolutionized archaeologists' ability to reconstruct and track diet in the past (Schoeninger 1989; Ambrose and Norr 1993). These studies function on a basic principle of chemistry. Elements consistently have the same number of protons but can have different numbers of neutrons, resulting in different weights. Isotopes are versions of the same element that display similar chemical properties because they have the same number of protons, but each isotope has a different number of neutrons and mass (Schoeninger 2018). The resources that we ingest have specific isotopic signatures from all of their composite elements, mostly carbon and nitrogen, that are incorporated into our tissues over time. As an isotopic chemist will eagerly tell you, "You are what you eat, plus a few per mil" (DeNiro and

Epstein 1976). The majority of isotopic chemistry applications in archaeology have involved the bulk stable isotopic chemistry of carbon, nitrogen, oxygen, and strontium. Such studies measure the ratio of the less common version of the element to the most common, such as the ratio of caribon-13 to stable carbon-12, because these isotopes fractionate at predictable rates between different species and across the environment due to their different weights. These studies have established important patterns in human diet and mobility through time and across multiple contexts.

More recently, archaeologists have expanded their application of isotopic chemistry to include compound-specific isotope analyses. Such analyses depend on extracting a specific substrate, such as fats or proteins, and measuring the isotopic composition of that substrate. Certain molecules fractionate isotopically at predictable rates and can be used to reconstruct compound-specific isotope signatures of different residues. This method was first applied to in studies of ceramic residues, in which fatty acid methyl esters (FAMEs) were extracted following a modified Bligh-Dyer technique, screened for composition via gas chromatography-mass spectrometry, and submitted for compound-specific isotope analysis via gas chromatography-combustion-isotopic ratio mass spectrometry (Mills and White 1987). In short, these assays established the presence of specific fatty acids and measured the quantity of these within the sampled residues. This technique was first successfully applied to residues from cooking vessels due to the potential for lipids to become “entrapped” and preserved in ceramic surfaces (Evershed 1993:77). Indeed, subsequent research showed that fatty acids are well preserved in ceramic materials, even for ceramic sherds found on the surface of archaeological sites (Eerkens 2002).

Fatty acids are uniquely informative because different foods can be differentiated through identifying saturated and unsaturated fatty acids of different lengths within residues. Specifically, there are sets of unique fatty acids found within various dietary sources that can be used as biomarkers, such as *n*-alkanes for marine fauna (Evershed 2008; Hansel et al. 2004; Skibo and Deal 1995). Through a compound-specific isotope analysis, researchers can identify both the presence of these biomarkers and their relative abundance via mixing models (Hobson 1999). In recent decades, several compound-specific isotope studies of fatty acids from ceramic residues have provided great insight into past diet composition and subsistence transitions, such as diets during and after the transition to agriculture in Northern Europe (Craig et al. 2011) and the role of marine foods in agriculturalist diets (Craig et al. 2007; Taché and Craig 2015). These showed the potential of this method to inform debates on past subsistence practices, particularly those that involved pottery.

Researchers have also applied this dietary reconstruction technique in contexts without ceramic materials. Rock residues provided one of the first non-ceramic targets for this type of analysis (Buonasera 2005; Quigg et al. 2001). These studies highlight the importance of sampling from non-archaeological contexts to provide points of comparison for archaeological materials, as fatty acids are ubiquitous and not necessarily ancient or related to food production (Buonasera 2005). In particular, research on residues from non-cooking vessels must carefully vet whether accreted residues are the result of subsistence decisions or natural processes. Further, such research must establish the preservational context for those features. Studies of residues from rocks used for stone boiling provided some of the first non-ceramic residue applications of this isotopic technique, though their results were mixed due to the complexity of sampling residues that were not definitively cooking-related. These studies demonstrate the importance of sample verification in chemical dietary reconstruction.

Archaeologists have also successfully applied compound-specific isotope chemistry techniques to soils associated with subsistence activities to provide another window into dietary reconstrution, though this is one of the most challenging applications of this technique (Evershed 2008:907). Cooking feature residues offer dark, greasy soils that appear rich in fatty acids. Many of these cooking residue studies have focused on features from northerly latitudes due to a favorable preservation environment associated with colder climates. In one of the earliest analyses of hearth fatty acids, E. Morgan et al. (1984) demonstrated both the excellent preservation environment found in Arctic sediments and the potential for dietary reconstruction based on cooking feature fatty acid analysis. Similarly, Kedrowski et al. (2009) demonstrated that acidic boreal soils provide an excellent preservation environment for fatty acids and suggested that they could survive for thousands of years. Based on these preliminary successes, Buonasera et al. (2015) applied a fatty acid methyl ester extraction and compound-specific isotope analysis to understand the relative abundance of marine fauna within cooking features from Arctic Small Tool tradition and Norton period occupations at Cape Espenberg, Alaska. The results offered a dietary reconstruction for components with poor faunal preservation associated with the Arctic Small Tool tradition, ca. 5,000 years ago, that had previously been complicated by a lack of identifiable faunal remains. Similarly, Choy et al. (2016) considered the relative abundance of salmonids within hearth cooking features from the Upward Sun River site to reconstruct diet in central Alaska during the terminal Pleistocene. In this case, the authors contextualized isotopic results with those from a conventional faunal analysis to highlight the benefits of isotopic reconstruction. Beyond Alaska, Heron et al. (2010) found evidence for marine mammal fat rendering through a combined compound-specific and bulk isotopic analysis of cooking feature soils from Arctic Norway. Each of these studies demonstrated the preservation of culturally-associated fatty acids within cooking features and offered refined interpretations of dietary reconstructions and subsistence strategies through compound-specific isotope analysis in contexts where faunal material was available (Choy et al. 2016) and unavailable (Buonasera et al. 2015; Heron et al. 2010).

Each of these studies suggest several reasons to employ a compound-specific isotope analysis to refine or even replace traditional fauna-based dietary reconstructions of Subarctic subsistence entirely. First, several diagenic processes that contribute to poor faunal preservation in the Subarctic may have a lesser or null effect on fatty acids derived from subsistence activities, such as dessication, freeze-thaw cycling, and high soil acidity (Evershed 2008:905; Morgan et al. 1984; Kedrowski et al. 2009). These diagenic processes are common within the Subarctic and can effectively destroy constituent bone collagen and/or mineral, but research has shown that fatty acids are more resilient to these conditions. Second, relative dietary contributions are much more difficult to extrapolate from a traditional faunal analysis than isotopic results. Traditional faunal analyses rely on reconstructing dietary composition based on estimating the minimum number of individuals (MNI) or the number of identifiable specimens (NISP) of various species present within a faunal assemblage. These methods for estimating relative dietary contributions can easily be biased by sample size (Payne 1972), sampling strategy (Thomas 1969), sample fragmentation (Marshall and Pilgram 1993), and even different standards for attributing minimum numbers (Grayson 1973). Finally, the testing extent necessary to estimate diet breadth, composition, and subsistence practices can be much smaller for chemical methods of dietary reconstruction. Evenly distributed isotopic samples from one hearth at an archaeological occupation can provide adequate data for dietary reconstruction whereas a traditional faunal analysis typically relies on faunal remains from a representative proportion of the site, typically entailing a much larger excavation area to mitigate sampling bias. Due to issues associated with preservation, quantification, and sampling of faunal remains, isotopic sampling of hearth fatty acids may provide a complementary or supplementary method for dietary reconstruction, particularly in the Subarctic.

There are several inherent issues associated with isotopic dietary recontruction that should also be addressed when weighing the potential merits of this technique. Hearths in particular provide a specific lens into human activity with several potential complicating factors. First, hearths may be reused over long periods of time. In settings where hunter-gatherers occupy sites over several seasons, hearth use may reflect a palimpsest of different subsistence practices during different seasons or by different groups. However, none of the hearths considered here appear to have been used for more than one relatively brief occupation, as is typical for Subarctic site patterning (Potter 2016). Additionally, faunal fatty acid residues from hearths are not necessarily related to cooking and human consumption but may be related to bone-fueled fires (Kedrowski et al. 2009) that would in turn include more elements selected for high grease content (Potter 2007). While bone-fueled fires may have been common before forests spread across central Alaska ca. 8,000 years ago (Kaufman et al. 2016), it is unlikely that the fires in this assemblage were fueled in this manner based on the abundance of woody plants during the late Holocene. Complicating factors related to hearth use and fuel likely did not affect the sample presented here, but preservation issues and inputs from potential non-cultural sources are factors that are carefully considered below.

Isotopic chemistry provides a provocative window into past subsistence economies, particularly where faunal preservation is limited. Previous research on compound-specific isotope analysis of fatty acids extracted from cooking residues found in soils and pottery suggests that this dietary reconstruction technique complements a traditional faunal analysis. This approach can successfully discriminate between a variety of faunal sources through gas chromatography mass spectrometry identification and dietary mixing models (Craig et al. 2011; Buonasera et al. 2015; Kedrowski et al. 2009; Choy et al. 2016). Further, a compound-specific isotope analysis can correct for deposition/preservation bias and provide a more accurate understanding of the relative importance of dietary items, such as fish, whose remains preserve poorly or are lost using standard sampling methods(Grayson 1984; Colley 1990). Here, I will consider how this technique compares to a traditional analysis of faunal material from three late Holocene occupations at two sites in central Alaska to evaluate whether future residue analyses can supplement a traditional faunal analysis in contexts where faunal material is limited or too fragmentary.

Physical Faunal and Soil pH Analysis Methods

At all four sites excavated as part of this research (see Chapter 4), a consistent collection strategy of faunal material was employed to facilitate the analysis of excavated remains. During excavation, faunal material was collected and bagged separately from both *in situ* and screened contexts. When bones were identified *in situ*, they were carefully excavated using organic tools and brushes. Larger faunal remains or clusters of faunal remains were pedestalled until the completion of the level to evaluate the relation of these remains to other artifacts and features during excavation. Pedestalled remains were then removed, with the accompanying pedestal in the case of friable faunal remains, wrapped in paper towel, and placed in a plastic box for transport. These remains were lightly cleaned with a soft brush, counted, and weighed at the University of Michigan Museum of Anthropological Archaeology (Delta Creek), or the University of Alaska Museum of the North (Caribou Knob, Klein Site). Faunal remains were accessioned separately from lithic material and other items recovered from the screen. At this stage, faunal materials were roughly sorted to identify diagnostic faunal elements. The Klein Site's lower and upper loci were the only occupations to yield such diagnostic elements.

The analysis of the Klein Site faunal assemblages was completed under the direction of Carol Gelvin-Reymiller, Holly McKinney, and Scott Shirar. Gelvin-Reymiller identified all faunal material recovered between 2008-2011, Holly McKinney identified fish bones recovered between 2016-2019, and Scott Shirar identified representative mammal and small game osseous remains recovered from the 2014-2019 excavations. Each of these analysts maintained a consistent analytical program to ensure comparable results. A variety of taphonomic variables were recovered for these specimens, including burning, calcification, weathering, and breakage. Here, we will consider the general results of this analysis as they pertain to identifying possible inputs for the isotopic dietary mixing model.

Archaeologists have attributed the lack of faunal remains at Alaskan archaeological sites to the acidic soils unique to coniferous boreal forests (Yesner 2001; Ping et al. 2008). Previous research has shown that faunal remains are best preserved in neutral (pH = 7) or slightly alkaline (pH = 7.5-8) soil environments (Nicholson et al. 2006). In contrast, acidic soils with a pH of 3.5-4.5 provide the worst environment for faunal preservation. Therefore, soil from each component at every site was sampled to ascertain the preservation environment and assess whether or not faunal abundance was associated with soil pH. Matt Ferderbar at the Cold Regions Research and

Engineering Laboratory, Ft. Wainwright assessed soil pH for each stratigraphic unit at Clearview, Caribou Knob, and Delta Creek and Dr. Joshua Reuther at the University of Alaska Museum of the North, Fairbanks assessed the soil pH of samples from the Klein Site.

Compound-Specific Isotope Sampling Methods for Feature Soils

During excavations, several hearth cooking features were identified and sampled. Features were identified based on changes in soil coloration, including oxidation and charcoal flecking, association with burnt or calcine bone, and general shape. Identified features were assigned a unique feature number that included the year and order of recovery (i.e., Feature 2019-1) and mapped in plan view for each excavation level where the feature was present. Features were also photographed in plan and profile at each level of excavation. Features were bisected with a trowel following cardinal directions (N-S, E-W) and soil samples were taken from at least one bisected side from every 5 cm level. In cases where cultural material was exceptionally dense, a bisected half was collected in its entirety for screening in the lab (i.e., Klein Site Upper Locus Feature 2019-5). Otherwise, charcoal, faunal, and lithic material were collected from the feature context following routine excavation protocols (see Chapter 4). In each level, feature soils were excavated in reverse order of deposition to capture the negative image of the feature in context. These methods were applied to eight features recovered from the Klein Site upper locus and one feature from the Klein Site lower locus. The Caribou Knob feature was excavated similarly, though by a crew of contract archaeologists from the Center for Environmental Management of Military Lands.

Fatty Acid Methyl Ester Extraction Method

Fatty acids from four hearth cooking features within three archaeological contexts all dated to the late Holocene were analyzed following standard methods for fatty acid methyl extraction to reconstruct the dietary items processed in these contexts. Approximately 1 g of soil was collected from hearths with characteristic black and/or greasy appearance associated with calcine and/or burned bone fragments (see for example Figure 5.1). Control soils from non-hearth contexts at both sites were also collected. Fatty acid methyl esters from these hearths were extracted with dichloromethane following a modified Bligh-Dyer technique standard in hearth residue analysis (Buonasera et al. 2015), with an appropriate amount of nonadecanoic acid serving as an internal standard.

Figure 5.1 Klein Site Upper Locus Feature 2018-5, in Lower Right Corner

To prepare and analyze each sample, approximately 2 g of hearth soil was weighed out into clean glass centrifuge tubes and 5 μg internal standard (1000ppm nonadecanoate) was added to each sample. Lipids were extracted in a single-phase with 10 mL DCM:M (dichloromethane:methanol; v/v 1:1) in 15 mL glass centrifuge tubes. Samples were sonicated for 20 minutes and centrifuged for 15 minutes at 4,000 rotations per minute (RPM) and the supernatant was filtered through glass wool into a clean glass centrifuge tube. Repeated solvent addition, sonication, centrifugation, and filtration of material in the first tube and added resulting fatty acids to the second tube. Centrifuged filtered extract in the second tube for 15 minutes at 4,000 RPM. Samples were filtered a third time into new 15 mL glass sample vials, which were subsequently placed under a gentle stream of nitrogen until all solvent had evaporated and the FAMEs were dried.

Methyl esters were derivatized by adding 5 mL sulfuric acid (4%) in methanol and heating samples to 85ºC for 60 minutes. After cooling for 20 minutes, 5 mL sodium bicarbonate solution was added to quench the reaction and derivatized lipids were extracted with 3 mL of hexanes. Samples were then vortexed, and supernatant was removed to a new 15 mL glass sample tube. Hexane addition, vortexing, and supernatant removal was repeated two more times. Vials containing derivatized lipids were placed on a heat block set to 30ºC and under a gentle stream of nitrogen for 30 minutes. 1 mL dichloromethane was added to each and contents were transferred to a new gas chromatography mass spectrometry (GC/MS) autosampler vial. Extracted and derivatized fatty acid methyl esters (FAMEs) were analyzed via GC/MS within 48 hours at the University of Michigan. Aliquots of these samples were dried and mailed overnight on ice to the Stable Isotope Facility at the University of California, Davis for compound-specific isotope analysis of FAMEs.

Throughout laboratory preparation and analysis, great care was taken to maintain a clean environment and protect sample integrity. Glassware was thoroughly washed with alkaline laboratory cleaner, fully rinsed, and air dried. All glassware was given an additional solvent rinse and left to air dry again before use. Nitrile gloves were worn at all stages of laboratory analysis. A sample blank was prepared and submitted to GC/MS analysis in parallel with samples to identify possible contaminants. Discretion

The resulting fatty acid methyl esters were analyzed at the University of Michigan on a Shimadzu QP-2010 GC/MS with a gas chromatographer that contains a 30-meter-long DB-5 column with a 0.25 mm I.D. and a quadrupole mass spectrometer capable of unit mass resolution. This analysis confirmed the presence of C16:0 and C18:0 fatty acids and measured the relative proportion of each within the sample. Aliquots of each sample were then submitted to the University of California Davis Stable Isotope Facility for compound-specific isotope analysis via gas chromatography-combustion-isotopic ratio mass spectrometry. Compounds were analyzed on a Trace 1310 gas chromatograph coupled to a Thermo MAT 253 isotopic ration mass spectrometer through a GC IsoLink II combustion interface. Samples were injected, splitless, on a DB-5 ms column (60 m x 0.25 mm OD, 0.5 mm film thickness; constant flow 1.4 mL/min). Once separated, FAMEs were quantitatively converted to CO_2 in with a NiO/CuO catalyst at 1000ºC, dried, and introduced to the isotopic ratio mass spectrometer. Provisional isotopic ratio mass spectrometer values were corrected both based on working standards composed of FAMEs calibrated against NIST standard reference materials, and for isotopic contribution of methanol, with a resulting standard deviation of ±0.11‰ or better. FAME sample $\delta^{13}C$ values are expressed in per mil (‰) ratios of ^{13}C to ^{12}C relative to the ratio for the standard reference, Vienna Peedee Belemnite.

Previous research has shown that the isotopic values of C16:0 and C18:0 in terrestrial and aquatic fauna are significantly different and suitable for stable isotope mixing models (Choy et al. 2016). Therefore, isotopic contributions of various fauna were estimated using $\delta^{13}C$ isotopic values of C16:0 and C18:0 using background compound-specific isotope data collected from Subarctic fauna and corrected post-industrial carbon (Taché and Craig 2015; Choy et al. 2016; Buonasera et al. 2015). SIAR version 4.2 (Parnell and Jackson 2013), an open-source package in R, was used to estimate relative contributions of potential dietary contributions and its Bayesian statistical framework incorporates uncertainty in modeling different food groups, making it ideal for estimating relative contributions of dietary items in hearth remains.

Physical Faunal and Soil pH Analysis Results

Clearview

Table 5.1 Soil pH Results from the North Wall of N502 E98, Clearview

Field Sample No.	Stratum	pH 1:5 DI H2O	pH 1:5 0.1M CaCl2
149	I	4.8	4.77
150	II	4.51	3.84
151	III	4.39	3.38
152	IV	5.28	5.06
148	V	5.83	5.11
153	VI	5.46	4.41

The extensive excavations at Clearview failed to recover any faunal materials. Results of an analysis of soil pH show that Stratum III, which contains the majority of the cultural material at Clearview, is also the most acidic unit. With a pH of 4.39, this stratum falls within the pH range least conducive to the preservation of faunal material (Table 5.1). Low soil pH can also limit the growth of destructive microbes and does not necessarily connote a poor preservation environment (Manifold 2012). However, low soil pH along with the complete lack of faunal material at Clearview suggests that these remains may have decomposed in the site's acidic soils.

Delta Creek

One hundred and sixty-three pieces of faunal material were recovered during the excavations of Delta Creek's late Holocene component. Several of these were large enough to permit a coarse-grained identification. These bones were unidentifiable to genus level based on lack of identifying landmarks. However, their size is consistent with a medium-bodied mammal such as caribou (*Rangifer tarandus*) or sheep (*Ovis dalli*). Sheep are not common in the vicinity of Delta Creek at present, but caribou do migrate through this area on their way to the foothills of the Alaska Range. The high vantage point of the site over the Delta Creek Drainage and foothills to the south would have provided site occupants with a unique view of the surrounding area that may have facilitated caribou hunting and the pursuit of game more generally.

The size and treatment of these bone fragments (Figure 5.2) is consistent with bone technology production with a groove and splinter technique (Nagy 1990:84). Further, a few of these fragments resemble Northern Dene/Athabascan bone point or awl preforms (Fafard 1999:69, Nagy 1990, 82). These bone fragments are heavily burned and may have been intentionally heat-hardened in preparation for reduction into osseous technology. Unfortunately, the small size of the faunal assemblage from Delta Creek's late Holocene component prohibits definitive identification of the type and use of these burned bones. Though no definitive bone points or other tools were recovered during excavations, these fragments may represent part of the late Holocene bone tool tradition associated with the Northern Dene/Athabascan transition.

Figure 5.2 Burned Bone Fragments Recovered from Delta Creek

The soil pH sampled from Delta Creek falls well outside of the range poor soil preservation (i.e., pH = 3.5-4.5; Nicholson 1996) throughout the profile, with a neutral to slightly alkaline pH in sampled soils (Table 5.2).Well-preserved bone was recovered from the late Holocene component, but faunal remains associated with the late Pleistocene and early Holocene components were poorly preserved, with a creamy texture, yellow-beige coloration, and little structural integrity. Soil alkalinity, often associated with clays, may have de-collagenated bone from the oldest components at the site and resulted in the poor preservation of bone.

Table 5.2 Soil pH Results from N504 E140 East Wall, Delta Creek

Depth below surface (cm)	**Component**	**pH 1:5 DI H2O**	**pH 1:5 0.1M CaCl2**
40	Late Holocene	7.84	7.02
60	N/A	7.39	6.82
80	Mid-Holocene	7.45	7.13
100	Early Holocene	7.69	6.92
120	Late Pleistocene	7.25	6.86

Caribou Knob

Over 4,000 pieces of fragmentary bone were recovered during all excavations at Caribou Knob. Nine additional bone fragments were recovered during the 2016-2018 seasons. However, these remains along with approximately 4,050 bone fragments recovered during initial excavations were unidentifiable because they were too fragmentary and/or calcified. While these remains were not identifiable to genus level, a general analysis based on element size suggests that they represent a mix of medium- to large-bodied mammal remains, such as moose or caribou, and small mammal remains, such as hare. These remains were tightly confined to the hearth food processing area, and their fragmentary nature suggests that bone marrow extraction and processing took place during the site's late Holocene occupation.

Results of the soil pH analysis show that the soil is most acidic at 5 cm below surface and remains relatively acidic throughout the profile (Table 5.3). The soil pH sampled from Caribou Knob falls well within the range associated with the poorest faunal preservation (3.5-4.5; Nicholson 1996), yet over 2,000 bone fragments were recovered in a feature at Caribou Knob, though none of these were identifiable past general categories. Researchers have suggested that acidic soils may limit the growth of destructive microbes, and this may be the case at Caribou Knob (Manifold 2012).

Table 5.3 Soil pH Results from the West Wall of N493 E93, Caribou Knob

Depth Below Surface	pH 1:5 DI H2O	pH 1:5 0.1M CaCl2
5 cm	4.34	4.13
10 cm	4.86	4.43
15 cm	4.94	4.27

Klein Site Upper Locus

The Klein Site upper locus featured an extensive assemblage of well-preserved and identifiable faunal material. The identifiable fauna represented a wide diet breadth, with the remains of waterfowl (*Cygnus*), at least three species of fish (*Esox*, *Lota*, *Salmonidae*), hare, (*Lepus americanus*), and moose (*Alces*). Much of this material was fragmented and heavily burned or calcine. Additionally, most of this burned, fragmentary faunal material was associated with darker soils and fragmented, heat-treated quartz. Over 1 kg of pink, friable and sometimes burned pieces of quartz around 1 cm^3 in size were recovered in association with cultural features and faunal remains. Archaeologists in the region typically interpret the association of burned, fragmented animal bones, rocks, and minerals as features of marrow extraction. However, the heat capacity of quartz is very low, and the quartz found around the lake quickly fragments upon heating, qualities that would make for a long boiling process and an unappetizing final product full of small quartz fragments(Graesch et al. 2014:181). A more parsimonious explanation for the association of these materials may be ascertained through further analysis. Further investigations that can map the extent and association of these large and often amorphous features across the landform may elucidate the cultural process that resulted in the disposal of these thousands of burned or calcine bone fragments in association with heated quartz pieces.

The soil pH results from the Klein Site fall well outside of the range poor soil preservation (i.e., pH = 3.5-4.5; Nicholson 1996) throughout the profile, with a neutral to alkaline pH in sampled soils (Table 5.4). Well-preserved bone was recovered from all archaeological components at the Klein Site, though much of this bone was heavily fragmented. The soil pH results suggest that faunal fragmentation was associated with cultural rather than taphonomic factors. These results are generalizable to the Klein Site lower locus as well based on similarities in soil development discussed in Chapter 4.

Table 5.4 Soil pH Results from Eicken Locus Test 3, Klein Site

Depth Below Surface	**Level**	**Average pH (1:5 DI H20)**
n/a	A/E horizon	6.18
n/a	B horizon	6.65
n/a	2 B horizon	7.10
n/a	C horizon	7.39
75-80 cm	AB/B	8.32
n/a	BWB	8.30
n/a	2C	8.33
n/a	2 BWB	8.18
n/a	3C	8.12
n/a	4C	8.30

Klein Site Lower Locus

The Klein Site lower locus featured an extensive assemblage of well-preserved and identifiable faunal material very similar in composition to those recovered from the upper locus. The remains of a medium carnivore (*Canis)*, moose (*Alces*), fish (*Esox*), waterfowl (*Cygnus*), and hare (*Lepus americanus*) were similarly heavily fragmented and associated with burned quartz pieces. In contrast to the remains from the upper locus, the lower locus remains were spatially constrained and recovered in direct association with one circumscribed feature of dark, greasy soil that was roughly square in shape (F2014-1). This feature was underlain by a large, flat piece of basalt, very similar to the feature recovered from Caribou Knob. Nearly all of the faunal material recovered from the lower locus was concentrated inside of this square feature or in the 50 cm around it. Again, the association of dark, greasy soils, burned and fragmented bone, and heat-treated quartz could suggest this feature represents the disposal of bone processed for marrow extraction. Given the formal shape, poor heat transfer capacity of quartz, and general context, however, this feature may be the result of another cooking or other cultural process.

Alternatively, the large basalt rock may have served as an anvil for cracking open large bones with quartz pieces. Additional testing to the east of the central excavation area could result in the recovery of material that would add to this interpretation.

Compound-Specific Isotope Analysis Results

Table 5.5 Results of Compound-Specific isotope Analysis of FAMEs Extracted from Hearth Remains

Site/Locus	Sample ID	Feature	Lipid Conc. (ug/mg)	$\delta^{13}C_{16:0}$	$\delta^{13}C_{18:0}$
Caribou Knob	2019-2-ck261	Control	0.11	-32.03	-31.13
Caribou Knob	2019-5-ck261	Control	0.19	-31.63	-31.48
Caribou Knob	2019-2-ck9	CK F1	0.36	-32.99	-31.92
Caribou Knob	2019-4-ck10	CK F1	0.47	-32.74	-31.49
Caribou Knob	2019-5-ck10	CK F1	0.13	-32.58	-31.53
Caribou Knob	2019-6-ck9	CK F1	0.18	-32.55	-31.58
Klein Site	2019-5-AEHOZ	Control	0.11	-29.64	-29.95
Klein Site	2019-6-AEHOZ	Control	0.05	-29.53	-29.67
Klein Site, lower	2019-4-ks315	KS F2014-1	0.10	-32.19	-31.13
Klein Site, lower	2019-4-ks354	KS F2014-1	0.09	-31.32	-31.11
Klein Site, lower	2019-5-ks315	KS F2014-1	0.29	-32.39	-31.11
Klein Site, upper	2019-4-ks624	KS F2018-3	0.10	-31.08	-31.02
Klein Site, upper	2019-6-ks624	KS F2018-3	0.05	-31.12	-31.06
Klein Site, upper	2019-4-ks656	KS F2018-5	0.13	-30.52	-31.04
Klein Site, upper	2019-5-ks656	KS F2018-5	0.11	-30.61	-30.88
Klein Site, upper	2019-6-ks656	KS F2018-5	0.04	-30.46	-30.96

Hearths were identified based on soil discoloration, abundance of charcoal or charcoal flecking, and presence of fragmentary and calcined bone. Further, carbon isotope ratios showed that hearth soils were significantly different from control soils at all occupations (Table 5.5). The results of an unpaired Student's *t*-test showed that Caribou Knob control and hearth $\delta^{13}C$ values of C16:0 and C18:0 were significantly different ($t = 4.55$, $p = 0.01$, and $t = 1.78$, $p = 0.01$, respectively). Similarly, control and hearth δ^{13}C values from the Klein Site also varied significantly in C16:0 ($t = 2.97$, $p = 0.02$) and C18:0 ($t = 14.67$, $p < 0.01$).

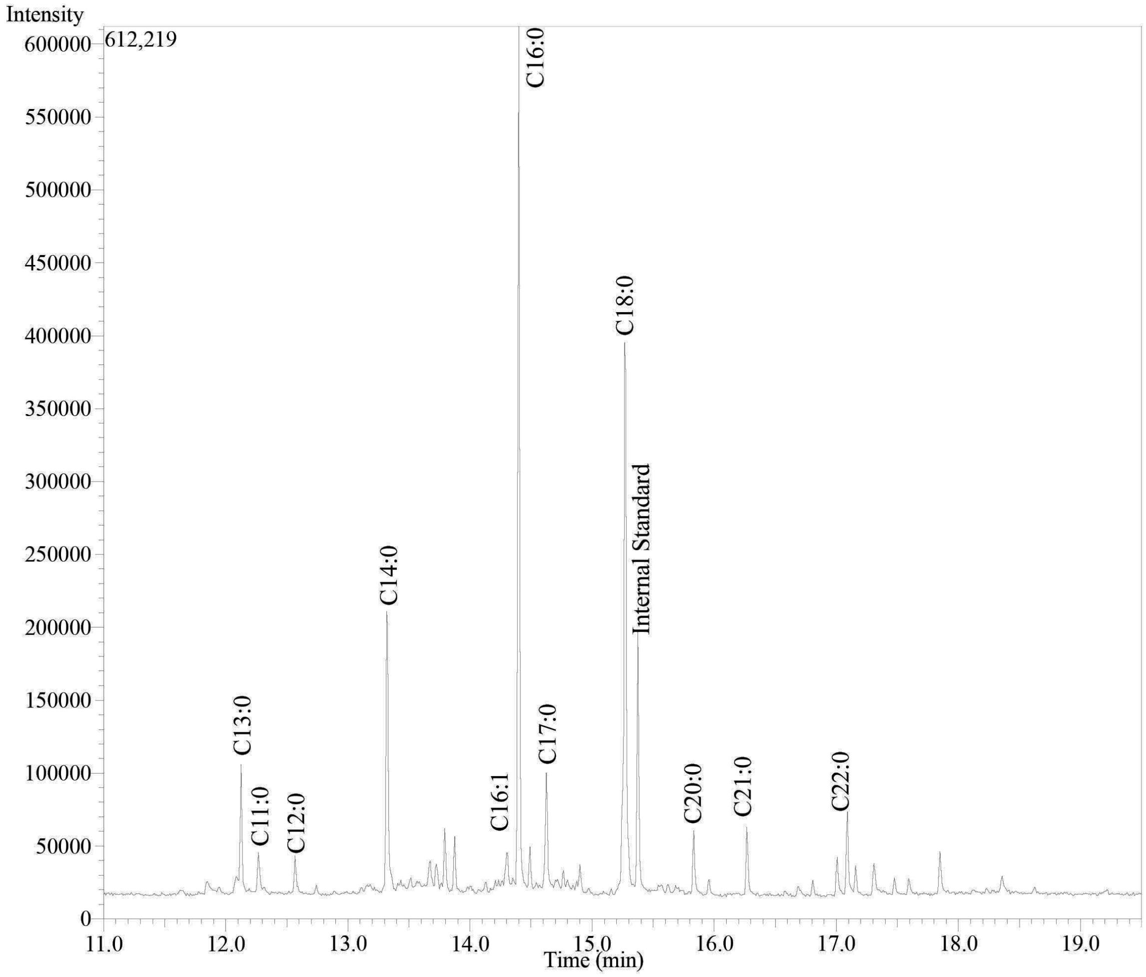


Figure 5.3 A Representative Chromatogram Derived from Klein Site Upper Locus Hearth Fatty Acid Methyl Esters

Hearth soils at Caribou Knob and both loci at the Klein Site contained a significant quantity of extractable fatty acids (FAs), identifiable by their FA methyl ester mass spectra (Figure 5.3). Long chain saturated FAs (C14:0 – C26:0) were the most abundant constituents, with hexadecenoic acid (C16:0) more abundant than octadecanoic (C18:0) acid. Unsaturated FAs were also identified, including C16:1, C18:1, and C18:2. We did not identify any FAs used as marine biomarkers, such as isoprenoid FAs (4,8,12-TMTD, pristanic acid, or phytanic acid), long-chain ω-(o-alkylphenyl) alkanoic acids, or dihydroxy FAs (Choy et al. 2016; Buonasera et al. 2015; Heron et al. 2010; Taché and Craig 2015).

The results of a Bayesian analysis of faunal contribution to hearth isotopic data show that a mix of faunal resources were used at Caribou Knob and both loci of the Klein Site (Figure 5.4), occupations that span ca. 1,300 cal BP to around 500 cal BP. The results should be seen as tentative for the Caribou Knob hearth as faunal remains were too fragmentary to allow for a formal identification past general categories. Specifically, no definitive fish remains were recovered from this site, though it is on a small lake, so inclusion of fish within the Bayesian model is provisional and based on the assumption that fish could have been pursued at the site.

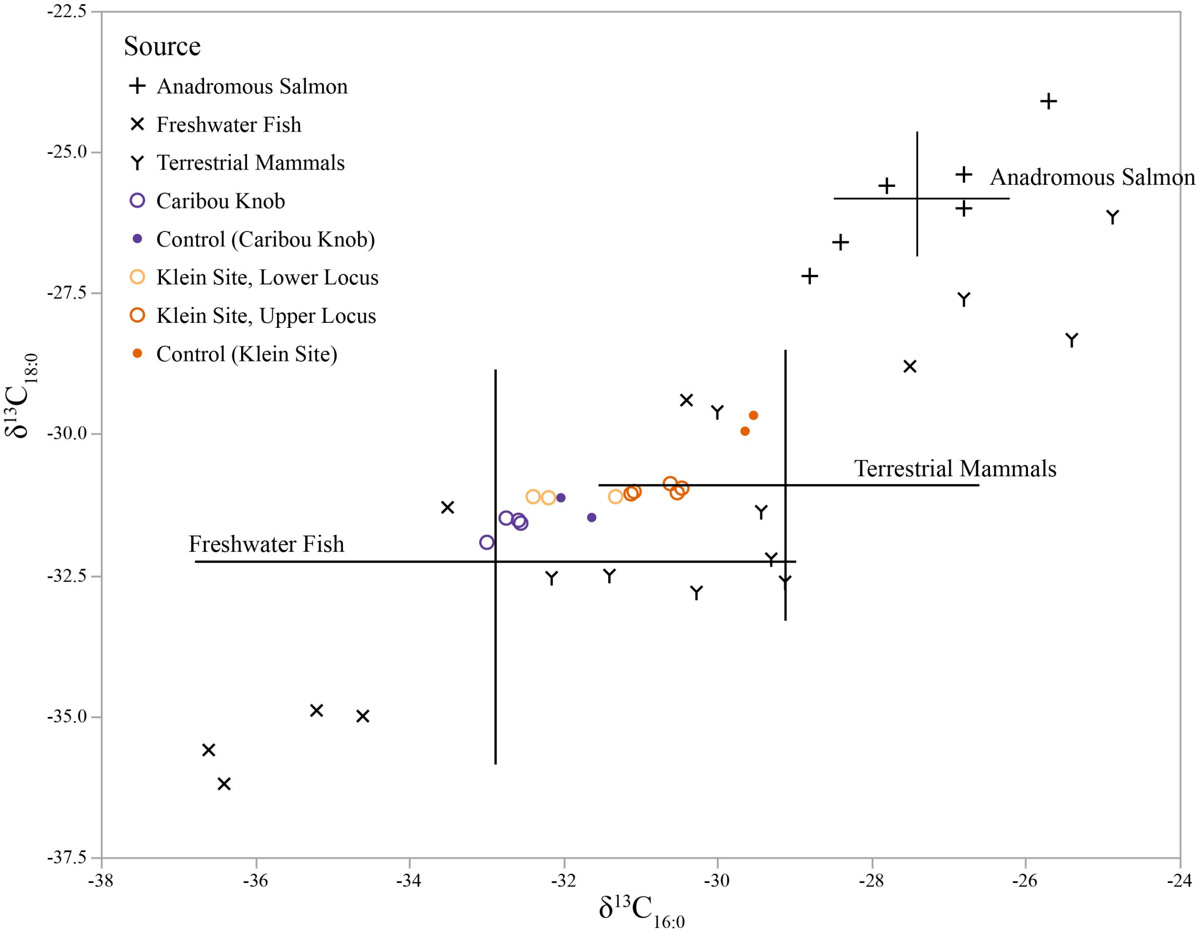


Figure 5.4 δ13C16:0 and δ13C18:0 Values of Lipids from Caribou Knob and Klein Site Hearth Residues

A mixing model estimated the relative probability of terrestrial, freshwater, and marine (anadromous salmon) resources within hearth soils (Choy et al. 2016; Taché and Craig 2015). This model showed that the majority (>50%) of fats found in hearth materials could be attributed to freshwater resources in all three contexts, and that lacustrine resources were supplemented by terrestrial and marine resources (Figure 5.5). This indicates that freshwater fish were of central importance in these three occupations spanning the late Holocene. The proportion densities for this mixing model indicated by histograms (Figure 5.6) further emphasizes the intensity of lacustrine fish signals within hearth fatty acids from each of these lowland cooking features.

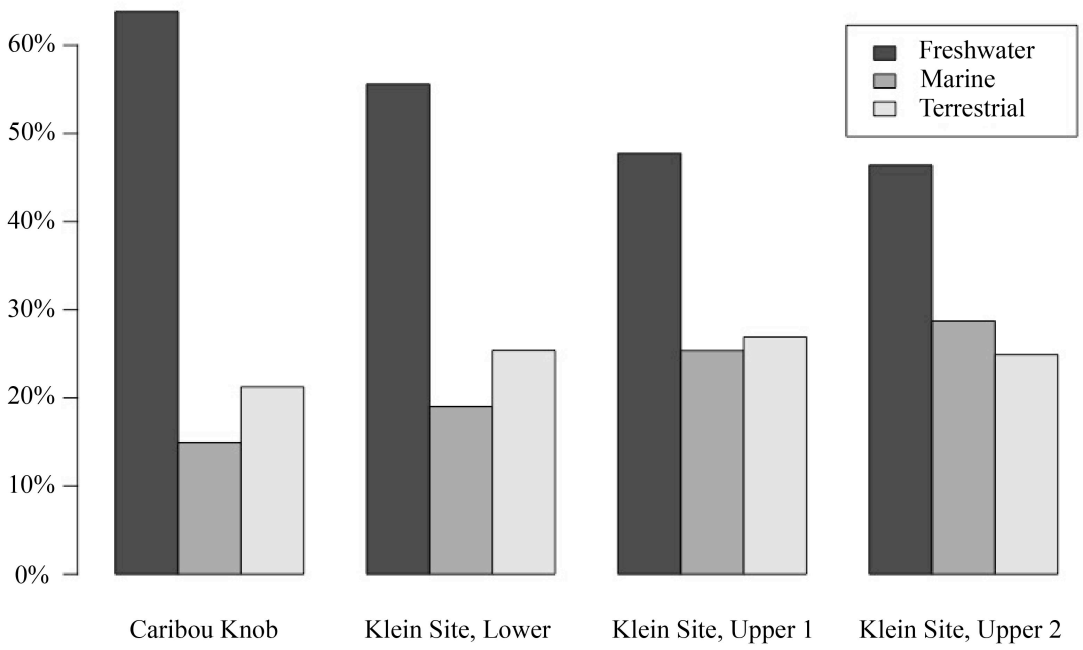


Figure 5.5 Relative Abundance of Terrestrial, Freshwater, and Marine Fauna in Hearth Remains at Lowland Occupations

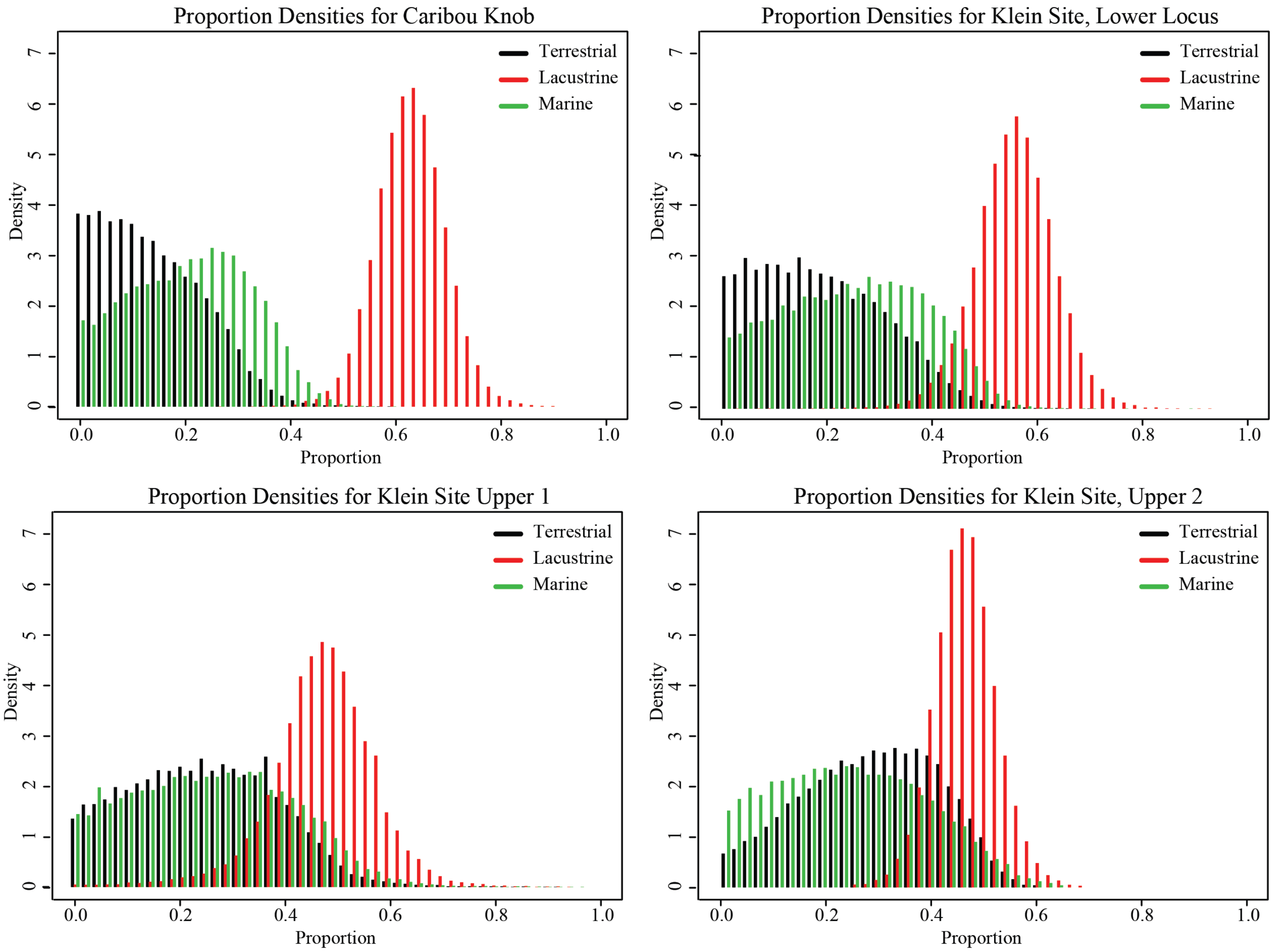


Figure 5.6 Proportion Density Histograms for Hearth Remains at Lowland Occupations

Northern Dene/Athabascan Subsistence

The results of physical faunal and isotopic dietary reconstruction suggest differences in subsistence at upland and lowland locations, and particularly, that lowland sites were used as specialized fish camps analogous to those used by Northern Dene/Athabascans today. Physical faunal identifications provided a rough outline of diet composition, with a mix of fish, large and small terrestrial fauna at lowland sites, and primarily medium to large bodied terrestrial fauna at upland sites. A compound-specific isotope analysis of fatty acid methyl esters from hearth remains provides a reconstruction of the relative contribution of different terrestrial and aquatic fauna that suggests that fish dominated subsistence activities at lowland sites. During the late Holocene, it appears that Northern Dene/Athabascans practiced an increasingly specialized subsistence round based on ecological zone. This finding is consistent with radiocarbon data proxies for a gradual population increase, increased population pressure, and increased resource intensification. Such practices would have supported growing populations using predictable and dense resources like migrating fish and caribou.

The dietary reconstruction presented here relies on two different analyses to draw its conclusions, a more traditional faunal identification and a novel isotopic profiling technique applied to archaeological cooking residues. These approaches offer different strengths and weaknesses on their own. Together, they offer a refined method for reconstructing subsistence practices, particularly among cultures where bone marrow extraction, fragmentation, and burning are common. A traditional identification of animal bones offers a positive verification of the fauna pursued in the past and minimum counts for the number of animals processed at a site. In contrast, a residue analysis provides a relative contribution of different known faunal inputs and can distinguish between major contributors but cannot provide total estimates for animals processed on site or directly identify those animals. The results presented here assert the importance of conducting a traditional faunal analysis because it anchors potential inputs in a Bayesian analysis of isotopic results. Simply put, a traditional physical identification obviates the “garbage in, garbage out” problem ubiquitous among mathematical models. However, the Bayesian model can offer relative contribution data that facilitates dietary comparisons and can be used to identify specialized subsistence pursuits. Here, these models clearly demonstrate specialization in freshwater fish at lowland ecological zones. Additional research in the region can generate a model of subsistence based on landscape information that archaeologists could use to reconstruct diet using preserved feature soils where investigators have failed to recover faunal remains.

Results from the analysis of soil pH indicate that faunal preservation varies due to factors beyond soil acidity, as the region’s archaeologists have previously argued. Soils from Clearview and Caribou Knob both feature low pH values and acidity well within the range of the poorest preservation environment for faunal remains (Nicholson 2016). Additionally, the cultural materials at both sites are found at a similar depth below surface. Yet, faunal remains recovered from Caribou Knob were well preserved, if heavily fragmented, and Clearview yielded no faunal remains at all during over a decade of intensive archaeological investigations. In contrast, faunal remains from Delta Creek, in one of the more favorable preservation environments according to soil pH, were among the most poorly preserved. This likely pertains to the depth and age of these faunal remains but indicates that the taphonomic processes contributing to faunal preservation are much more nuanced than soil pH alone.

Different on-site activities may provide a better explanation for the differences in faunal preservation across these archaeological occupations. The faunal remains recovered from

Caribou Knob are very similar in preservation quality to those recovered from both components of the Klein Site, which features a much more favorable soil pH and arguably a better preservation context. Faunal remains from all three contexts were heavily fragmented, calcine, or burned. Remains from the Klein Site lower locus and Caribou Knob were also found in a tightly circumscribed area in association with a large, flat rock. These results are preliminary but suggestive, indicating that site activities and cultural practices provide a better explanation for faunal preservation than soil acidity. Archaeologists in the region should continue to sample soil pH to provide additional insight into the differential recovery of faunal remains across sites in the Subarctic. If the absence of faunal remains is indicative of on-site activities rather than soil pH, archaeologists can use these data to draw important conclusions about cultural activities through time in this dynamic region.

Summary

The dietary reconstruction considered here relies upon traditional faunal identification and novel residue analysis techniques to present a wholistic profile of subsistence among Northern Dene/Athabascans during the late Holocene transition. Using these two analytical techniques together shows how different resources such as fish and caribou were used together in both absolute and relative terms. We can never recover all of the faunal remains or identify all of the bones processed at a site for taphonomic and other reasons. However, by combining the modeling strengths of isotopic residue analysis with the quantitative strengths of a traditional faunal identification, archaeologists can more accurately reconstruct diet generalization throughout the past and particularly at sites that feature poorly preserved faunal remains or limited testing extents, such as those excavated through contract archaeology or those that have been subsequently destroyed after initial testing. Residue analysis of compound-specific isotope composition should not be used in isolation but can augment the quantitative results of a traditional faunal identification to answer pressing theoretical questions.

Chapter 6 Northern Dene/Athabascan Landscapes

Introduction

Land use strategies represented through site patterning analysis are fundamental to contextualizing adaptation, social relations, and environmental systems in the past. Particularly in reconstructing the decisions of highly mobile foragers, land use strategies provide key insights into the adaptive decision-making process. In this chapter, I consider the spatial manifestations of the Northern Dene/Athabascan transition through ecological, settlement patterning, and chronological variables to identify the factors most relevant to Northern Dene/Athabascan decision-making during this period of change.

Geospatial approaches serve to unite disparate data and explore larger patterns across regional ecological use, integrating human experiences with environmental data through spatial relatedness. The complex record of Subarctic archaeological research conducted through academic, tribal, and industrial interests, among others, has resulted in varying levels of site assessment that can be integrated at a landscape level, particularly when sites have not been excavated at a large scale (Kintigh 2006). Moreover, a landscape level analysis provides an opportunity to synthesize regional trends and better investigate causal explanations premised on resource availability, such as those presented here. Multiscalar syntheses of regional interaction have consistently revealed the complexity of past social interaction (Mills et al. 2015). Considering the wealth of available data from Subarctic Alaska and Yukon through a landscape-level analysis presents an opportunity to identify broader trends in settlement patterning spanning the mid- to late Holocene.

Settlement Patterning Analysis in Archaeology

Analyses of settlement patterning, or the location, size, and use of archaeological sites within a past landscape, became commonplace well before computer modeling. During the first half of the 20th century, archaeological researchers became increasingly interested in mapping archaeological occupations across broad landscapes. Steward (1937, 1938), Braidwood (1937), and Phillips, Ford, and Griffin (1951) provided some of the earliest analyses of macroscale variation inside and beyond North America. These early mapping endeavors inspired what many archaeologists consider the foundational settlement patterning analysis: Willey's (1953) settlement patterning analysis of Viru Valley, Peru. Based on extensive survey and pottery surface collections, Willey illustrated the value of tracking and studying variation in settlement size, function, and location in archaeological research that foreshadowed the synthetic explanatory framing of the New Archaeology in the following decade. From Turkey to the Great Basin, these early mapping studies combined natural and social data at a sub-regional level and revealed the promise of this synthetic technique for resolving broad archaeological questions around the world (Parsons 1972).

For hunter-gatherer archaeologists, Binford (1980) provided a heuristic model of hunter-gatherer settlement strategies based on his experiences working with the Nunamiut in Northwest Alaska. In this seminal theoretical treatment, Binford lays out a heuristic model of hunter-gatherer land use on a spectrum from residential to logistical mobility. Residential mobility, employed more frequently by so-called foragers, consists of a system of moving people to resources by "mapping on" to important subsistence resources on the landscape. At the other end of the settlement patterning spectrum, Binford proposed logistical mobility, a strategy employed by what he termed “collectors” that involved moving resources to people through a series of specialized logistical camps. This theoretical model, while not unproblematic, has been employed in many subsequent considerations of hunter-gatherer subsistence and landscape use, including in the Subarctic (Potter 2008a).

Landscape Archaeology

As regional synthesis gained intellectual traction in British archaeology during the early 1970s, it became known as landscape archaeology, distinct from what was then called field archaeology (Fleming 2006). Landscape archaeology includes data pertaining to the ecological setting and natural environment in addition to settlement patterning data based on recovered material culture (Marquardt and Crumley 1987), and has increasingly been used to refer to studies of the past that incorporate archaeological and ecological data. Studies of hunter-gatherer spatial patterning in particular refer to archaeologies of landscape rather than settlement patterning studies, distinguishing their theoretical foundations, models, and approaches. Recent contributions to landscape archaeology have also drawn heavily on historical ecology, which follows the diachronic development of coupled human-environment systems by considering the environment as a landscape (Balée 2006).

Postmodernist British landscape archaeologists have problematized the ideological overlays inherent to these developing quantitative efforts and responded with a qualitative, phenomenological approach in the 1980s (Cosgrove 1985). Postmodern landscape studies rejected geospatial databasing and settlement pattern heuristics, such as Binford’s (1980) residential-logistical mobility model, in favor of an experiential approach. This postmodernist approach was subsequently critiqued by processual archaeologists who asserted that the experiential approach lacked intellectual rigor and that this approach also resulted in constructions of landscape consciousness steeped in the inherent bias of the Western gaze (Fleming 2006). Together, postmodernist and processual critiques coalesced around many of the potential theoretical issues associated with employing a quantitative and/or experiential approach to studies of past landscapes, stemming from issues associated with conflating data from multiple scales and the critical distinction between studies of spaces and places (Basso 1996; Lock and Molyneaux 2006:5–6).

Both processual and postmodern/post-processual paradigms offer theoretical insights when their inherent bias is accounted for. Any quantitative method has inherent biases that should be addressed before that method can be successfully applied, and geospatial analyses are no exception (Brouwer Burg 2017; Lock and Pouncett 2017). Alternatively, phenomenological approaches and postmodern critiques highlight the challenge of situating the static dots and numbers stored in massive geospatial databases within a lived landscape that was recursively experienced by people in the past from a perspective that was likely very different from that of the archaeologists who have subsequently collected spatial data. An anthropological consideration of these past landscapes should engage with the social and natural landscape represented by material culture and openly consider the potential bias of quantitative techniques in investigations of past perceptions at multiple scales.

Geospatial Information Systems and the Big Data Revolution

Archaeologists mobilize both settlement patterning and landscape theoretical paradigms in geospatial information system databases that leverage spatial and chronological information in massive databases, many of which are publicly available. Radiocarbon dating revolutionized many aspects of archaeology, including the analysis of settlement patterning and landscape archaeology, because it expanded inquiry beyond material cultures with defined stylistic chronologies. Many of the first settlement patterning studies were completed through ceramic analysis, but as radiocarbon databases grew in size and availability, researchers could begin considering the spatial dynamics of material remains across many more cultures, for those with and without a stylistic chronology. As radiocarbon dating became more common, faster, and less expensive through the 1970s and 1980s, the first geospatial information systems were adopted by archaeologists (Kvamme 1989). The increased use of computer databases for storing information and computer software designed to create data visualizations that facilitated novel studies of settlement patterning and past landscapes. Moreover, the storage and accessibility of these fine-grained data made it possible for individual researchers to synthesize of decades of previous archaeological research conducted by numerous investigators for various purposes. While Steward and others had to collect much of their regional datasets themselves, these databases allowed archaeologists to collect, retain, and distribute archaeological data across disciplines. The big data revolution of the past decades has allowed for the computational consideration of massive geospatial datasets that have the potential to answer some of the most foundational questions about human history (Kintigh et al. 2014; McCoy 2017).

A number of synthetic studies of hunter-gatherer history have combined newly available radiocarbon data, geospatial datasets, and contributions from evolving theoretical debates. Grappling with thorny issues related to the representativeness of survey results (Flannery 1976:131–132), radiocarbon calibration issues (Surovell and Brantingham 2007), and illustrating social landscapes of hunter-gatherers (Wobst 2006), this research shows that spatial data can challenge archaeological assumptions of hunter-gatherer organization based in ethnographic analogy. However, spatial data can also strip material of its culture and transform dynamic past histories and landscape relations into static points. This may encourage researchers to fish for meaning in vast datasets without precise research objectives or elaborated theoretical perspectives. As data get bigger, the temptation to collect still more and subject those data to ever more ambitious statistical analyses grows greater. Indeed, the widespread adoption of geospatial analysis via ArcGIS Desktop in archaeology has granted researchers the ability to shift between multiple scales of inference easily and perhaps obviates important considerations of scalar differences (Harris 2006). Such obtuse quantitative efforts may continue to obscure the social relations of past hunter-gatherers if these novel geospatial technologies are not carefully employed. As is true for all archaeological research, the most compelling and innovative spatial research on hunter-gatherers iterates social and natural environmental scales within quantitative data to represent the broader tapestry of political, ecological, and cultural place.

Geospatial Analysis in the Subarctic

Several Subarctic researchers have drawn from regional datasets to illustrate past Dene/Athabascan landscape orientation in this region. However, these studies frequently draw from one side of the US-Canada border and rarely synthesize history across the broader Northern Dene/Athabascan region, despite documented linguistic and cultural continuity spanning this arbitrary geopolitical border. Scholars frequently aggregate available archaeological data into upland and lowland ecozones based on data compiled for the USGS that indicate an ecological division around 500–600 masl (Gallant et al. 1995; Blong 2016; Wygal 2010; Potter 2008a; Graf and Bigelow 2011). Potter (2008a, 2008b) provided the most comprehensive aggregation of excavation and survey data to date from central Alaska. In these studies, he combined data from radiocarbon-dated archaeological sites that had available reports verifying the provenience of radiocarbon-dated material to evaluate trends in subsistence and technology from the late

Pleistocene through the late Holocene. Potter (2008a) also considered correlations between technology, subsistence, and landform type (lakeshore, terrace, etc.), though upland excavation data is notably absent from central Alaskan datasets (Blong 2016). Nonetheless, this analysis provided a general overview of the relationship between these spatial and technological variables, indicating that microblade use was strongly correlated with lakeside occupations. Beyond this, the spatial data, including elevation and proximity information, have yet to be fully evaluated within more recent data from Alaskan excavation contexts.

A number of archaeologists have leveraged spatial and chronological information related to isolated ice patch finds from central Alaska and Yukon to synthesize subsistence traditions in upland ecological zones. Archaeological assemblages from ice patches are most notable both for their well-preserved organic remains and potential to establish fine-grained chronologies because of their association within stratified snow deposits. However, such artifacts are typically isolates found in receding ice that are not affiliated with an occupational context (Hare et al. 2004, 2012; Dixon et al. 2005). All of the isolated objects recovered from these melting ice patches appear related to caribou hunting and upland subsistence pursuits. Given this context, there are certain limitations on the synthetic value of these remains. First, an analysis of site patterning depends on charting comparable spans of occupational activities, which technological isolates cannot provide. Second, without occupation data, the cultural context and affiliation of these remains are murkier and lack the information necessary to distinguish between different activites and different cultures. Nevertheless, these comprehensive studies strongly indicate a transition from stone to organic and metal technologies, as well as from atlatl and dart technology to bow and arrow technology (Dixon et al. 2005; Hare et al. 2012, 2004; Potter 2016). On the basis of these isolated arrow shafts and bow fragments, archaeologists have argued that they are representative of a broader Northern Dene/Athabascan transition. Yet, archaeologists have not recovered comparable technological remains within occupation contexts from either Yukon or central Alaska that corroborate conclusions derived from ice patch research, such as evidence for the production of bow and arrow technology or evidence for an abrupt switch from stone to metal and bone technology. This is even more confounding given the relatively large number of securely dated archaeological contexts from the late Holocene in both central Alaska and Yukon (Potter 2008a).

Very recently, researchers have successfully synthesized spatial data from Yukon ice patch finds using raw material sourcing data gathered through X-Ray Fluorescence (Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019). These studies combined sourcing data from relatively and radiocarbon-dated contexts to investigate the influence of the potentially catastrophic White River Ash (WRA) east volcanic event on regional trade in vitreous clinker (Kristensen, Andrews, et al. 2019) and obsidian (Kristensen, Hare, et al. 2019) tool stone. These studies seek to test the hypothesis that either the WRA north or east event resulted in a transition from stone to organic or metal tools in addition to other cultural changes and an out-migration from Yukon. Archaeologists have primarily recovered clinker artifacts and debitage east of Yukon and none have been recovered in central Alaska, while obsidian trade networks spanned from central Alaska's northwest corner (Batza Tena) to northeastern British Columbia (Mt. Edziza). These regional sourcing studies identified minor disruptions in both clinker and obsidian trade around the time of the WRA east event, consistent with the timing of an environmental explanation for the Northern Dene/Athabascan transition. The authors argue that these reflect broad cultural changes beyond Yukon. However, the theoretical connection between the different processes structuring raw material trade, cultural changes, and migration is tenuous.

These authors suggest that Yukon Dene/Athabascans moved to neighboring communities following the eruption, picking up new raw materials and shifting their culture, before either returning to the Interior or moving south, even further from of the study area. This conflicts with contemporary understandings of Northern Dene/Athabascan territoriality and neighboring relations. Moreover, linguistic data on a Yukon origin for the Dene/Athabascan migration is equivocal and is under reinvestigation (Wilson 2019). However, both of these recent spatial studies do effectively mobilize data from ice patch finds in order to explore Northern Dene/Athabascan mobility, social networks, and interaction at a coarse-grained level and show the potential for synthesizing archaeological data through geospatial analysis.

Only one study has successfully combined legacy radiocarbon data from both sides of the US-Canada border, and this study also focused squarely on impacts of the WRA events on population size and movements, broadly construed. In his posthumously published research, Mullen (2012) argued that site patterning data tentatively suggest that both WRA events were followed by population declines related to out-migration using data aggregated and published in the Canadian Archaeological Radiocarbon Database. These results were based on summed probability distributions for radiocarbon dates from ice patch and non-ice patch contexts, which was necessary to aggregate the bare minimum of dates to yield a representative sample (Surovell and Brantingham 2007). Therefore, these results may suffer from certain population size estimate issues associated with conflating isolated ice patch finds with overall population size. Yet, this study does establish that landscape-level analyses of Northern Dene/Athabascan history are not only possible but can yield compelling results that can bring greater historical context to Northern Dene/Athabascan culture.

Previous synthetic geospatial research in the study region shows both the potential and the limitations of such attempts to combine decades of aggregated data to reconstruct past landscape relationships. Of these, one study did incorporate data from both sides of the US-Canada geopolitical border, which illustrated that such a broad study is possible but did not include any ecological data, considerations of settlement patterning, or non-environmental explanations for the Northern Dene/Athabascan transition (Mullen 2012). Additionally, the most recent geospatial studies from the region consider the Northern Dene/Athabascan transition and migration specifically, but do not actively consider non-environmental hypotheses for this transition (Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019). The Alaskan examples (Potter 2008a, 2008b) illustrate how a fine-grained analysis that includes ecological information and more recent data from both Alaska and Yukon might shed light on intertwined processes of cultural change and migration represented in technology, subsistence, and mobility using a theoretical framework (Potter 2008a; 2008b). Each of these studies have shown that the region's archaeological datasets are adequate for geospatial analysis and invite an investigation of Northern Dene/Athabascan history that combines ecological and archaeological data to provide a high-resolution landscape analysis.

Methods of Geospatial Analysis

A geospatial research project must determine a specific research area, challenging due to the fluid nature of geosocial borders and limitations of our ability to extend known boundaries deeper into the past. The distribution of Northern Dene/Athabascan groups has undoubtedly changed over the millennia following the Dene/Athabascan migration and even since the original designation of those groups by Westerners during the 19th century (Osgood 1936). Northern

Dene/Athabascans, though largely anchored to villages in the present, have a history of mobility and adaptive flexibility that underscores the arbitrary nature of lines on maps. Further, anthropologists have noted that the first Western explorers and researchers invented just as much as they observed boundaries between Northern Dene/Athabascan subgroups or tribes, such as Tanana, Koyukon, etc. (De Laguna 1995:20). The organizational predilections of Western researchers certainly framed past accounts of Northern Dene/Athabascans and informs geographic considerations of Northern Dene/Athabascan distribution. Nevertheless, these hazy geographic outlines provide a general framework for Northern Dene/Athabascan landscapes of the past (Figure 6.1). These Northern Dene/Athabascan landscapes are anchored in the physical geography of the region, natural resources traditionally used by Northern Dene/Athabascans, and oral histories that document past socio-economic interactions between Northern Dene/Athabascans and Inuit (Krauss et al. 2011). Previous researchers have drawn similar boundaries to represent cultural-linguistic groups in the region (Reedy-Maschner and Maschner 1999:704; Potter 2016:540). Additionally, the large scale of this analysis is designed to overcome issues associated with the undoubted expansion and contraction of Northern Dene/Athabascan territory during the last 6,000 years.

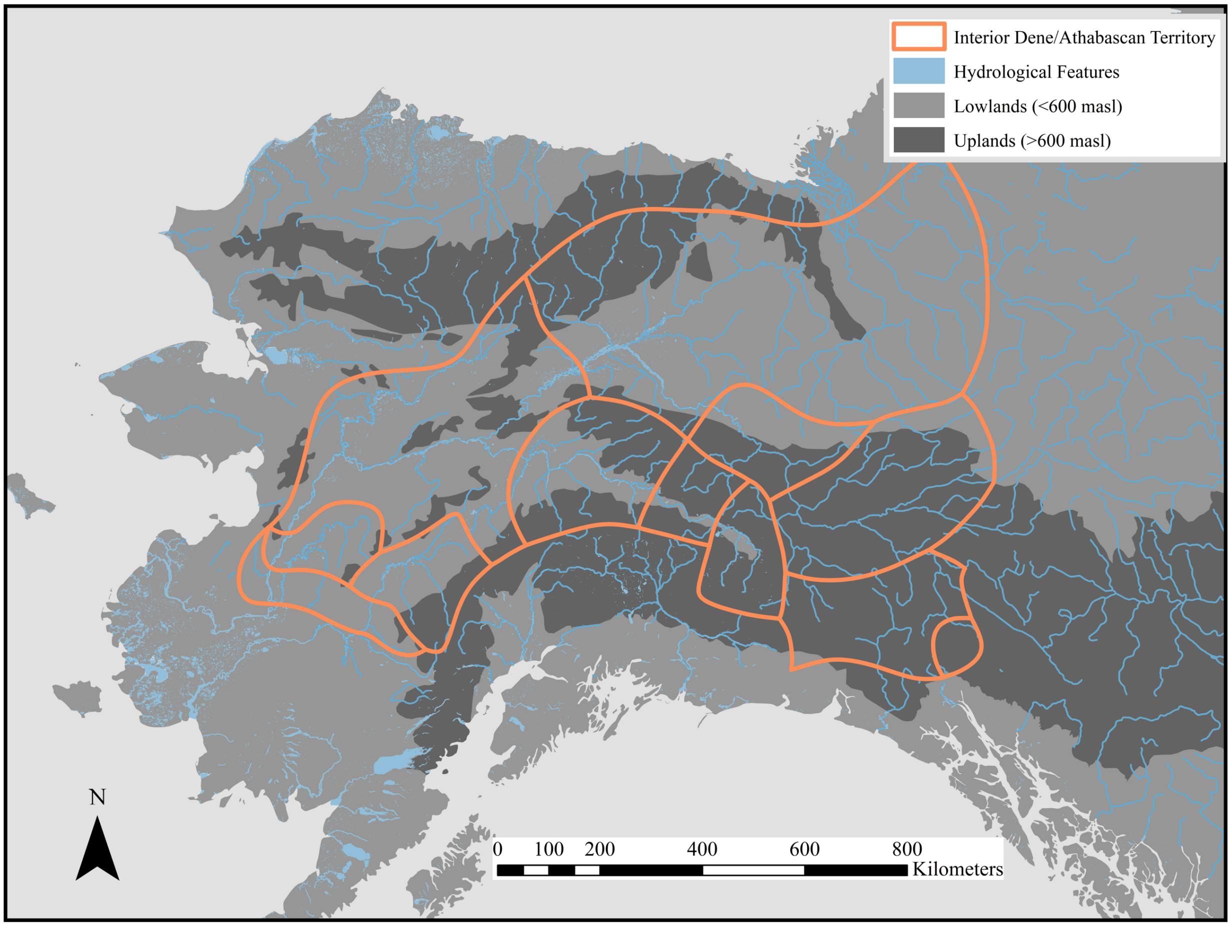


Figure 6.1 Northern Dene/Athabascan Linguistic Groups in Central Alaska and Yukon (Krauss et al. 2011)

Archaeological Sites and Radiocarbon Chronology

To populate the Northern Dene/Athabascan landscape with past occupations, I aggregated legacy cultural heritage data stored in online geospatial databases. As in any region, archaeological survey coverage varies due to disciplinary focus and accessibility issues. Previous research has focused on areas accessible by road, though in recent decades helicopter-based surveys have facilitated the identification of sites in more remote areas in both Yukon and Alaska. Indeed, several proposed industrial projects have necessitated extensive surveys of these more remote areas. Further, disciplinary focus on both the colonization of the Americas and melting glaciers has contributed to renewed attention on these remote locales with materials that may be lost as global temperatures rise. Therefore, the available spatial data result from a vast area that archaeologists have intensively investigated, particularly in recent years, and are representative of human-landscape relations in various ecological zones.

Site location and associated radiocarbon dates were accumulated for all occupations within the study area using data stored with limited public access in the Alaska Heritage Resource Survey database (ADNR-OHA 2019) and the Canadian Archaeological Radiocarbon Database (Martindale et al. 2016). Both of the databases require verified researcher credentials for access due to the sensitive nature of the spatial data that they document. The Alaska Heritage Resource Survey presents data from mandatory reports submitted to the Alaska State Historic Preservation Office during and after archaeological investigations as well as data published in academic journal articles, dissertations, theses, and books. It is a comprehensive source of information on site location, chronology, and previous investigations of sites ranging from the oldest in Alaska through the postcolonial period. In contrast, the Canadian Archaeological Radiocarbon Database is a repository developed by Canadian archaeologists to share chronological information. Archaeological investigations in Canada are the central focus and the most well-represented, though this database includes information from both paleontological and archaeological investigations within and beyond Canada. Like the Alaska Heritage Resource Survey, each entry in the Canadian Archaeological Radiocarbon Database offers references to government reports, journal articles, dissertations, theses, and other manuscripts where radiocarbon data is published.

After aggregating all archaeological occupations identified within the Northern Dene/Athabascan region, I screened the database for radiocarbon-dated sites and also included certain relatively dated occupations. Radiocarbon dating presents another significant source of potential biases in the dataset related to survey coverage, sampling, and dated materials. Each of the radiocarbon-dated occupations considered were carefully vetted for lab and sample quality, definitive association with cultural remains, and occupation length. Ice patch finds and other ephemeral occupation contexts were not considered in this analysis, but occupations that were relatively dated using tephra or stratigraphic position were included if they were bracketed by radiocarbon-dated contexts and if they adhered to other quality standards.

Radiocarbon Calibration and Population Size Estimation

Radiocarbon dates for each component at all occupations were calibrated using Calib 7.1 (Stuiver et al. 2019:1; Stuiver and Reimer 1993). Limitations and potential complications are myriad within a landscape analysis premised upon radiocarbon-dated contexts evaluated by different researchers for different purposes (Brouwer Burg 2017). First, evaluating distributions and landscape relations based on radiocarbon-dated contexts presents issues related to sampling bias. Sampling bias can arise from bracket dating, where only the oldest and most recent contexts are submitted for radiocarbon dating, differential preservation of sites at certain locations with fewer sites overall at earlier time periods, and variation in present-day access to different points across the broader landscape (i.e., the limited Subarctic road system). Second, studies of hunter-gatherer landscape use must consider the duration, season, and frequency of occupation at specific sites. Northern Dene/Athabascans were highly mobile hunter-gatherers that likely occupied several camps in their annual round, and this is also carefully evaluated in the dataset considered below. Finally, this geospatial analysis relies on data collected for various governmental, private, and academic purposes by numerous researchers with different training and experience over seven decades. Site testing standards varied widely during this period and across these disciplinary foci and this must be considered in studies focused on legacy data.

Moreover, each of these complicating factors could both introduce potential bias in the variation of site distribution over time and challenge estimates of population size at different periods in Subarctic history (Surovell and Brantingham 2007). Therefore, the dataset was carefully considered to evaluate how complicating factors related to site identification and reporting, radiocarbon dating standards, and site occupation timing affected the resulting dataset. Specifically, I quantified the consistency in survey coverage, radiocarbon dating, and season of occupation to determine whether the available sample is representative before proceeding with an analysis of geospatial variation.

The resulting database suggests that late Holocene occupations may be oversampled (see below), but careful evaluation of reported survey and excavation data indicate that disciplinary focus did not significantly bias this sample, i.e., sites were consistently radiocarbon-dated when appropriate material was available and regardless of assumed age. Subarctic assemblages do not offer chronologically diagnostic artifacts, with the potential exception of side-notched projectile points, so nearly every assemblage is radiocarbon-dated when possible. Further, previous chronological studies of this region suggest that taphonomic processes may result in poor preservation of sites along braided rivers but does not contribute significantly to site identification and recovery across the broader landscape. Additionally, the results presented below show that there is no significant difference in proximity to rivers from the mid- to late Holocene. In sum, this sample appears diagnostically representative of landscape use.

Landscape use studies and estimates of past population size are frequently complicated by attributing a set number of people to a given site. For example, with two populations of the same size, a more residential system of mobility results in few sites with low size variability, while a more logistical system of mobility results in many sites with a high size variability.

Though a more logistical system results in more sites, the population size is not necessarily greater. Therefore, approximate site sizes were estimated for all occupations in the sample to resolve sampling issues related to variation in site occupation duration and population size. In most cases, site reports include only limited data about overall site size due to different testing standards across the study region and the discipline. Hence, site sizes were attributed based on reported information when available, and landform diameter was estimated using topographic maps of the region for all sites in the dataset (USGS 2017). Using landform size as a proxy for site size is not unproblematic, as any proxy inherently suffers from issues of oversimplification. However, landform size and site size were compared when these data were available, and the results of this comparison suggest that landform size is an appropriate proxy for site size in the majority of cases and was used as the measure for overall site size here. On the heterogeneous Subarctic landscape, scarred by glacial valleys and dotted with a patchwork of terminal moraines, estimating landform size was relatively straightforward. Intuitively, it follows that larger landforms are chosen for longer term occupations with higher populations and smaller landforms are selected for shorter and smaller occupations, though this would not be so for more homogenous landscapes. Incorporating site size data with chronology reflects a wholistic land use strategy that can demonstrate changes in occupation number that may be due to shifts from residential to logistical mobility rather than overall population size.

Landscape Analysis

The sampled area covers 916,200 km^2 and past occupations located within this area are associated with a range of ecological zones, elevations, and resource accessibility. Using publicly available environmental data, I constructed a base map that incorporates these landscape features and offers context for site placement and landscape use through time. I aggregated hydrological features, including rivers, streams, lakes, and ponds for the study area from the Alaska Department of Natural Resources and Parks Canada at a resolution of 1:1,000,000 (ADNR-IRM 1998; Natural Resources Canada 2019). I added ecological data at a relatively low resolution that is comparable to previous geospatial research in the region (Potter 2008; Wygal 2010; Blong 2016). Ecological zones (e.g., upland and lowland) were defined based on modern climate, vegetation, hydrology, terrain, and elevation (Nowacki et al. 2001; Gallant et al. 1995), and delineations used by other archaeologists in the region (Wygal 2010; Blong 2016; Potter 2008a; Graf and Bigelow 2011). Upland and lowland zones were drawn based on Level I ecoregion data hosted by the Environmental Protection Agency (Commission for Environmental Cooperation 1997; Gallant et al. 1995; ; see also Chapter 2, Ecology). Gallant et al. (1995:20) divided forested and mountainous interior ecoregions by elevation, with a cut off of about 500-600 masl that generally distinguishes lowland and upland ecoregions. More specifically, the interior bottomlands feature forests distinct from Arctic bottomlands and have lower terrain roughness than adjacent Yukon Flats and Uplands. The boundaries adjacent to the Brooks, Alaska, and Wrangell Mountain ecoregions are generalized at a 600 m contour, exemplifying a distinction between alpine and non-alpine ecologies (Gallant et al 1995: 21). The study area comprises 386,718 km^2 of uplands and 529,482 km^2 of lowlands. Additionally, these ecoregions serve as a categorial indicators of elevation because they relate to variation determined in part by altitude. The resulting base map comprises ecological, hydrological, and elevation variation within the study area.

After base map, site chronology, and site size data were aggregated in a larger geospatial database, I carried out an analysis of categorical and continuous variables related to past land use spanning the mid- to late Holocene. Occupations were grouped into three time periods approximately corresponding to reconstructed culture-historic periods: 6,000–2,000 cal BP, 2,000–1,150 cal BP, and 1,150–100 cal BP (the two latter periods representing pre- and post-WRA east; Potter 2008, Esdale 2008, Holmes 2008). For each site, the ecological zone was recorded, along with the distance to the nearest lake and the nearest river. Data from each of these periods was compared with counts of sites in different ecological zones, average distance to rivers and lakes, and average site size, in order to identify and evaluate any significant shifts in site size and placement during the Northern Dene/Athabascan transition. Several statistical tests were applied to the resulting dataset. A two-tailed Student's *t*-test was applied to understand differences in site size and distances throughout the period of interest. When appropriate, these data were corrected for right-hand skew through log-normalization. A two-tailed Fisher's exact test was applied to overall counts of sites to determine whether or not significant differences existed in site number and distribution at different periods. The results of this analysis will be considered below.

Results

The data aggregated through a thorough investigation of legacy archaeological data resulted in a total of 198 radiocarbon-dated or conclusively relatively dated archaeological occupations. A total of 79 archaeological sites were occupied between 6,000 and 2,000 cal BP and a total of 119 sites were occupied after 2,000 cal BP (Figure 6.2; Table 6.1; Appendix C). Of the sites with radiocarbon dates between 2,000 cal BP and 100 cal BP, 61 occupations pre-date the WRA east event (ca. 1,000 years ago) and 58 post-date this event, according to the median probabilities of calibrated radiocarbon dates.

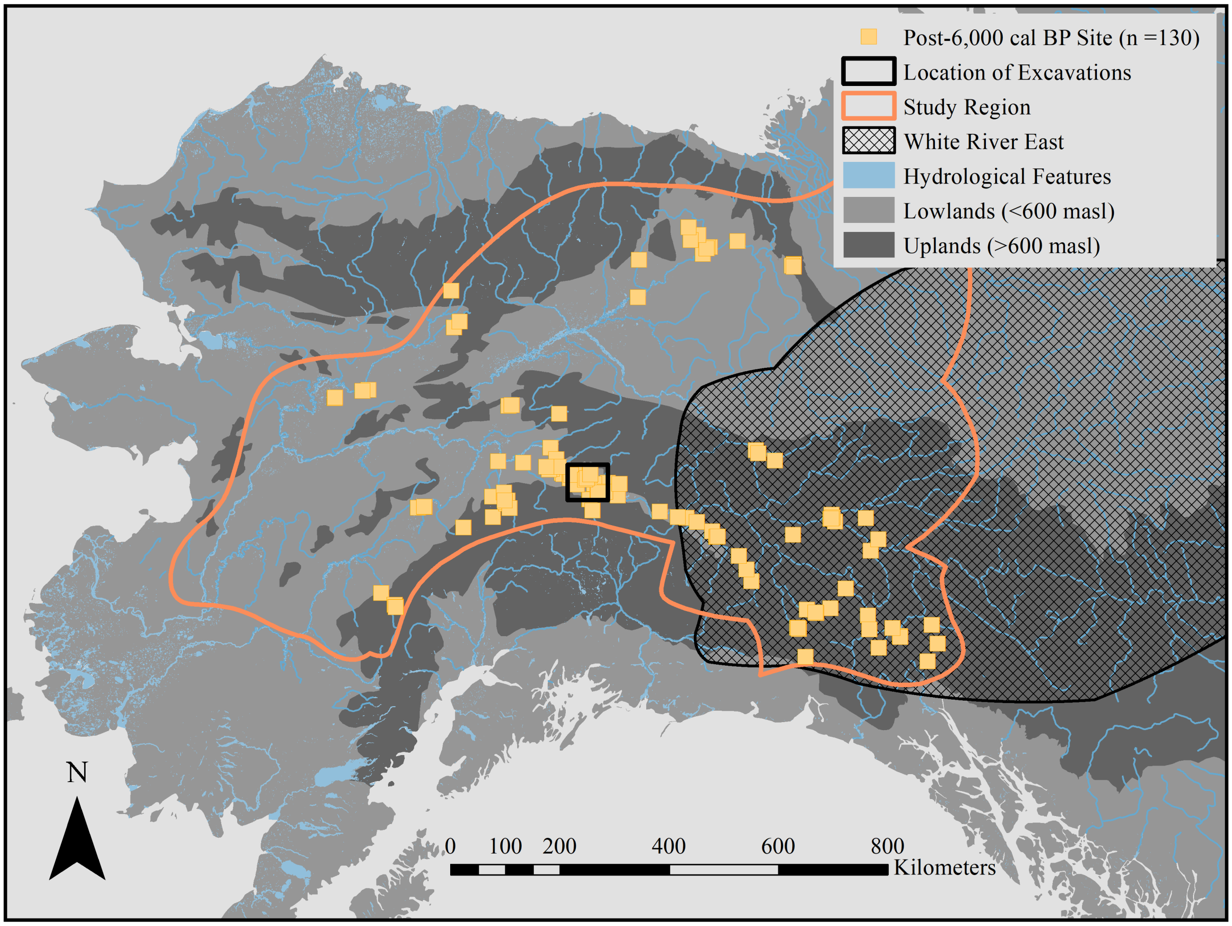


Figure 6.2 Northern Dene/Athabascan Sites in the Study Region Occupied After 6,000 cal BP

Occupation size and ecological information reveal significant differences in spatial patterning across these periods of Subarctic history that suggest that Northern Dene/Athabascans gradually expanded their uniquely adapted subsistence strategy across both upland and lowland ecological zones over the past 2,000 years, with significant shifts in land use from the previous period. These will be considered in detail below.

Table 6.1 Results of Landscape Analysis

	6,000-2,000 cal BP Assemblages	**2,000-100 cal BP Assemblages**	**2,000-1,150 cal BP Assemblages**	**1,150-100 cal BP Assemblages**
Total number (*n*)	79	119	61	58
Upland (*n*)	56	56	29	27
Lowland (*n*)	23	63	32	31
Mean distance to nearest lake (km)	11.9	9.3	7.3	9.5
Mean distance to nearest river (km)	1.3	1.9	2.5	1.2
Mean diameter (m)	163	159	163	157
Mean upland diameter (m)	182	168	186	158
Mean lowland diameter (m)	114	151	143	156

Pre- and Post-2,000 cal BP

Landscape data from before and after 2,000 cal BP demonstrate the changes to landscape relations that is part of the broader Northern Dene/Athabascan transition (Figure 6.3). The results of a two-tailed Student's *t*-test show that no significant difference exists in overall site size during the pre- and post-2,000 cal BP periods ($t = -0.21$, $p = 0.84$). Additionally, average upland site sizes before and after 2,000 cal BP are not significantly different ($t = 0.28$, $p = 0.78$), nor are average lowland site sizes before and after 2,000 cal BP ($t = -1.17$, $p = 0.25$). However, upland sites are significantly larger in diameter than lowland sites before 2,000 cal BP period ($t = -2.66$, $p = 0.01$), by around 70 m on average. After 2,000 cal BP, upland sites are around 20 m larger in diameter than lowland sites, and this difference is also significant ($t = 2.16$, $p = 0.03$). Average site size does not change significantly before and after 2,000 cal BP and upland sites remain significantly larger than lowland sites throughout the mid- to late Holocene, though by a smaller margin after 2,000 cal BP.

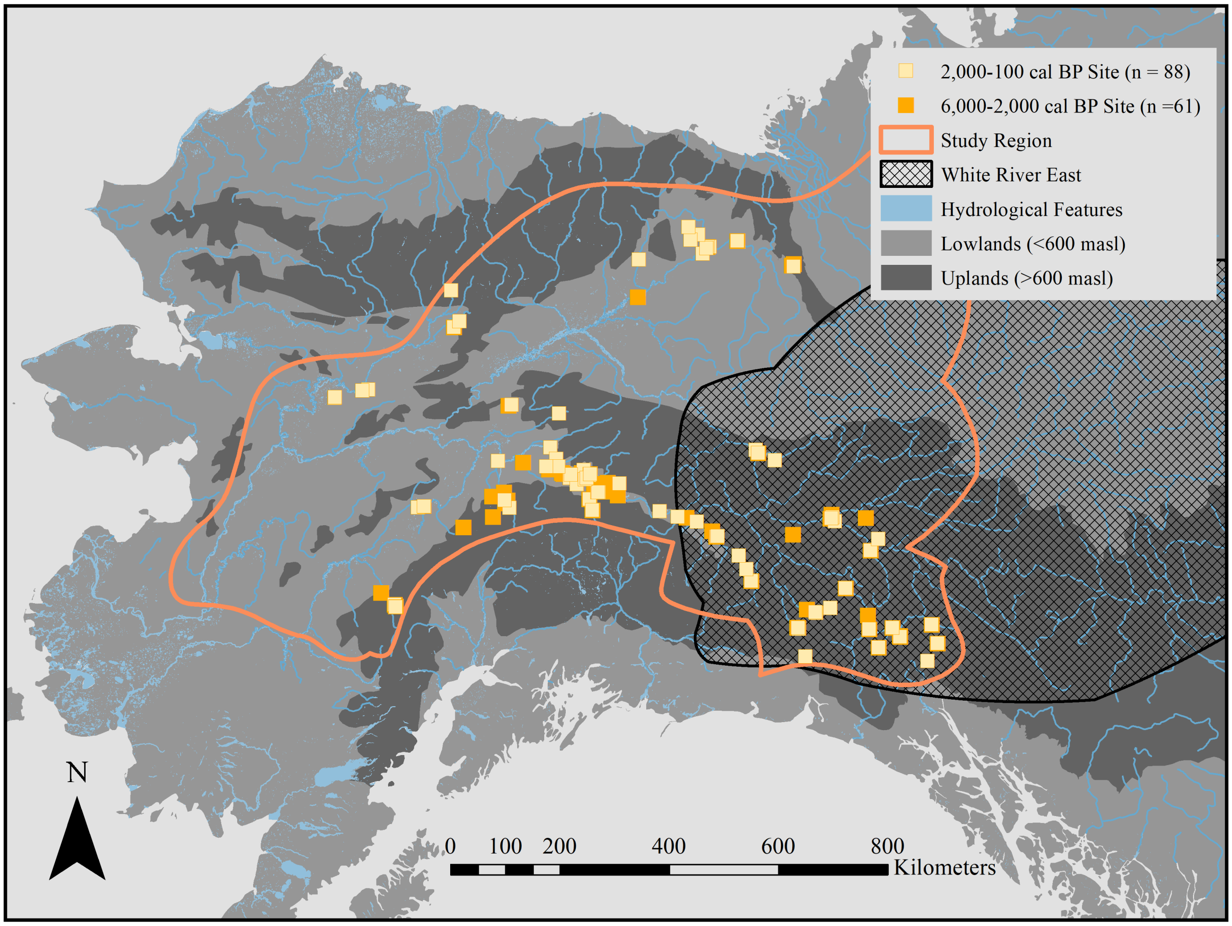


Figure 6.3 Northern Dene/Athabascan Sites in the Study Region Occupied between 6,000– 2,000 cal BP and 2,000–100 cal BP

To ascertain resource and landscape use at different periods in the past, I considered site placement in different ecoregions and relative to rivers and lakes. The results of a two-tailed Student’s t-test show no significant difference between proximity to rivers before and after 2,000 cal BP ($t = 0.5$, $p = 0.61$). Contrastingly, the results of a t-test showed that post-2,000 cal BP occupations were significantly closer to lakes than pre-2,000 cal BP sites ($t = 2.04$, $p = 0.04$). On average, post-2,000 cal BP occupations were 2.4 km closer to lakes than pre-2,000 cal BP sites. Finally, the results of a Chi-squared test show that the distribution of sites was significantly different during the pre- and post-2,000 cal BP periods ($p < 0.001$), with significantly more upland sites than lowland sites during the pre-2,000 cal BP period and an even distribution during the post-2,000 cal BP period.

Pre- vs. Post-White River Ash East

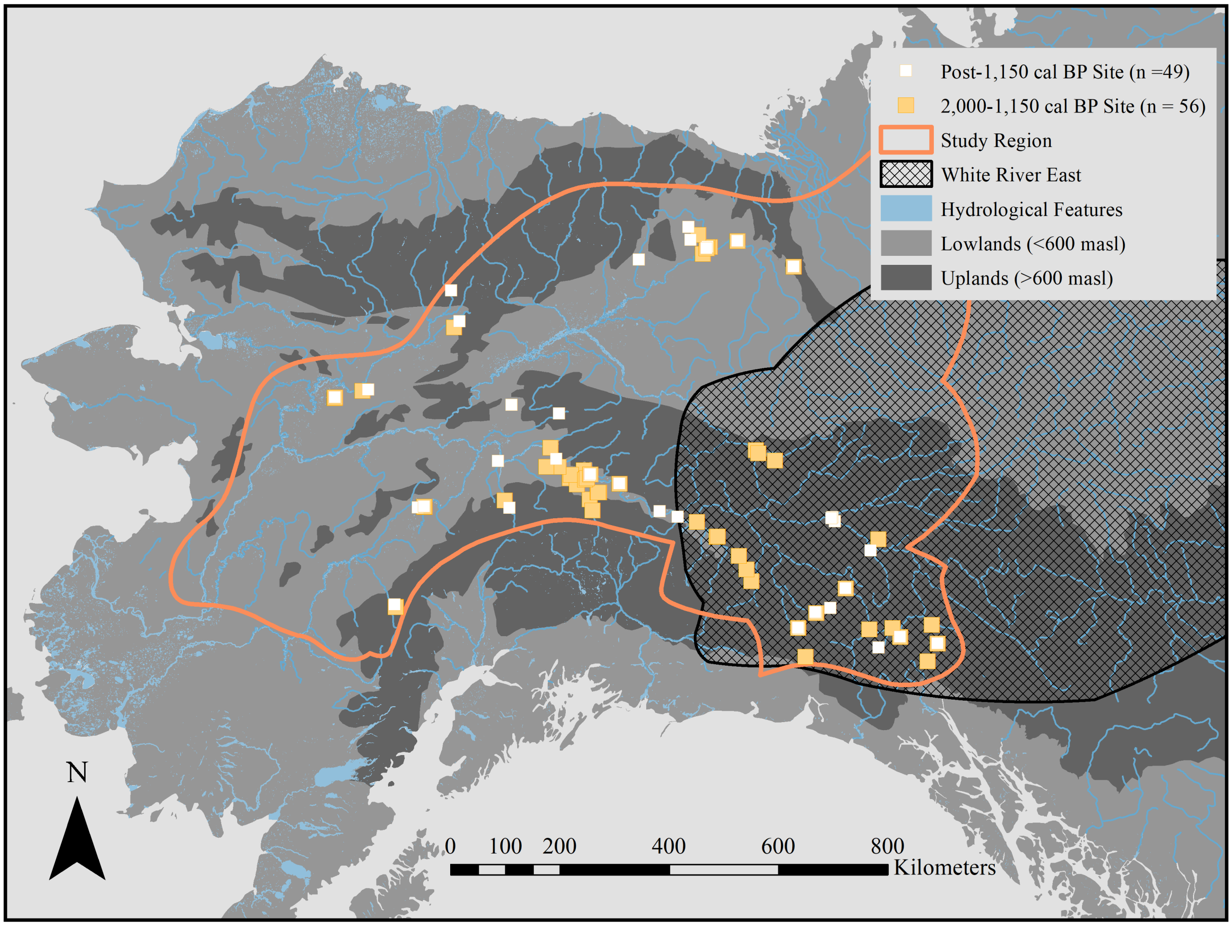


Figure 6.4 Northern Dene/Athabascan Sites Occupied after 2,000 cal BP relative to the White River Ash East

Results were further divided into pre- and post-WRA east to ascertain landscape use patterns during the last 2,000 years of Northern Dene/Athabascan history (Figure 6.4). A two-tailed Student's t-test showed no significant difference in overall site diameter before and after the WRA east event (t = -0.85, p = 0.4). Additionally, the difference in average site diameter among upland sites occupied before and after the WRA east was not significant (t = 1.5, p = 0.12). Average lowland site diameters remain consistent before and after the WRA east as well (t

= 0.07, *p* = 0.95). However, before the WRA east, upland site diameters were 43 m larger than lowland site diameters on average and this difference is significant (*t* = 2.16, *p* = 0.03). After the WRA east, there is no significant difference between average upland and lowland site diameters (*t* = 0.95, *p* = 0.48). Upland sites were significantly larger than lowland sites before the WRA east but not after, and this represents the only significant change in site size during this period

Patterns in site placement relative to rivers and lakes as well as overall sites present in upland and lowland locations were assessed to document landscape patterning before and after the WRA east event. The results of a two-tailed Student's *t*-test showed that post-WRA east occupations were significantly closer to rivers than pre-WRA east sites (*t* = -2.67, *p* < 0.01), 1.4 km closer on average. In contrast, no significant difference was found in lake proximity pre- and post-WRA east (*t* = -0.49, *p* = 0.63). Finally, a Chi-squared test showed no significant difference in upland and lowland site distribution between these two periods (*p* = 0.91), indicating that the distribution of sites in upland and lowland ecoregions was consistent before and after the WRA east.

Mid- to Late Holocene Subarctic Landscapes

The results presented here strongly suggest that Northern Dene/Athabascans gradually changed their use of landscape to facilitate specialized subsistence pursuits in distinct upland and lowland locations and support increasing regional populations. Furthermore, the results do not suggest that either the WRA east or north had a significant impact on interregional Northern Dene/Athabascan culture, nor are the results consistent with an unknown but equally rapid environmental collapse. These results are, however, consistent with the data recovered and analyzed from five occupations in central Alaska and suggests that the Northern

Dene/Athabascan transition and migration can be attributed to shifts in social structuration, regional population increases, and fissioning.

By comparing land use between 6,000–2,000 cal BP vs. 2,000–100 cal BP and 2,000–1,150 cal BP vs. 1,000–100 cal BP, the data suggest gradual rather than rapid changes in landscape use. The data considered here show significant changes in land use over the long term (i.e., 6,000–2,000 cal BP vs. 2,000–100 cal BP) but no significant changes in the shorter term (after 1,150 cal BP). Specifically, sites are closer to lakes, more likely to be located in the lowlands after 2,000 cal BP, and lowland sites, while still significantly smaller than upland sites, increase in size relative to upland sites. After 1,150 cal BP, lowland sites are significantly larger than upland sites and all sites are significantly closer to rivers compared to the preceding 1,000 years. First, this shows that the WRA east even ca. 1,150 cal BP did not trigger an expanded use of lowland ecological resources as this had already begun ca. 2,000–1,000 years ago. Before 2,000 cal BP, 71% of all sites in the region were located in the uplands (*n* = 56) whereas only 47% of sites were located in the uplands after 2,000 cal BP (*n* = 56). The number of upland sites remains consistent during the subsequent period: before the WRA east, 48% of sites (*n* = 29) were located in the uplands whereas afterwards 47% of sites were located in the uplands (*n* = 27). While the number of upland sites remains consistent throughout the mid- to late Holocene, the number of lowland sites nearly triples, from just 23 before 2,000 cal BP to 63 sites after 2,000 cal BP. Second, gradual increases in lowland site size relative to upland site size suggest an increasing adaptation to specialized fishing in the region with continued use of upland resources. Before 2,000 cal BP, upland site diameter was 70 m larger on average, compared to 20 m larger on average after 2,000 cal BP. Of sites occupied after 1,150 cal BP, average upland site diameters were only 2 m larger than lowland sites. These data indicate that lowland sites were increasing in size relative to upland sites. This increased reliance on lowland ecoregions relative to upland ecoregions is also reflected in the lack of significant changes to the number and size of upland sites across the entire time period detailed above. Third, site placement in relation to prominent lowland features such as lakes and rivers shows the increasing focus on these predominantly lowland resources through the 2,000–100 year before present period, with decreased distance between sites and lakes and subsequent decreases in the distance between sites and rivers after 1,000 years before present. With the caveat that decreased distance to rivers through time may be related to taphonomic processes (braided rivers are common in this region), these results all reflect gradual shifts in land use rather than punctuated transitions elicited by sudden environmental shifts, such as a volcanic eruption.

The gradual changes in landscape relations represented in these landscape are consistent with expectations for a scenario in which Northern Dene/Athabascans changed shifted land use strategies response to increasing populations and regional population density. In environments with predictable and dense resources, specialized use of those resources provides the optimal foraging strategy. Increasingly territorial and endogamous groups could support growing populations through intensified use of predictable and dense resources such as seasonally abundant fish and caribou. Significantly, the landscape data show gradual increases in the specialized use lowland locales in distance to riverine and lacustrine resources, lowland site size, and number of lowland sites. The distance between lowland sites and lakes and rivers decreases beginng ca. 2,000 cal BP. Additionally, lowland site sizes are significantly larger after 1,000 years ago and the number of lowland sites increases significantly after 2,000 cal BP. Upland site use, however, remains consistent from 6,000 cal BP to present, with consistent numbers of occupations and occupation size throughout the period considered here. Each of these trends in site placement and size are consistent with ethnographic and oral historic accounts that emphasize the increased importance of centralized fishing camps as seasonal villages in the region's recent past and ethnographic present with continued use of upland ecoregions for big game hunting. Communal caribou hunting is still pursued across the uplands by Northern Dene/Athabascans while intensive fish harvesting and processing takes place in the lowlands.

Summary

These results document gradual increases in population size through increased number of sites and increases in site size, particularly those in the lowlands. The emphasis on lowland resources reflects increasingly intensive use of fish among Northern Dene/Athabascans during this period. Combined, these land use shifts are consistent with gradual changes in the social landscape associated with shifts in group structuration suggested by Ives (1990). As groups become increasingly endogamous, territorial, and large, new subsistence strategies promoted further group growth. As a result, large groups likely fissioned with some regularity and this fissioning likely resulted in the Dene/Athabascan migration.

Chapter 7 Reconstructing the Northern Dene/Athabascan Transition and Migration

Introduction

The results aggregated from two scales of technological, subsistence, and land use data have several implications for the Northern Dene/Athabascan transition and the ultimate migration south. Specifically, these results show that Northern Dene/Athabascan land use gradually changed to become more specialized between 1,800–1,200 cal BP, reflecting predictions associated with a pronounced demographic change rather than rapid ecological deterioration associated with a volcanic eruption and/or sudden caribou population bottleneck. Moreover, the results indicate that the timing of this change is inconsistent with an adaptive response to either WRA event, further demonstrating that the Dene/Athabascan migration resulted from gradual demographic shifts.

Transition to an Intensified Subsistence Economy

Generally, subsistence and technological results from investigations of five occupations that pertain directly to the Northern Dene/Athabascan transition reflect intensified resource use based on ecological zone and are consistent with an overall increase in diet breadth associated with the broader Northern Dene/Athabascan transition. Artifacts recovered from five components located in both upland and lowland ecological contexts are suggestive of location-specific uses of technology and strategies for technological production. First, lowland sites yielded much higher quantities of exotic material, such as obsidian and copper. Additionally, expedient tools were recovered in significantly higher quantities from occupations in lowland ecological zones, as was debitage associated with late stage bifacial reduction. In contrast, sites located in upland ecological zones exhibited significantly more microblades and early bifacial reduction than lowland occupations. These results indicate that technology was structured around resource availability and associated with specific upland and lowland subsistence pursuits, suggesting that bifacial reduction began in the uplands and reduced bifaces were transported for further reduction, use, and modification in the lowlands, where expedient tools, exotic materials, and, potentially, osseous tools were curated (Shinkwin 1979). Tools associated with these distinct upland and lowland assemblages could have lowered the handling time of different resources to maximize their yield, thus serving to increase subsistence returns without increasing territory extents. Within a multiscalar context, this limited inter-assemblage analysis provides one proxy for explaining why Northern Dene/Athabascan diet breadth and populations increased during the late Holocene.

Previous research has shown limited evidence for the specialized use of hunting technologies within Northern Archaic lithic assemblages prior to the Northern Dene/Athabascan transition. Specifically, one technological curation model of the suggests that bifacial reduction occurred in the uplands and was associated with upland caribou hunting and microblade reduction took place in the lowlands and was associated with lowland moose and bison hunting (Potter 2008; Wygal 2010). The technological data presented here illustrate greater ecological specialization in raw material, reduction strategy, and use among Northern Dene/Athabascan assemblages, that indicate a technological transition between 1,800–1,200 cal BP. The interassemblage data considered here are compelling but limited. Without additional subsistence and settlement patterning data, it would be impossible to argue that the patterns in the data considered here were not the result of any number of equifinal processes. Additional research focused on reduction sequence, chronology, and location from occupations spanning the period and region of interest could further articulate the nature and timing of this technological change and would likely reveal greater nuance in Northern Archaic technological organization. In sum, these technological results suggest an increase in specialization relative to current understandings of the Northern Archaic that is consistent with increased populations and territoriality suggested by the diet breadth and economic defensibility models.

Results from a compound-specific isotope analysis of fatty acid methyl esters from hearth contexts also suggest that diet breadth increased during the Northern Dene/Athabascan transition, consistent with previous research (Potter 2008; Holmes 2008), but the results also show that subsistence use was specialized based on ecological context. Specifically, the dietary mixing model presented here showed that freshwater resources likely comprised over half of all subsistence resources cooked in all three lowland occupations. These probability distribution data indicate a specialized use of freshwater resources in these lowland settings, demonstrating that this lower-ranked resource was intensified even though higher-ranked resources, such as caribou, were locally available (Broughton 1994). Previous multiscalar research has shown that environmental variability drives security and generalization, not optimization and intensification, among foragers. The dietary reconstructions presented here are consistent with economic intensification suggested by specialization in salmon associated with the Northern Dene/Athabascan transition (Morgan 2009) and conflict with expectations for a response to sudden ecological failure, such as a volcano-induced caribou population crash. Future geochemical research on upland hearth remains could elaborate on these findings.

The analysis of landscape data is also consistent with the results from hearth remains and previous research that suggests intensified use of lowland ecological zones ca. 2,000–1,000 cal BP (Potter 2008). Starting ca. 2,000 years ago, the overall number of sites as well as the number of lowland sites significantly increased, reflecting changes in subsistence suggested by archaeological and ethnohistoric data. Additionally, upland site size remains constant while lowland site size grows significantly. The rising the number of lowland sites in combination with the expansion of average site footprint indicate the increased importance of this ecological zone after 2,000 years ago. Upland site size and count remain consistent throughout this period, indicating that these sites maintain their importance within a subsistence system that became increasingly oriented around specific upland and lowland resources. This suggests that late summer and early fall resource scheduling conflicts and increased population size were resolved by committing to an increasingly specialized subsistence system within upland and lowland ecological zones.

A Gradual Change

Evidence from technology, subsistence, and landscape use presented above indicate that the changes to subsistence, mobility, and technology associated with the Northern Dene/Athabascan transition were gradual, occurred between 1,800–1,200 cal BP, and were unrelated to volcanic-induced environmental degradation. The results of the technological analysis above suggest that assemblages vary more with location than age. Evidence for microblade production was recovered both from Clearview, one of the earliest occupations considered here, and from the lower locus at the Klein Site, which was occupied around 1,000 years later and well after the WRA east event. Archaeologists have previously suggested that microblade use ended around the time of this event and atlatl and dart technology was replaced by bow and arrow technology based on data from Yukon ice patches (Potter 2008; Hare et al. 2012; Holmes 2008). Yet, the limited evidence for continued microblade reduction from the Klein Site presented here is in line with a growing body of research that indicates that microblade production continued for at least 600 more years after the WRA east in central Alaska and Yukon (Shinkwin 1979; Rainey 1940; Holmes 2008; Proue et al. 2011; Fafard 1999; Esdale 2007). The introduction of copper technology in this region has also been associated with the WRA east event (Hare et al. 2012; Cooper 2007; Moodie et al. 1992). Again, results from the upper locus of the Klein Site suggest that copper technology was already present in the region ca. 1,250 cal BP, well before the WRA east event, though the copper materials recovered showed evidence of cold hammering indicating that hot-working, a unique characteristic of most Northern Dene/Athabascan copperwork, may have been developed later in the region (Franklin et al.1981). The prolonged use of microblade technologies suggested by a growing body of evidence, including microblade technology at the Klein Site, and the earlier introduction of copper tools represented by artifacts at the Klein Site upper locus indicates that both technological transitions were gradual and unrelated to the WRA east, a conclusion broadly supported by recent synthetic research in the region (Kristensen, Hare, et al. 2019; Grund and Huzurbazar 2018).

The geochemical results presented above also point towards a prolonged transition that spans the late Holocene. Hearths at sites occupied from 1,300–500 cal BP all showed similar patterns in subsistence use according to the isotopic composition of fatty acids extracted from those soils. This indicates that fish were an important resource from at least 1,300 cal BP. Additionally, the lack of definitive bow and arrow technology in assemblages through 500 cal

BP indicates that overall increases in diet breadth are unrelated to a transition to bow and arrow technology, consistent with previous research that showed increased diet breadth preceded the introduction of bow and arrow technology to the region (Kristensen, Andrews, et al. 2019: 787). However, bow and arrow technology in the region is commonly made of wood or bone, materials that do not preserve well in Subarctic soils (Fafard 1999, Hare et al. 2012) and thus, the absence of evidence of bow and arrow technology is not evidence of absence. Future excavation research that involves both soil pH testing and analyses of fatty acid methyl esters should be conducted to identify preservation contexts and dietary trends of Northern Archaic tradition assemblages. Such results may reveal a wide diet breadth at even earlier periods in Subarctic history (Holmes 1975: 101) and contextualize the preservation environment of these assemblages.

Results of the landscape analysis show evidence for gradual changes during the Northern Dene/Athabascan period that spans 2,000 cal BP to the protohistoric period ca. 100 cal BP and a significant departure from the previous period, suggesting a prolonged period of cultural change and a broad window for the timing of the Dene/Athabascan migration. Before and after the WRA east ca. 1,150 cal BP, we observed no significant changes in number of sites nor any changes in upland site size. This indicates that upland resources were pursued similarly during the last 2,000 years of Northern Dene/Athabascan history, and that communal caribou hunts likely continued through this period. However, lowland sites were significantly larger, and occupations were significantly closer to rivers after 1,000 years ago, suggesting that commitment to lowland resources and particularly riverine resources such as fish had increased by this time. These changes in landscape use may be related to a general lowland expansion associated with increasingly intensified use of fish that spans the late Holocene or may simply represent preservation bias associated with braided rivers common to the region (Anderson et al. 2019). Additional geospatial analysis with currently available archaeological and geological data from the region could establish the relationship between site age and proximity to these vacillating and destructive hydraulic features.

Recent research has re-emphasized the importance of understanding the complex Northern Dene/Athabascan social landscape, with a network of traded exotic raw materials that collectively spans Northwest Alaska to southern Alberta and beyond. Kristensen, Andrews, et al. (2019) and Kristensen, Hare, et al. (2019) conclude that neighboring Northern Dene/Athabascan and non-Dene/Athabascan groups shared their territories with southern Yukon Dene/Athabascans for a brief time following the WRA east event before these affected Northern Dene/Athabascans either returned or moved further south, towards Alberta and the Great Plains, and adopted bow and arrow technology from coastal, non-Athabascan groups. However, the results presented here suggest that Northern Dene/Athabascans adapted to increased population pressure with increased territoriality, which provides a more parsimonious explanation for a gradual decrease in interactions among Northern Dene/Athabascans and increased interactions between Yukon Dene/Athabascans and neighboring groups represented by obsidian and clinker sourcing studies (Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019; Dyson-Hudson and Smith 1978). Further, the sudden adoption of bow and arrow technology is frequently associated with increased territoriality and likelihood of interpersonal conflict, providing a tangible trigger for the adoption of this technology represented in Yukon ice patch assemblages (Maschner and Mason 2013). Together, the data from this multiscalar analysis indicate that trade network dynamics in Yukon reflect broader changes to the social landscape related to increased population size.

Athabascan Culture and Migration

Combined, this multiscalar dataset suggests that a gradual increase in population that began in the region around 2,000 cal BP led to the Northern Dene/Athabascan transition, a suite of changes across mobility, subsistence, and technology among Dene/Athabascans in the Subarctic during the late Holocene, and that these changes are intimately linked to the broader Dene/Athabascan migration in which part of the population permanently began moving south. Consistency between Northern and Southern Dene/Athabascan terminology for ceramic, copper, and bow and arrow technology indicates that this technological transition was inherent to the iterative process of the Dene/Athabascan migration (Wilson 2019; Ives 2010; Colson 1979). Results from a multiscalar dataset comprising subsistence, mobility, and technology point to a gradual change that resulted from regional resource stress caused by population increase and pressure, not by a rapid environmental change (Figure 7.1).

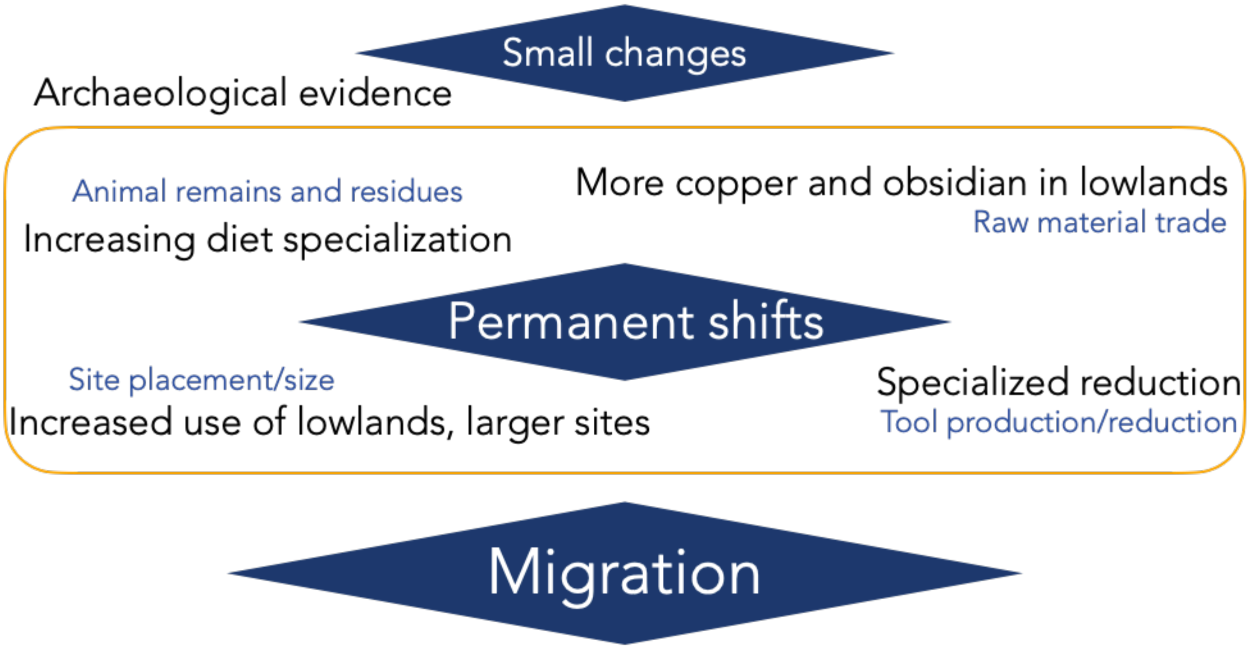


Figure 7.1 Multiscalar Model of Migration with Results of Investigations

Population pressure may have resulted from a population increase, facilitated by endogamous local group growth kinship systems documented in northern Canadian Dene (Ives 1990). Archaeological evidence from the broader Western Arctic suggests that this population increase was *in situ* rather than based in territorial encroachment by neighboring groups (Friesen 2016). Oral histories, environmental dynamics, ethnographic comparison, and the nature of Northern Dene/Athabascan kinship suggest an *in situ* population increase could be attributed to endogamous local group growth, a hereditary social structure documented in protohistoric Northern Dene/Athabascan groups such as Beaver of present-day Alberta, Canada (Ives 1990:302). Beaver kinship structure, based on a Dravidian system of cross-cousin marriage associated with Northern Dene/Athabascan kinship terms, favors group conservation and local growth via three key mechanisms: recruitment from outside the group, affinal relations between group and non-local group spouses, and maturation and marriage of children within the group (Ives 1990:113). This endogamous social organization is practiced among Arctic Drainage Dene/Athabascans that neighbor central Alaskan and Yukon Dene/Athabascans during the ethnographic present as well as Western Apache (Kraus and White 1956). Finally, if a local group growth kinship system emerged cyclically in the Northern Dene/Athabascans, this may explain the multiple, pulsed southward migrations proposed by linguistic historians of Southern Dene (Wilshusen 2010).

Local group growth social structures have several archaeological proxies associated with the structure of this group formation and population growth more generally. Ives (1990) envisioned local group growth systems as semi-sedentary within Binford’s (1980) residential-logistical mobility paradigm, with large central residences complemented by a series of smaller logistical foraging camps. Increased sedentism and group size should be facilitated by a reliance on communally harvested resources. As opposed to local group alliances, where communal hunting serves largely to maintain social networks across large distances, local group growth formations rely on communal foraging and stored resources as a means of supporting larger local groups (Kelly 2013:161). Hence, endogamous local group growth formations represent a transition to increased communalization and isolation from neighboring groups (Dyson-Hudson and Smith 1978). Yet, this explanation for *in situ* population increase remains largely speculative as it is difficult to conclusively assess with the available archaeological data. Further collaboration between linguistic and archaeological researchers in the region could better test the relationship between kinship, social structure, and population size before and during the late Holocene

Given the linguistic and historical context, the demonstrated late Holocene increase in the region's archaeological sites may be suggestive of a shift to a local group growth formation because a shift in kinship structuration accounts for the mechanism of growth via kin structuration terminology and opposite sex sibling cores, linguistic conservatism as it relates to novel technologies (Wilson 2019), and the gradual shift to increased sedentism and logistical mobility illustrated in the region's archaeological data (Ives 1990:324). *In situ* population growth driven by this localized shift in kinship structuration would lead to endogamous, siloed communities that could have increased their commitment to predictable and dense subsistence resources in order to support increasing populations (Kelly 2013:161). Moreover, ethnographic data suggest that predictable and dense but seasonally available resources foster a territorial system of resource control (Dyson-Hudson and Smith 1978). Essentially, this shift from exogamous to endogamous group organization likely resulted in the suite of changes to mobility, subsistence, and technology documented within the archaeological record of the region.

Therefore, I argue that the Dene/Athabascan migration event was ultimately caused by demographic change—specifically, a population increase—that was itself plausibly precipitated by a shift to endogamous, local group growth formation. Based on the data considered here, I conclude that an overall increase in regional populations led to the Northern Dene/Athabascan transition and resulted in the Dene/Athabascan migration, in contrast with previous assessments that correlated these changes and migration exclusively with volcanic activity in the region (Mullen 2012; Hare et al. 2012; Derry 1975; Workman 1979). Additional research should be conducted to determine the pace, degree, and type of behavioral change immediately following the WRA east event on both sides of the US-Canada border, and to quantify site-level variation between riverine and lacustrine sites in lowland ecological zones, especially in central Yukon. Such future research endeavors could establish whether or not this increase in population can be attributed to historic shifts in group formation principles.

These conclusions reinforce the importance of considering hunter-gatherer culture and history from a theoretical standpoint that offers tangible material predictions from an entangled environmental and social perspective. Archaeologists frequently focus on rapid environmental changes such as volcanic eruptions, drought, and temperature change in their explanations of hunter-gatherer adaptation and cultural change. However, these sudden perturbations may provoke adaptive responses that are distinguishable from responses to prolonged environmental, demographic, or social changes. These adaptive responses must be considered as distinct from biological adaptations and can be viewed within an aggregational model of adaptation suggested by Colson (1979). This research shows the importance of carefully tracking the timing and type of adaptive shifts at various scales to isolate causal factors. Further, the results suggest that Subarctic hunter-gatherers are resilient to rapid ecological shifts and more sensitive to gradual demographic change. Research that focuses on cultural changes in hunter-gatherers in other regions can complement the findings presented here by showing the effects of various external and internal pressures on land use, subsistence, and mobility throughout the past.

Heritage, Theory, and Environmental Bias

From a theoretical perspective, the White River Ash events do not provide the most parsimonious explanation for the Northern Dene/Athabascan migration. However, this has not kept archaeologists from pursuing this explanation in their research for the last five decades, implicitly reemphasizing the tenuous relationship between Northern Dene/Athabascans and their environment. Theoretical concerns with this explanation owe to issues related to Northern Dene/Athabascan history and the timing and severity of the volcanic eruption compared to other, more regular ecological perturbations. In the Subarctic, caribou populations crash with great regularity, likely every two to three human generations (Burch 1972:356), and it is widely recognized that Northern Dene/Athabascans exercised a suite of adaptive strategies to combat the losses related to these regular caribou die-offs. First, intergenerational oral histories addressed additional resources and alternative regions with friendly neighboring groups that could temporarily support increased populations (Whallon 2011:25; Dyson-Hudson and Smith 1978). Second, Northern Dene/Athabascans moved hundreds of kilometers interannually and high mobility buffers against regional ecological disturbances. For these reasons, it is unlikely that a regionalized environmental downturn would result in a suite of dramatic *in situ* cultural transition.

The WRA events may not have produced the severe ecological effects assumed by archaeologists, either. Both ashfalls were patchily distributed, even the larger ashfall associated with the WRA east volcanic event. Research conducted following Mount St. Helens' 1980 eruption provides several ecological and chronological parallels with the eruptions originating from the Mount Churchill-Bona massif. First, both environments support a variety of cervids, salmonids, and lichens. Second, the eruptions are of the same type and severity. The results of research on Mount St. Helens' ecological rebound shows that the ecological effects of volcanoes are patchy, and some pockets appear to survive unaltered following an eruption (Crisafulli et al. 2018). Further, salmonids, bovids and even lichens rebound within two to three decades and perhaps even in less than a decade (Crisafulli et al. 2018; Blackman et al. 2018; Nelson et al. 2018). Thus, this research stresses the responses to volcanic events are patchy, unevenly distributed, and generally less severe than often assumed, particularly by archaeologists. The Mount St. Helens eruption offers a parallel ecological example that emphasizes the unlikelihood of the WRA events motivating a monocausal inter-regional cultural overhaul among Northern Dene/Athabascans and a related out-migration.

Since Workman's (1979) initial supposition that volcanic activity caused the Northern Dene/Athabascan transition, archaeological research has increasingly called into question the degree to which the WRA actually impacted Northern Dene/Athabascans. Syntheses of chronological and material cultural data from Yukon, the area most likely impacted by the WRA events, emphasize the limited population-level effect of these past eruptions. Mullen's (2012) study of summed probability distributions reflects a small population downturn ca. 1,800 cal BP, at the time of the smaller WRA north, but no correlated population effect at the time of the WRA east. Paleoecologists have yet to recover any evidence for an ecological disruption linked to this smaller and earlier WRA event and thus the correlated population decrease may be a product of the small dataset considered. Additionally, recent research on artifact sourcing focused on western Canadian assemblages has failed to identify conclusive or long-term disruptions in broader trade networks spanning this critical period (Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019), suggesting that a rapid regional decline in Northern Dene/Athabascan populations is unlikely. These recent syntheses of Canadian material data related to Northern Dene/Athabascan history emphasize the unlikelihood of a monocausal volcanic explanation for the Northern Dene/Athabascan transition and migration.

Recent synthetic research and problematic theoretical assumptions have not kept researchers from pursuing an environmental explanation for the Northern Dene/Athabascan transition and migration. Environmental explanations and volcanoes in particular are anchored within archaeological imaginations and difficult to unmoor, even with mounting evidence that calls these explanations into question. Is it because of the Western ontological dichotomy of (and fixation on) man vs. nature? Does it owe to many archaeologists' fascination with the "Pompeii premise"? Or does the reluctance to give up this just-so environmental explanation simply reflect distaste for employing sociality and para-processualist paradigms in hunter-gatherer archaeology? Regardless, the persistence of this volcanic explanation within Northern Dene/Athabascan archaeology is yet another example of positivist pitfalls and the prevalence of implicit bias within hypothetical-deductive reasoning. Here, the danger is not only that the "truth" or a greater understanding of the archaeological record and human history may escape archaeologists, but that the Northern Dene/Athabascans of the past may be denied agency to survive a basic environmental hurdle that they almost certainly overcame with ease due to a refined adaptive framework honed over millennia. Our understanding of Northern Dene/Athabascan resilience, survivorship, and, ultimately, heritage will be incomplete if we continue to promote faulty models of environmental determinism in our archaeological conclusions. The same could be said of other regions, peoples, and periods around the world. Interpreting hunter-gatherer history through a limited environmental perspective hampers our ability to explore and appreciate the broad spectrum of human culture.

Archaeologists can overcome these limited and quasi-environmentally deterministic frameworks by incorporating lines of evidence from other subfields of anthropology and other social scientific disciplines. Linguistic data can provide a new window into human sociality, placemaking, and landscape learning in the past due to the depth and breadth of cognitive information stored in speech. As archaeologists, we don't know what we don't know about the past and our assertions are limited by our experiences: we can only imagine the things about the past that are based in known concepts. To push past these rigid assumptions of human behavior and culture, students of hunter-gatherers must reflect on different knowledge systems, ways of storing and transferring information, and of social systems that have nothing to do with the natural environment at all. Borrowing theoretical and methodological approaches from other disciplines can augment our perspective on the past and enrich our understanding of human history.

Future Directions

The work presented here suggests many possibilities for research in the coming years on both sides of the US-Canada border, from additional testing to evaluating previously excavated collections, and possibilities for refining models of human mobility and adaptation in the past. This research presents novel results from multiple scales employing several methods that shed light on new or understudied areas of inquiry across the discipline and the region. Briefly, this section outlines research that could build on the results presented and discussed here to add to our understanding of Northern Dene/Athabascan history, hunter-gatherers, and migrations throughout the past.

Archaeological research that considers newly recovered or existing collections of lithic and faunal material from central Alaska and Yukon should be conducted to verify or refute the conclusions discussed here. Namely, archaeologists in the region should conduct additional comprehensive testing of late Holocene assemblages found in stratified occupational contexts. The results presented here comprise detailed artifactual data from two ecological zones and five occupations spanning nearly 1,000 years of history, but they are drawn from a relatively circumscribed geographic area within an intensively investigated archaeological landscape, the middle Tanana River Valley. Recovering additional material from sites in neighboring regions across central Alaska and Yukon and comparing those materials to the data presented here would provide many comparative avenues for synthesizing late Northern Dene/Athabascan history. Recent and on-going cultural resource management research efforts that have expanded wide-scale surveys beyond the road system and are quite promising in this respect (Anders et al. 2020; Esdale et al. 2018; Proue et al. 2016). For academic researchers, whose grant budgets often include support for remote field access, targeting critically under-researched areas could provide new insights into landscapes used by Northern Dene/Athabascans for millennia but largely ignored by archaeologists in the present. Alternatively, archaeologists of the region may be able to draw from existing collections of materials housed at regional museums to produce comparable results without increasing space demands on museums or incurring costs related to conducting remote fieldwork. The research presented here provides new insight into the complex social relations and social structuration shaping Northern Dene/Athabascan behaviors and adaptations. Additional material and collections-based research will articulate this complex relationship further and provide greater insight into human decision-making in the past.

In Chapter 5, I presented the results of a relatively novel residue analysis technique applied to preserved fatty acids extracted from cooking features that provided critical insights into diet breadth and specialization during the Northern Dene/Athabascan transition. This technique is relatively fast, inexpensive, and comprehensive in its results, which can be used to reconstruct the relative contributions of various fauna to fats preserved in ancient cooking hearths. Thus far, this technique has largely been employed in coastal regions. The results presented here demonstrate its applicability to central Alaskan and interior Subarctic archaeological research questions, as limited previous research using cooking feature remains from a much earlier occupation has shown (Choy et al. 2016). Many archaeologists collect soil samples through site testing for future use and many kilos of soil are housed at research museums such as the University of Alaska Museum of the North. These soils should be analyzed through this novel technique to provide profiles of past diet breadth in central Alaska, Yukon, and beyond through isotopic chemistry. A compound-specific isotope analysis of cooking feature fats is particularly useful for sites that have limited testing extents or limited quantities of identifiable fauna. Where some faunal remains are necessary to provide an accurate baseline for Bayesian dietary mixing models and a regional model of subsistence would inform such research, this residue analysis approach obviates a total collection and tedious hours of comparative faunal identification while providing an accurate relative contribution of different faunal sources to cooking activities. Legacy collections can be reanalyzed using this technique and aggregating an isotopic database could leverage the region's strengths in survey coverage and theory-driven scientific research.

Landscape analysis increasingly provides a gateway to regional syntheses in archaeology. In Chapter 6, I considered how macro and micro geospatial scales can be compared to elucidate more information about mobility, technological organization, subsistence, and landscape use in the past. Critically, the results showed the potential for estimating site size based on landform size and further using landform size as an anchor for radiocarbon date-based population estimates. Increases in the number of sites alone may signal one of several land use changes, such as changes in residential mobility, and may not reflect population size at all. However, overall site size connotes population number and/or occupation duration and can be compared to the number of sites to reconstruct a more accurate estimate of overall population(c.f. Yellen 1977:105). Particularly in Subarctic contexts where occupation length is relatively consistent through time, site size may serve as a relevant adjustment for population estimates that should be considered in similar archaeological contexts. Further, the research presented here shows that site size is strongly correlated with landform size, indicating that site extent testing may not be necessary in cases where satellite imagery resolution is refined enough to determine landform size. This proxy for population size has potential across the Subarctic and should be considered in other cases to determine patterns of past mobility and demography through time.

The recovery of additional material culture or data from legacy collections and landscape analysis that I suggest all require careful collaboration across the arbitrary US-Canada geopolitical border. Currently, many researchers silo themselves into their respective national boundaries to pursue research, even though many attend regional conferences internationally and ideas are liberally shared across the international border. For example, four of the five previous examples of geospatial synthesis relevant to Northern Dene/Athabascan history and heritage have included data from only one side of the US-Canada border (Potter 2008a, 2008b;

Kristensen, Andrews, et al. 2019; Kristensen, Hare, et al. 2019). I acknowledge that integrating regional datasets presents certain challenges, particularly when ecological data are collected at different resolutions and where historic territories are difficult to accurately reconstruct. To make interregional syntheses possible, Subarctic researchers should pursue increased and deliberate international collaborations that are connected by shared interests in Northern Dene/Athabascan communities in the past and present. Canadian and Alaskan archaeologists have focused on the extensive material culture of the region with equal vigor, though occasionally contrast in methodological or theoretical focus. Future collaborations will ensure the richness of Northern Dene/Athabascan heritage is shared across invisible and arbitrary geopolitical borders using newly collected data from the field and the lab.

The metaphor of crossing invisible lines applies equally to interagency collaborations. Alaska and Canada both have rich traditions of academic, contract, and governmental archaeology that have each provided different insights into a shared understanding of the past. In many ways, the collaboration between these differently funded and managed groups is already strong. Moving forward, Subarctic archaeologists and anthropologists can build on that strength by continuing meaningful interagency collaborations that provide inroads for partnering with local Indigenous communities. Academic researchers can workshop strategies for building on contract and government research. Contract and government archaeologists can push academic archaeologists in new directions based on their regional and community expertise. Increasingly, academic researchers are located outside of the region, and contract and government archaeologists may be one of their only anchors into changing developments on the ground and potential inroads for collaboration with local stakeholders. Meanwhile, academic researchers can provide new methodological and theoretical insights that may shape the way contract and government researchers design and execute survey and test excavations. Leveraging the institutional strengths of these partnerships has consistently resulted in the most successful research in this region and will likely foster even more powerful connections in decades to come, particularly if they actively involve Indigenous communities in their research design.

Combined, the data generated through such future research has the potential to refine our understanding of Subarctic political economies, social structuration, networking, alliance-building, and kinship in the recent past. These dynamics may produce parallels that can be extended into research on the much deeper past to understand how the first denizens of this region constructed the first social networks in the Americas that allowed generations of successive Indigenous communities to thrive. Ultimately, the model of migration from the Subarctic employed here can be used to profile the original dispersal out of the Subarctic associated with the further peopling of the North American continent ca. 14,000 years ago. Additional research is necessary to determine the applicability of this model to the initial colonization/peopling of the Americas.

These potential directions have regional implications that could shape the way we understand Northern Dene/Athabascan history, heritage, and culture, but the research presented here has implications for the study of the past beyond the Subarctic as well. In Chapter 1, I discussed the wealth of data we as archaeologists may have implicitly ignored by focusing on natural, environmental drivers for changes in hunter-gatherer culture. The research presented then showed the many ways that punctuated, environmental change failed to explain the Northern Dene/Athabascan transition and the migration that followed. Indeed, by considering the social environment as a coupled and equally important trigger for hunter-gatherer adaptation as the natural environment, this research produced a wealth of data that can be employed by hunter-gatherer archaeologists more generally and a model of cultural change focused on migration that anthropologists can apply to a range of scenarios. Modeling social environments and demographic change at multiple scales can push our assumptions of human mobility, subsistence, and culture more broadly to provide insight into adaptive patterns in our species' history. How many cases of socially motivated cultural change have archaeologists overlooked due to a dogmatic focus on variables present in the natural environment, on volcanoes, on cold snaps, on droughts? This research suggests we may have overlooked many indeed. Archaeologists can consider information within linguistic, oral historic, and ethnographic sources to think critically about how and when sociality invokes adaptive changes among hunter-gatherers. If social environments are not considered in environmental reconstructions, researchers cannot hope to build accurate models of the past, as this research has shown.

The multiscalar model that I developed to interpret the archaeological data that I presented here provides a useful framework for integrating existing and novel data. Each of the lines of evidence that I considered could not have elaborated upon the Dene/Athabascan migration on its own, but by integrating these site- and regional-level datasets, my evaluation bolstered the more tentative conclusions established by smaller datasets. Like the legs on a tripod, multiscalar datasets offer different checks at different scales of inquiry that can integrate datasets and serve to verify preliminary conclusions. This is not a new approach but incorporating regional settlement patterning data and site-specific data does require explicit theoretical framing and detailed baseline data on the archaeological setting to be successful. A synthetic approach to multiscalar data represents is a formidable undertaking but leverages the strengths of legacy archaeological data and detailed datasets that may only exist in unpublished or grey literature, as well as novel excavation or geospatial information. When one assemblage or one data class is not representative enough to define causal relationships, incorporating additional data, and particularly data derived from a different scale, can disentangle issues of equifinality and verify conclusions.

The research that I presented here mobilized a multiscalar and multiproxy dataset to address the trigger of the Dene/Athabascan migration. Today, genetic research has augmented our ability to identify past movements at a resolution that would not be possible archaeologically in most cases. However, human dispersals suggested by genetic data need to be verified using multiple lines of evidence and must reference available cultural information. The indiscriminate nature of many genetic studies, the lack of proper ethical considerations, and the messiness of population genetic modeling can all contribute to a slap-dash interpretation of past human movement and identity. People are complex. Migrations, like the Dene/Athabascan migration or the Bantu expansion, are processes that unfold gradually over generations of lived human experiences. Understanding the cultural consequences that underpin these large-scale human movements is critical to verifying the reality of these migrations as well as their potential causes. The interdisciplinary approach inherent to archaeological research facilitates these connections and, just as the research here has shown, can successfully elaborate upon the nature and timing of the migration process. It is one thing to know that a migration happened, via genetic or other data; it is another to explain it.

Conclusion

This multiscalar research project suggests that the Dene/Athabascan transition and subsequent migration were gradual and socially mediated, with important consequences for our understanding of Subarctic cultural systems and hunter-gatherer decision-making more generally. The synthesized data presented above suggest that social and demographic factors, possibly augmented by environmental stress, caused the Dene/Athabascan migration and associated cultural transition. Site use, as indicated by location, technology, and subsistence evidence, and broader patterns in landscape use show that resource use was broader overall after 2,000 cal BP. However, comparisons of artifactual, landscape, and geochemical data between upland and lowland sites shows specialization by ecological zone, with large upland camps focused on caribou and large lowland camps targeting fish, contrasting expectations for environmental stress based in human behavioral ecology and ethnographic analysis. Additionally, variation in site and land use also indicate that this change was relatively slow, indicating that prolonged demographic shifts ultimately resulted in adaptation and migration, rather than rapid ecological fallout associated with volcanic activity in the region.

The results of this analysis contribute to our understanding of late Holocene hunter-gatherer history in several dimensions. First, data from excavations showed the prolonged use of microblade technology through the WRA east event and document some of the earliest copper artifact use and manufacture in this region. Second, these results emphasize the feasibility of residue analysis of hearths from late Holocene occupations in the region, particularly where remains are too fragmentary or poorly preserved for a traditional faunal analysis. Third, the landscape analysis presented here highlights the utility of uniting results from diverse field research endeavors collected at different scales, such as cultural resource management, academic, and government projects, in the interest of explicating regional landscape relationships. Finally, this research highlights the potential of evaluating past episodes of hunter-gatherer cultural change and migration in social and environmental terms using predictions drawn from human behavioral ecology. Future research on central Alaskan and Yukon occupations spanning the Holocene can expand on these findings to further refine our understanding of Subarctic culture, migration, and hunter-gatherer history at many periods in the past. Now, as Dene say, the winter has grown shorter.

Appendices

Appendix A – Dene/Athabascan Technology Examples

Appendix A provides photographs of tools and tool fragments recovered during excavations at Clearview, Caribou Knob, Delta Creek, and the Klein Site (2009-2019). Photos taken by the author and Whitney McLaren.

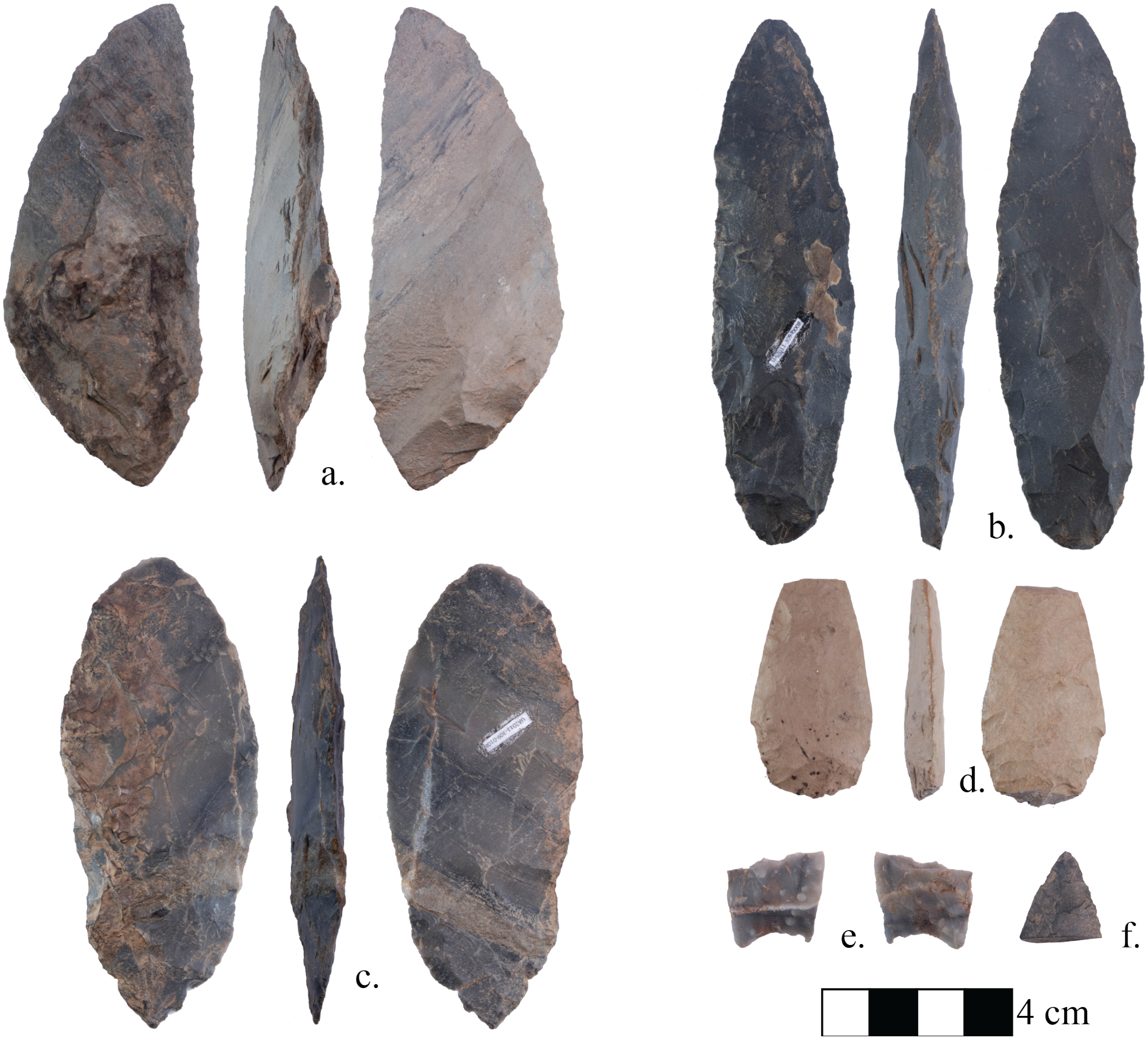


Figure 0.1 Bifaces (a.-c.) and Biface Fragments (d.-f.) Recovered From Clearview (Clockwise from bottom left: UA2011-309-108, UA2016-136-72, UA2011-309-008, UA2018-71-23 , UA2017-92-101, UA2016-136-402)

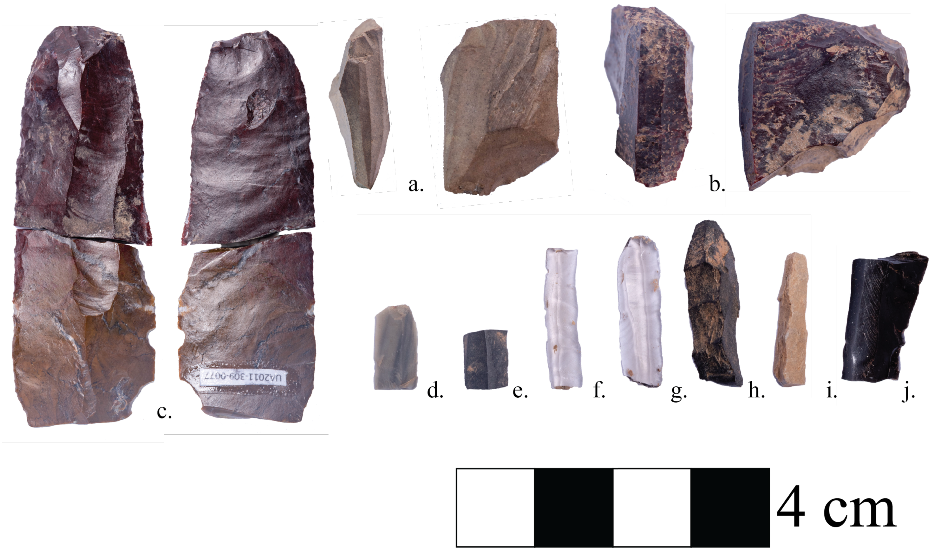


Figure 0.2 Microblade Core Fragments (a.-b.), Blade (c.), and Microblades/Microblade Fragments (d.-j.) Recovered From Clearview (Clockwise from bottom left: UA2018-71-45, UA2017-91-105, UA2011-309-77/44, UA2016-136-530, UA2016-136-645, UA2016-136-625, UA2016-136-624, UA2016-136-651, UA2016-136-628, UA2016-136-626)

Figure 0.3 End Scrapers (a.-c.), and Two Expedient Scraper Tools (d., e.) Recovered from Clearview, Including Two Possible Shaft Straighteners (c., d.; from top left: UA2017-92-197, UA2011-309-62, UA2018-71-13, UA2016-136-355, UA2016-136 -427)

Figure 0.4 Microblade from Delta Creek (UA2017-91-88)

Figure 0.5 A Large Tci-Tho Found Associated with Hearth Materials at Caribou Knob (UA2011-297-0003)

Figure 0.6 Unifacial Tool Fragments (a.-d.), Bifacial Tool Fragment (e.), and Microblade (f.) from Caribou Knob (From top left: UA2011-297-78, UA2011-297-29, UA2011-297-95, UA2016-137-150, UA2016-137-270, UA2017-93-38)

Figure 0.7 An Example of a Wedge-Shaped Microblade Core Tablet from the Klein Site, Upper Locus (UA2018-61-611)

Figure 0.8 Expedient scrapers (tci-thos) from the Klein Site Upper Locus (a.UA2019-154-129, b. UA2019-154-126, c. UA2017-66-159)

Figure 0.9 A Copper Awl (a. UA2019-154-211) and a Large Piece of Copper Scrap (UA2019-154-128) from the Klein Site Upper Locus

Figure 0.10 Unifacial End Scraper Recovered from the Klein Site, Lower Locus (UA2018-61-228)

Appendix B – Results of Debitage Analysis

Appendix B provides the complete results of debitage analysis of material from Clearview, Caribou Knob, Delta Creek, and the Klein Site (2009-2019) conducted by the author and Senna Catenacci.

Site	Catalog Number	Weight (g)	Size Class	Raw Material	Type
Caribou Knob	UA2011-297-0001	6.04	3	Chalcedony	Alternate
Caribou Knob	UA2011-297-0002	2.16	3	Grey chert	Secondary
Caribou Knob	UA2011-297-0004	0.39	2	Grey chert	Edge preparation
Caribou Knob	UA2011-297-0008	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0008	0.04	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0008	0.1	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0008	0.18	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0008	0.11	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0008	0.42	2	Black chert	Alternate
Caribou Knob	UA2011-297-0014	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0014	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0014	0.08	1	Chalcedony	Bifacial pressure flake
Caribou Knob	UA2011-297-0020	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0023	0.33	2	Grey chert	Edge preparation
Caribou Knob	UA2011-297-0028	0.01	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0031	0.1	1	Red chert	Alternate
Caribou Knob	UA2011-297-0032	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0043	0.14	2	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0048	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0048	0.02	1	Red chert	Unifacial pressure flake
Caribou Knob	UA2011-297-0051	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0051	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0064	4.63	3	Chalcedony	Interior
Caribou Knob	UA2011-297-0065	0.11	2	Chalcedony	Late bifacial thinning
Caribou Knob	UA2011-297-0070	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0072	2.48	3	Chalcedony	Secondary
Caribou Knob	UA2011-297-0075	0.09	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0077	0.09	2	Black chert	Edge preparation
Caribou Knob	UA2011-297-0079	6.63	3	Black chert	Edge preparation
Caribou Knob	UA2011-297-0084	0.01	1	Jasper	Early thinning

Caribou Knob	UA2011-297-0084	0.01	1	Red chert	Interior
Caribou Knob	UA2011-297-0084	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0084	0.04	1	Grey chert	Alternate
Caribou Knob	UA2011-297-0084	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0084	0.05	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0084	0.05	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0084	0.06	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0084	0.06	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0084	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0084	0.12	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0084	0.31	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.01	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.02	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.02	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.03	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.04	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.04	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.04	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.04	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.04	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.04	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.05	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.06	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.06	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.06	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.06	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.07	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.07	1	Red chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.07	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0087	0.08	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.08	1	Red chert	Interior
Caribou Knob	UA2011-297-0087	0.09	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.09	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.09	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.1	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2011-297-0087	0.12	1	Red chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.14	1	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.16	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.09	2	Red chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.13	2	Black chert	Interior
Caribou Knob	UA2011-297-0087	0.13	2	Black chert	Interior
Caribou Knob	UA2011-297-0087	0.14	2	Red chert	Alternate
Caribou Knob	UA2011-297-0087	0.16	2	Black chert	Interior
Caribou Knob	UA2011-297-0087	0.16	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.17	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.21	2	Black chert	Interior
Caribou Knob	UA2011-297-0087	0.21	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.22	2	Red chert	Edge preparation
Caribou Knob	UA2011-297-0087	0.22	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.22	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.22	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.26	2	Black chert	Interior
Caribou Knob	UA2011-297-0087	0.27	2	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.27	2	Grey chert	Secondary
Caribou Knob	UA2011-297-0087	0.37	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	0.79	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	1.55	3	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0087	2.86	3	Red chert	Early thinning
Caribou Knob	UA2011-297-0090	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0090	0.07	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0090	0.07	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0090	0.27	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0090	2.03	3	Chalcedony	Secondary
Caribou Knob	UA2011-297-0091	0.03	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0091	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2011-297-0091	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0091	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2011-297-0091	0.14	1	Red chert	Late bifacial thinning
Caribou Knob	UA2011-297-0091	0.17	1	Chalcedony	Late bifacial thinning
Caribou Knob	UA2011-297-0091	0.12	2	Black chert	Alternate
Caribou Knob	UA2011-297-0091	0.16	2	Black chert	Late bifacial thinning
Caribou Knob	UA2011-297-0091	0.21	2	Black chert	Alternate
Caribou Knob	UA2011-297-0091	0.23	2	Red chert	Late bifacial thinning

Caribou Knob	UA2011-297-0091	0.96	3	Jasper	Interior
Caribou Knob	UA2011-297-0091	4.23	3	Red chert	Secondary
Caribou Knob	UA2016-137-0001	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0001	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0001	0.02	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0001	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0001	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0001	0.04	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0001	0.05	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0001	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0001	0.13	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0001	0.16	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0001	0.19	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0002	0.07	2	Grey chert	Early thinning
Caribou Knob	UA2016-137-0003	0.02	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0003	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0003	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0003	0.13	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0003	0.11	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0004	0.34	2	Grey chert	Interior
Caribou Knob	UA2016-137-0005	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0006	0.28	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0007	0.15	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0008	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0009	0.44	2	Black chert	Alternate
Caribou Knob	UA2016-137-0010	0.07	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0010	0.13	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0011	0.57	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0012	0.26	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0013	0.02	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0014	0.07	1	Jasper	Bifacial pressure flake
Caribou Knob	UA2016-137-0015	0.35	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0016	0.11	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0017	0.11	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0018	0.14	2	Red chert	Alternate
Caribou Knob	UA2016-137-0021	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0023	0.11	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0024	0.07	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0026	0.04	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0027	0.01	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2016-137-0027	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0028	0.21	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0029	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0029	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0029	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0029	0.03	1	Black chert	Alternate
Caribou Knob	UA2016-137-0029	0.03	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0029	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0029	0.11	1	Black chert	Alternate
Caribou Knob	UA2016-137-0031	0.03	1	Grey chert	Interior
Caribou Knob	UA2016-137-0032	0.41	2	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0034	0.07	1	Grey chert	Secondary
Caribou Knob	UA2016-137-0035	0.3	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0037	0.15	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0038	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0039	0.26	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0040	0.07	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.01	1	Grey chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.01	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.01	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.01	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0041	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.03	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.03	1	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0041	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.05	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0041	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0041	0.06	1	Black chert	Early thinning
Caribou Knob	UA2016-137-0041	0.18	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Alternate
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0042	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0042	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0042	0.03	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0042	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0042	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0042	0.1	2	Black chert	Alternate
Caribou Knob	UA2016-137-0042	0.26	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0044	0.23	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0045	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0045	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0049	0.69	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0051	0.03	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0052	0.06	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0053	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0054	0.4	2	Black chert	Alternate
Caribou Knob	UA2016-137-0056	0.11	2	Black chert	Early thinning
Caribou Knob	UA2016-137-0057	0.1	2	Black chert	Alternate
Caribou Knob	UA2016-137-0058	0.01	1	Grey chert	Edge preparation
Caribou Knob	UA2016-137-0059	0.02	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0060	0.07	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0063	0.1	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0064	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0065	0.33	2	Black chert	Alternate
Caribou Knob	UA2016-137-0066	0.09	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0068	0.09	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0069	0.1	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0073	0.09	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0074	0.03	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0076	0.11	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0079	0.25	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0080	0.64	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0083	0.47	2	Jasper	Late bifacial thinning
Caribou Knob	UA2016-137-0083	1.47	3	Jasper	Alternate
Caribou Knob	UA2016-137-0085	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0089	0.17	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0090	0.32	2	Black chert	Edge preparation

Caribou Knob	UA2016-137-0092	0.09	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0093	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0096	0.09	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0097	0.05	1	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0099	0.17	2	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0100	0.1	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0103	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0104	0.55	2	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0106	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.02	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.02	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.02	1	Grey chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.03	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.03	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0106	0.03	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0106	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.05	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0106	0.05	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0106	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.12	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.15	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0106	0.16	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0106	0.43	2	Red chert	Interior
Caribou Knob	UA2016-137-0106	0.91	3	Black chert	Alternate
Caribou Knob	UA2016-137-0108	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0109	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0110	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0110	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0111	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0112	0.46	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0114	0.09	1	Black chert	Alternate

Caribou Knob	UA2016-137-0116	0.12	2	Black chert	Alternate
Caribou Knob	UA2016-137-0118	0.08	1	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0119	0.06	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0119	0.74	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0119	0.9	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Alternate
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Alternate
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Rhyolite	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.01	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.01	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.01	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Alternate
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.03	1	Grey chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.03	1	Rhyolite	Edge preparation
Caribou Knob	UA2016-137-0120	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.04	1	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.05	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2016-137-0120	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.05	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.06	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.09	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.14	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.13	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.13	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.14	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.15	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.17	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.18	2	Black chert	Interior
Caribou Knob	UA2016-137-0120	0.19	2	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.2	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0120	0.2	2	Black chert	Interior
Caribou Knob	UA2016-137-0120	0.21	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.22	2	Black chert	Alternate
Caribou Knob	UA2016-137-0120	0.22	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0120	0.26	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0120	0.27	2	Black chert	Alternate
Caribou Knob	UA2016-137-0120	0.29	2	Black chert	Unifacial pressure flake
Caribou Knob	UA2016-137-0121	0.24	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0123	0.23	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0125	0.16	2	Black chert	Alternate
Caribou Knob	UA2016-137-0127	0.16	2	Grey chert	Early thinning
Caribou Knob	UA2016-137-0128	0.19	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0129	0.12	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0130	0.16	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0132	0.26	2	Black chert	Alternate
Caribou Knob	UA2016-137-0140	0.05	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0142	0.11	2	Black chert	Alternate
Caribou Knob	UA2016-137-0145	0.43	2	Red chert	Early thinning
Caribou Knob	UA2016-137-0146	0.52	3	Black chert	Alternate
Caribou Knob	UA2016-137-0148	0.55	2	Red chert	Interior
Caribou Knob	UA2016-137-0149	0.09	2	Grey chert	Alternate
Caribou Knob	UA2016-137-0150	1.49	2	Red chert	Interior
Caribou Knob	UA2016-137-0153	0.05	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0154	0.33	2	Black chert	Edge preparation

Caribou Knob	UA2016-137-0155	0.16	2	Black chert	Alternate
Caribou Knob	UA2016-137-0156	1.53	3	Black chert	Secondary
Caribou Knob	UA2016-137-0157	0.13	2	Black chert	Alternate
Caribou Knob	UA2016-137-0162	0.1	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0165	0.16	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0175	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0176	0.11	2	Black chert	Alternate
Caribou Knob	UA2016-137-0177	0.1	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0178	0.12	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0180	0.06	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0181	0.14	2	Rhyolite	Alternate
Caribou Knob	UA2016-137-0182	0.11	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0188	0.13	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0191	0.02	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0192	0.18	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0193	0.07	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0195	0.15	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0197	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0199	0.5	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0200	0.45	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0204	0.07	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0205	0.02	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0209	0.16	2	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0213	0.38	2	Black chert	Edge preparation
Caribou Knob	UA2016-137-0214	0.2	2	Black chert	Alternate
Caribou Knob	UA2016-137-0215	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0215	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0215	0.05	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0215	0.41	2	Jasper	Alternate
Caribou Knob	UA2016-137-0215	0.61	2	Red chert	Edge preparation
Caribou Knob	UA2016-137-0216	0.47	2	Black chert	Interior
Caribou Knob	UA2016-137-0217	0.44	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0218	0.01	1	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0219	0.7	2	Red chert	Edge preparation
Caribou Knob	UA2016-137-0220	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0220	0.09	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0220	0.11	1	Black chert	Alternate
Caribou Knob	UA2016-137-0220	0.09	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0220	0.26	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0223	0.01	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2016-137-0223	0.04	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0223	0.08	2	Red chert	Edge preparation
Caribou Knob	UA2016-137-0225	0.01	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0225	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0225	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0225	0.04	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0225	0.06	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0225	0.06	1	Grey chert	Late bifacial thinning
Caribou Knob	UA2016-137-0225	0.09	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0225	0.11	1	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0225	0.12	2	Jasper	Late bifacial thinning
Caribou Knob	UA2016-137-0225	0.13	2	Red chert	Secondary
Caribou Knob	UA2016-137-0226	0.22	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0227	0.19	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0228	0.45	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0229	1.05	3	Red chert	Interior
Caribou Knob	UA2016-137-0231	0.14	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0232	0.03	1	Red chert	Microblade
Caribou Knob	UA2016-137-0232	0.28	2	Red chert	Secondary
Caribou Knob	UA2016-137-0233	0.65	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0234	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0234	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0234	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0234	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0234	0.04	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0234	0.04	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0234	0.07	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0234	0.06	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0234	0.29	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0234	0.31	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0235	0.14	2	Black chert	Interior
Caribou Knob	UA2016-137-0235	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0235	0.27	2	Black chert	Interior
Caribou Knob	UA2016-137-0237	0.25	2	Black chert	Alternate
Caribou Knob	UA2016-137-0238	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0238	0.03	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0238	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0238	0.13	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0238	0.2	2	Black chert	Alternate
Caribou Knob	UA2016-137-0238	0.24	2	Black chert	Late bifacial thinning

Caribou Knob	UA2016-137-0239	0.12	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0239	0.22	2	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0240	0.2	2	Red chert	Late bifacial thinning
Caribou Knob	UA2016-137-0241	0.05	1	Black chert	Edge preparation
Caribou Knob	UA2016-137-0243	0.03	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0243	0.03	1	Red chert	Edge preparation
Caribou Knob	UA2016-137-0243	0.04	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0243	0.07	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0243	0.08	1	Rhyolite	Bifacial pressure flake
Caribou Knob	UA2016-137-0243	0.08	1	Brown chert	Edge preparation
Caribou Knob	UA2016-137-0243	0.08	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0244	1.28	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0245	0.38	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0247	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0248	0.16	2	Black chert	Late bifacial thinning
Caribou Knob	UA2016-137-0252	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0253	0.09	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2016-137-0254	0.1	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0001	0.55	2	Black chert	Alternate
Caribou Knob	UA2017-093-0005	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0005	0.13	2	Black chert	Secondary
Caribou Knob	UA2017-093-0007	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2017-093-0007	0.04	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0007	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0010	3.23	3	Jasper	Secondary
Caribou Knob	UA2017-093-0011	0.16	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0011	0.1	2	Chalcedony	Early thinning
Caribou Knob	UA2017-093-0012	0.01	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0012	0.03	1	Jasper	Edge preparation
Caribou Knob	UA2017-093-0012	0.03	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0012	0.04	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0012	0.05	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0012	0.05	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0012	0.06	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0012	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0012	0.07	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0012	0.11	1	Red chert	Late bifacial thinning
Caribou Knob	UA2017-093-0012	0.12	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0012	0.11	2	Jasper	Edge preparation
Caribou Knob	UA2017-093-0012	0.16	2	Black chert	Edge preparation

Caribou Knob	UA2017-093-0013	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0013	0.02	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0014	0.23	2	Black chert	Alternate
Caribou Knob	UA2017-093-0016	0.08	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0016	0.21	2	Black chert	Early thinning
Caribou Knob	UA2017-093-0017	0.03	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0017	0.1	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0017	0.2	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0017	0.2	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0017	0.14	2	Red chert	Interior
Caribou Knob	UA2017-093-0017	0.22	2	Black chert	Alternate
Caribou Knob	UA2017-093-0018	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0018	0.01	1	Rhyolite	Bifacial pressure flake
Caribou Knob	UA2017-093-0018	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0018	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0018	0.11	1	Jasper	Primary
Caribou Knob	UA2017-093-0019	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0019	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0019	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0019	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0019	0.06	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0019	0.09	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0020	0.14	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0020	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0020	0.21	2	Black chert	Secondary
Caribou Knob	UA2017-093-0020	0.23	2	Black chert	Early thinning
Caribou Knob	UA2017-093-0020	0.39	2	Black chert	Early thinning
Caribou Knob	UA2017-093-0020	0.41	2	Black chert	Interior
Caribou Knob	UA2017-093-0020	0.41	2	Black chert	Secondary
Caribou Knob	UA2017-093-0020	0.56	2	Black chert	Early thinning
Caribou Knob	UA2017-093-0020	0.83	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0020	0.94	2	Black chert	Edge preparation
Caribou Knob	UA2017-093-0020	1.56	3	Black chert	Interior
Caribou Knob	UA2017-093-0021	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0021	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0022	0.73	2	Chalcedony	Alternate
Caribou Knob	UA2017-093-0023	0.11	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Alternate
Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Bifacial pressure flake

Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Edge preparation
Caribou Knob	UA2017-093-0024	0.01	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.02	1	Black chert	Alternate
Caribou Knob	UA2017-093-0024	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.02	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.03	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.03	1	Red chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.03	1	Black chert	Edge preparation
Caribou Knob	UA2017-093-0024	0.03	1	Jasper	Primary
Caribou Knob	UA2017-093-0024	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.04	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.05	1	Jasper	Primary
Caribou Knob	UA2017-093-0024	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.06	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.07	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.07	1	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.08	1	Grey chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.08	1	Black chert	Early thinning
Caribou Knob	UA2017-093-0024	0.09	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.1	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.13	1	Jasper	Primary
Caribou Knob	UA2017-093-0024	0.18	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.1	2	Grey chert	Interior
Caribou Knob	UA2017-093-0024	0.1	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.15	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.18	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.19	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.22	2	Jasper	Bifacial pressure flake
Caribou Knob	UA2017-093-0024	0.23	2	Red chert	Core tablet
Caribou Knob	UA2017-093-0024	0.29	2	Jasper	Edge preparation
Caribou Knob	UA2017-093-0024	0.38	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0024	0.81	2	Red chert	Unifacial pressure flake
Caribou Knob	UA2017-093-0024	1.03	2	Chalcedony	Alternate
Caribou Knob	UA2017-093-0024	1.12	3	Black chert	Interior
Caribou Knob	UA2017-093-0024	7.63	3	Chalcedony	Secondary
Caribou Knob	UA2017-093-0025	0.13	2	Black chert	Alternate
Caribou Knob	UA2017-093-0025	0.29	2	Black chert	Alternate
Caribou Knob	UA2017-093-0026	0.24	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0027	0.39	2	Black chert	Late bifacial thinning

Caribou Knob	UA2017-093-0028	0.02	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0028	0.79	2	Black chert	Alternate
Caribou Knob	UA2017-093-0028	0.98	3	Black chert	Interior
Caribou Knob	UA2017-093-0028	1.18	3	Black chert	Interior
Caribou Knob	UA2017-093-0029	0.32	2	Black chert	Late bifacial thinning
Caribou Knob	UA2017-093-0034	0.01	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.01	1	Red chert	Edge preparation
Caribou Knob	UA2017-093-0034	0.02	1	Black chert	Edge preparation
Caribou Knob	UA2017-093-0034	0.03	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.04	1	Rhyolite	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.05	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.05	1	Rhyolite	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.08	1	Black chert	Bifacial pressure flake
Caribou Knob	UA2017-093-0034	0.15	2	Rhyolite	Late bifacial thinning
Caribou Knob	UA2017-093-0035	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-2	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-2	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-2	0.11	1	Black chert	Edge preparation
Clearview	UA2017-92-3	0.09	1	Rhyolite	Alternate
Clearview	UA2017-92-3	0.29	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-3	0.52	1	Black chert	Early thinning
Clearview	UA2017-92-4	0.42	1	Rhyolite	Alternate
Clearview	UA2017-92-5	0.83	1	Rhyolite	Alternate
Clearview	UA2017-92-6	0.01	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-6	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-6	0.06	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-6	0.1	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-6	0.11	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-6	0.11	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-6	0.13	1	Black chert	Unifacial pressure flake
Clearview	UA2017-92-6	0.17	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-6	0.19	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-6	0.19	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-6	0.2	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-6	0.23	1	Black chert	Early thinning
Clearview	UA2017-92-6	0.23	1	Black chert	Edge preparation
Clearview	UA2017-92-6	0.39	1	Black chert	Early thinning
Clearview	UA2017-92-7	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-7	0.06	1	Black chert	Edge preparation

Clearview	UA2017-92-7	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-7	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-8	0.16	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-8	0.37	1	Black chert	Early thinning
Clearview	UA2017-92-8	0.51	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-9	4	2	Black chert	Interior
Clearview	UA2017-92-10	0.05	1	Rhyolite	Unifacial pressure flake
Clearview	UA2017-92-10	0.12	1	Rhyolite	Edge preparation
Clearview	UA2017-92-10	0.15	1	Grey chert	Microblade
Clearview	UA2017-92-11	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-11	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-11	0.2	1	Rhyolite	Edge preparation
Clearview	UA2017-92-12	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-13	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-13	0.07	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-13	0.11	1	Rhyolite	Alternate
Clearview	UA2017-92-13	0.12	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-13	0.16	1	Black chert	Edge preparation
Clearview	UA2017-92-13	0.16	1	Rhyolite	Edge preparation
Clearview	UA2017-92-13	0.19	1	Black chert	Microblade
Clearview	UA2017-92-14	0.07	1	Black chert	Microblade
Clearview	UA2017-92-17	0.02	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-17	0.06	1	Black chert	Edge preparation
Clearview	UA2017-92-17	0.09	1	Black chert	Edge preparation
Clearview	UA2017-92-17	1.11	2	Black chert	Interior
Clearview	UA2017-92-20	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-20	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-20	0.05	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-20	0.05	1	Grey banded chert	Late bifacial thinning
Clearview	UA2017-92-20	0.08	1	Black chert	Microblade
Clearview	UA2017-92-20	0.13	1	Black chert	Edge preparation
Clearview	UA2017-92-20	0.17	1	Black chert	Early thinning
Clearview	UA2017-92-20	0.2	1	Grey banded chert	Late bifacial thinning
Clearview	UA2017-92-22	0.01	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-22	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-22	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-22	0.02	1	Black chert	Edge preparation
Clearview	UA2017-92-22	0.03	1	Rhyolite	Edge preparation
Clearview	UA2017-92-22	0.03	1	Rhyolite	Late bifacial thinning

Clearview	UA2017-92-22	0.04	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-22	0.04	1	Black chert	Edge preparation
Clearview	UA2017-92-22	0.04	1	Rhyolite	Edge preparation
Clearview	UA2017-92-22	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-22	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-22	0.15	1	Black chert	Alternate
Clearview	UA2017-92-22	0.17	1	Black chert	Edge preparation
Clearview	UA2017-92-22	0.22	1	Rhyolite	Alternate
Clearview	UA2017-92-22	0.26	1	Rhyolite	Edge preparation
Clearview	UA2017-92-25	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-25	0.03	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-25	0.05	1	Black chert	Edge preparation
Clearview	UA2017-92-25	0.05	1	Brown chert	Edge preparation
Clearview	UA2017-92-25	0.05	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-25	0.09	1	Rhyolite	Edge preparation
Clearview	UA2017-92-25	0.1	1	Brown chert	Alternate
Clearview	UA2017-92-25	0.3	1	Grey chert	Early thinning
Clearview	UA2017-92-26	0.05	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-26	0.07	1	Black chert	Edge preparation
Clearview	UA2017-92-26	0.07	1	Brown chert	Late bifacial thinning
Clearview	UA2017-92-26	0.1	1	Black chert	Edge preparation
Clearview	UA2017-92-28	0.04	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-28	0.04	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-28	0.06	1	Rhyolite	Alternate
Clearview	UA2017-92-28	0.07	1	Black chert	Edge preparation
Clearview	UA2017-92-28	0.09	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-28	0.09	1	Black chert	Edge preparation
Clearview	UA2017-92-28	0.13	1	Black chert	Microblade
Clearview	UA2017-92-28	0.17	1	Rhyolite	Edge preparation
Clearview	UA2017-92-28	0.22	1	Grey chert	Edge preparation
Clearview	UA2017-92-28	0.29	1	Chalcedony	Early thinning
Clearview	UA2017-92-28	0.39	1	Rhyolite	Edge preparation
Clearview	UA2017-92-28	0.4	1	Black chert	Edge preparation
Clearview	UA2017-92-28	0.43	1	Chalcedony	Alternate
Clearview	UA2017-92-31	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-31	0.02	1	Black chert	Edge preparation
Clearview	UA2017-92-31	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-31	0.03	1	Black chert	Edge preparation
Clearview	UA2017-92-31	0.06	1	Brown chert	Late bifacial thinning
Clearview	UA2017-92-31	0.08	1	Brown chert	Edge preparation

Clearview	UA2017-92-31	0.08	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-31	0.08	1	Rhyolite	Microblade
Clearview	UA2017-92-31	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-31	0.19	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-31	0.21	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-31	0.24	1	Rhyolite	Edge preparation
Clearview	UA2017-92-31	0.28	1	Black chert	Alternate
Clearview	UA2017-92-33	0.08	1	Grey banded chert	Late bifacial thinning
Clearview	UA2017-92-33	0.12	1	Grey banded chert	Late bifacial thinning
Clearview	UA2017-92-34	0.04	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-35	0.02	1	Black chert	Edge preparation
Clearview	UA2017-92-35	0.05	1	Chalcedony	Early thinning
Clearview	UA2017-92-35	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-35	3.4	2	Rhyolite	Secondary
Clearview	UA2017-92-36	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-36	0.76	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-39	0.03	1	Brown chert	Bifacial pressure flake
Clearview	UA2017-92-39	0.03	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-39	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-39	0.04	1	Black chert	Alternate
Clearview	UA2017-92-39	0.04	1	Rhyolite	Edge preparation
Clearview	UA2017-92-39	0.04	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.05	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-39	0.07	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.07	1	Rhyolite	Microblade
Clearview	UA2017-92-39	0.08	1	Rhyolite	Alternate
Clearview	UA2017-92-39	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-39	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-39	0.09	1	Chalcedony	Edge preparation
Clearview	UA2017-92-39	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.12	1	Black chert	Alternate
Clearview	UA2017-92-39	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.14	1	Rhyolite	Microblade
Clearview	UA2017-92-39	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-39	0.17	1	Grey chert	Early thinning
Clearview	UA2017-92-39	0.17	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.2	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.22	1	Black chert	Edge preparation
Clearview	UA2017-92-39	0.23	1	Rhyolite	Late bifacial thinning

Clearview	UA2017-92-39	0.26	1	Rhyolite	Early thinning
Clearview	UA2017-92-39	0.27	1	Rhyolite	Edge preparation
Clearview	UA2017-92-39	0.29	1	Rhyolite	Edge preparation
Clearview	UA2017-92-39	0.33	1	Rhyolite	Early thinning
Clearview	UA2017-92-39	0.37	1	Grey banded chert	Alternate
Clearview	UA2017-92-39	0.38	1	Rhyolite	Edge preparation
Clearview	UA2017-92-39	0.58	1	Rhyolite	Early thinning
Clearview	UA2017-92-39	0.95	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-39	0.87	2	Rhyolite	Early thinning
Clearview	UA2017-92-40	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-40	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-40	0.02	1	Rhyolite	Edge preparation
Clearview	UA2017-92-40	0.03	1	Rhyolite	Alternate
Clearview	UA2017-92-40	0.03	1	Other chert	Bifacial pressure flake
Clearview	UA2017-92-40	0.04	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-40	0.05	1	Rhyolite	Alternate
Clearview	UA2017-92-40	0.05	1	Black chert	Edge preparation
Clearview	UA2017-92-40	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-40	0.07	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-40	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-40	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-40	0.08	1	Black chert	Platform rejuvination
Clearview	UA2017-92-40	0.1	1	Rhyolite	Alternate
Clearview	UA2017-92-40	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-40	0.1	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-40	0.11	1	Rhyolite	Alternate
Clearview	UA2017-92-40	0.11	1	Rhyolite	Edge preparation
Clearview	UA2017-92-40	0.11	1	Rhyolite	Microblade
Clearview	UA2017-92-40	0.11	1	Rhyolite	Microblade
Clearview	UA2017-92-40	0.12	1	Rhyolite	Microblade
Clearview	UA2017-92-40	0.13	1	Rhyolite	Edge preparation
Clearview	UA2017-92-40	0.13	1	Chalcedony	Microblade
Clearview	UA2017-92-40	0.14	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-40	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-40	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-40	0.15	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-40	0.2	1	Black chert	Early thinning
Clearview	UA2017-92-40	0.24	1	Black chert	Edge preparation
Clearview	UA2017-92-40	0.27	1	Rhyolite	Interior
Clearview	UA2017-92-40	0.39	1	Black chert	Late bifacial thinning

Clearview	UA2017-92-40	0.78	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-41	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-41	0.03	1	Rhyolite	Edge preparation
Clearview	UA2017-92-41	0.04	1	Rhyolite	Alternate
Clearview	UA2017-92-41	0.05	1	Rhyolite	Edge preparation
Clearview	UA2017-92-41	0.08	1	Quartzite	Alternate
Clearview	UA2017-92-41	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-41	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-41	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-41	0.12	1	Rhyolite	Alternate
Clearview	UA2017-92-41	0.19	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-41	0.28	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-41	0.4	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-42	0.4	1	Black chert	Early thinning
Clearview	UA2017-92-44	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-44	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-44	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-44	0.02	1	Black chert	Microblade
Clearview	UA2017-92-44	0.04	1	Rhyolite	Alternate
Clearview	UA2017-92-44	0.04	1	Grey chert	Edge preparation
Clearview	UA2017-92-44	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-44	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-44	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-44	0.07	1	Rhyolite	Edge preparation
Clearview	UA2017-92-44	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-44	0.08	1	Black chert	Microblade
Clearview	UA2017-92-44	0.08	1	Black chert	Microblade
Clearview	UA2017-92-44	0.09	1	Rhyolite	Edge preparation
Clearview	UA2017-92-44	0.11	1	Black chert	Microblade
Clearview	UA2017-92-44	0.11	1	Black chert	Microblade
Clearview	UA2017-92-44	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-44	0.35	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-45	0.78	1	Basalt	Late bifacial thinning
Clearview	UA2017-92-49	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-49	0.04	1	Black chert	Microblade
Clearview	UA2017-92-49	0.06	1	Black chert	Edge preparation
Clearview	UA2017-92-51	0.02	1	Chalcedony	Microblade
Clearview	UA2017-92-53	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-53	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-53	0.03	1	Rhyolite	Bifacial pressure flake

Clearview	UA2017-92-53	0.03	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.04	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-53	0.04	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-53	0.04	1	Rhyolite	Microblade
Clearview	UA2017-92-53	0.05	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.05	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.05	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.05	1	Rhyolite	Microblade
Clearview	UA2017-92-53	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.07	1	Black chert	Alternate
Clearview	UA2017-92-53	0.08	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.08	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.09	1	Rhyolite	Early thinning
Clearview	UA2017-92-53	0.09	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.1	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-53	0.1	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.11	1	Black chert	Edge preparation
Clearview	UA2017-92-53	0.11	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.12	1	Rhyolite	Early thinning
Clearview	UA2017-92-53	0.13	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.13	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.13	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.17	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.2	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.22	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.22	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.23	1	Black chert	Early thinning
Clearview	UA2017-92-53	0.24	1	Rhyolite	Early thinning
Clearview	UA2017-92-53	0.24	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-53	0.25	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.25	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.26	1	Rhyolite	Early thinning
Clearview	UA2017-92-53	0.29	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-53	0.31	1	Rhyolite	Early thinning

Clearview	UA2017-92-53	0.32	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.32	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.37	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.45	1	Rhyolite	Alternate
Clearview	UA2017-92-53	0.5	1	Black chert	Interior
Clearview	UA2017-92-53	0.71	1	Rhyolite	Edge preparation
Clearview	UA2017-92-53	0.92	2	Black chert	Alternate
Clearview	UA2017-92-54	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-54	0.06	1	Rhyolite	Early thinning
Clearview	UA2017-92-55	3.55	2	Rhyolite	Early thinning
Clearview	UA2017-92-56	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-56	0.05	1	Black chert	Edge preparation
Clearview	UA2017-92-56	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-56	1.39	2	Black chert	Early thinning
Clearview	UA2017-92-56	2.15	2	Rhyolite	Early thinning
Clearview	UA2017-92-58	0.08	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-58	9.89	2	Rhyolite	Interior
Clearview	UA2017-92-59	0.02	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-59	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-60	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.02	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-60	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-60	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.03	1	Rhyolite	Alternate
Clearview	UA2017-92-60	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.03	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.04	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.05	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.05	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.05	1	Black chert	Microblade
Clearview	UA2017-92-60	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.07	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-60	0.08	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.09	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-60	0.1	1	Rhyolite	Alternate
Clearview	UA2017-92-60	0.1	1	Rhyolite	Alternate

Clearview	UA2017-92-60	0.1	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.1	1	Black chert	Microblade
Clearview	UA2017-92-60	0.11	1	Black chert	Microblade
Clearview	UA2017-92-60	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-60	0.12	1	Black chert	Microblade
Clearview	UA2017-92-60	0.14	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.14	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.15	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.15	1	Rhyolite	Microblade
Clearview	UA2017-92-60	0.17	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.17	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-60	0.19	1	Rhyolite	Alternate
Clearview	UA2017-92-60	0.27	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.46	1	Rhyolite	Edge preparation
Clearview	UA2017-92-60	0.8	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-60	0.91	1	Rhyolite	Alternate
Clearview	UA2017-92-60	0.95	1	Black chert	Early thinning
Clearview	UA2017-92-60	1.53	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-61	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-61	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-61	0.04	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-61	0.06	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-61	0.08	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-61	0.11	1	Rhyolite	Edge preparation
Clearview	UA2017-92-61	0.12	1	Rhyolite	Edge preparation
Clearview	UA2017-92-61	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-61	0.21	1	Rhyolite	Edge preparation
Clearview	UA2017-92-61	0.24	1	Rhyolite	Edge preparation
Clearview	UA2017-92-61	1.03	1	Rhyolite	Edge preparation
Clearview	UA2017-92-62	0.15	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-68	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-68	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-68	0.06	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-68	0.07	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-68	0.14	1	Grey banded chert	Edge preparation
Clearview	UA2017-92-68	0.18	1	Chalcedony	Late bifacial thinning
Clearview	UA2017-92-68	0.21	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-68	0.25	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-70	0.09	1	Rhyolite	Bifacial pressure flake

Clearview	UA2017-92-70	0.16	1	Black chert	Microblade
Clearview	UA2017-92-71	0.38	1	Chalcedony	Platform rejuvination
Clearview	UA2017-92-72	0.04	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-72	0.3	1	Rhyolite	Edge preparation
Clearview	UA2017-92-74	0.11	1	Grey chert	Edge preparation
Clearview	UA2017-92-74	0.33	1	Grey chert	Early thinning
Clearview	UA2017-92-74	0.37	1	Other chert	Platform rejuvination
Clearview	UA2017-92-75	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-75	0.04	1	Chalcedony	Late bifacial thinning
Clearview	UA2017-92-75	0.05	1	Rhyolite	Edge preparation
Clearview	UA2017-92-75	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-75	0.07	1	Rhyolite	Alternate
Clearview	UA2017-92-76	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-77	0.09	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-77	0.12	1	Chalcedony	Edge preparation
Clearview	UA2017-92-78	0.17	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-78	0.18	1	Grey chert	Primary
Clearview	UA2017-92-82	1.88	2	Black chert	Core Face Rejuvination
Clearview	UA2017-92-83	0.77	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-86	0.09	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-88	0.12	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-89	0.03	1	Grey chert	Edge preparation
Clearview	UA2017-92-89	0.06	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-89	0.26	1	Grey chert	Alternate
Clearview	UA2017-92-93	0.19	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-94	0.03	1	Black chert	Microblade
Clearview	UA2017-92-94	0.04	1	Black chert	Microblade
Clearview	UA2017-92-94	0.11	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-94	0.11	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-94	0.23	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-95	0.31	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-96	0.04	1	Black chert	Unifacial pressure flake
Clearview	UA2017-92-98	0.05	1	Black chert	Microblade
Clearview	UA2017-92-98	0.07	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-98	0.08	1	Black chert	Microblade
Clearview	UA2017-92-98	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-99	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-99	0.06	1	Rhyolite	Edge preparation
Clearview	UA2017-92-99	0.1	1	Quartzite	Edge preparation
Clearview	UA2017-92-99	1.15	1	Grey chert	Alternate

Clearview	UA2017-92-100	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-100	0.07	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-100	0.07	1	Rhyolite	Edge preparation
Clearview	UA2017-92-102	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-102	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-102	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-102	0.09	1	Rhyolite	Edge preparation
Clearview	UA2017-92-102	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-102	4.46	2	Rhyolite	Interior
Clearview	UA2017-92-103	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-103	0.03	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-103	0.04	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-103	0.04	1	Black chert	Microblade
Clearview	UA2017-92-103	0.05	1	Black chert	Unifacial pressure flake
Clearview	UA2017-92-103	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-103	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-103	0.12	1	Grey banded chert	Late bifacial thinning
Clearview	UA2017-92-103	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-103	0.15	1	Grey banded chert	Edge preparation
Clearview	UA2017-92-107	0.07	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-107	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-108	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-108	0.16	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2017-92-109	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-109	0.01	1	Rhyolite	Edge preparation
Clearview	UA2017-92-109	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-109	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-110	0.03	1	Black chert	Unifacial pressure flake
Clearview	UA2017-92-110	0.05	1	Black chert	Unifacial pressure flake
Clearview	UA2017-92-111	0.09	1	Rhyolite	Secondary
Clearview	UA2017-92-111	0.12	1	Black chert	Microblade
Clearview	UA2017-92-111	0.38	1	Grey chert	Secondary
Clearview	UA2017-92-112	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-112	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-113	0.1	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-113	0.21	1	Rhyolite	Alternate
Clearview	UA2017-92-114	0.02	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-114	0.02	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-114	0.04	1	Black chert	Bifacial pressure flake

Clearview	UA2017-92-114	0.05	1	Black chert	Edge preparation
Clearview	UA2017-92-114	0.12	1	Rhyolite	Edge preparation
Clearview	UA2017-92-114	0.31	1	Rhyolite	Alternate
Clearview	UA2017-92-114	0.44	1	Rhyolite	Edge preparation
Clearview	UA2017-92-114	1.34	1	Black chert	Edge preparation
Clearview	UA2017-92-115	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-115	0.04	1	Black chert	Edge preparation
Clearview	UA2017-92-115	0.05	1	Black chert	Alternate
Clearview	UA2017-92-115	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-115	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-115	0.11	1	Rhyolite	Edge preparation
Clearview	UA2017-92-115	0.14	1	Rhyolite	Edge preparation
Clearview	UA2017-92-115	0.16	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-115	0.27	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-116	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-116	0.13	1	Rhyolite	Edge preparation
Clearview	UA2017-92-117	0.06	1	Chalcedony	Unifacial pressure flake
Clearview	UA2017-92-117	0.07	1	Black chert	Edge preparation
Clearview	UA2017-92-117	0.1	1	Rhyolite	Edge preparation
Clearview	UA2017-92-117	0.11	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-117	0.12	1	Chalcedony	Late bifacial thinning
Clearview	UA2017-92-117	0.23	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-117	0.24	1	Rhyolite	Alternate
Clearview	UA2017-92-117	0.3	1	Rhyolite	Edge preparation
Clearview	UA2017-92-118	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-118	0.02	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-118	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-118	0.07	1	Rhyolite	Edge preparation
Clearview	UA2017-92-118	0.2	1	Rhyolite	Core Face Rejuvination
Clearview	UA2017-92-119	0.03	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-120	0.01	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-120	0.04	1	Chalcedony	Alternate
Clearview	UA2017-92-120	0.05	1	Black chert	Edge preparation
Clearview	UA2017-92-120	0.09	1	Chalcedony	Edge preparation
Clearview	UA2017-92-120	0.09	1	Black chert	Microblade
Clearview	UA2017-92-120	0.09	1	Rhyolite	Microblade
Clearview	UA2017-92-120	0.11	1	Rhyolite	Edge preparation
Clearview	UA2017-92-120	0.12	1	Rhyolite	Core Face Rejuvination
Clearview	UA2017-92-120	0.14	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-120	0.44	1	Black chert	Late bifacial thinning

Clearview	UA2017-92-121	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-122	0.03	1	Grey chert	Unifacial pressure flake
Clearview	UA2017-92-122	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-122	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-122	0.15	1	Rhyolite	Edge preparation
Clearview	UA2017-92-122	0.47	1	Black chert	Secondary
Clearview	UA2017-92-122	0.48	1	Rhyolite	Edge preparation
Clearview	UA2017-92-123	0.06	1	Rhyolite	Alternate
Clearview	UA2017-92-123	0.15	1	Rhyolite	Alternate
Clearview	UA2017-92-123	0.2	1	Rhyolite	Alternate
Clearview	UA2017-92-123	0.21	1	Rhyolite	Alternate
Clearview	UA2017-92-123	0.26	1	Black chert	Early thinning
Clearview	UA2017-92-124	0.13	1	Rhyolite	Edge preparation
Clearview	UA2017-92-124	0.19	1	Rhyolite	Alternate
Clearview	UA2017-92-125	0.19	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-126	0.1	1	Rhyolite	Edge preparation
Clearview	UA2017-92-126	0.28	1	Rhyolite	Alternate
Clearview	UA2017-92-126	0.3	1	Rhyolite	Edge preparation
Clearview	UA2017-92-128	0.06	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-128	1.15	2	Black chert	Alternate
Clearview	UA2017-92-129	0.18	1	Rhyolite	Alternate
Clearview	UA2017-92-129	0.19	1	Black chert	Edge preparation
Clearview	UA2017-92-129	0.21	1	Rhyolite	Edge preparation
Clearview	UA2017-92-131	0.08	1	Rhyolite	Bifacial pressure flake
Clearview	UA2017-92-131	0.08	1	Black chert	Microblade
Clearview	UA2017-92-131	0.2	1	Rhyolite	Microblade
Clearview	UA2017-92-132	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-134	0.3	1	Grey chert	Interior
Clearview	UA2017-92-135	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-136	0.01	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-136	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2017-92-136	0.09	1	Black chert	Bifacial pressure flake
Clearview	UA2017-92-136	0.26	1	Chalcedony	Unifacial pressure flake
Clearview	UA2017-92-139	0.04	1	Chalcedony	Bifacial pressure flake
Clearview	UA2017-92-140	0.04	1	Chalcedony	Unifacial pressure flake
Clearview	UA2017-92-140	0.41	1	Rhyolite	Early thinning
Clearview	UA2017-92-141	0.06	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-142	0.1	1	Grey chert	Alternate
Clearview	UA2017-92-142	0.25	1	Rhyolite	Microblade
Clearview	UA2017-92-143	0.07	1	Rhyolite	Late bifacial thinning

Clearview	UA2017-92-143	0.12	1	Rhyolite	Edge preparation
Clearview	UA2017-92-143	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2017-92-144	0.27	1	Grey banded chert	Early thinning
Clearview	UA2017-92-144	0.45	1	Chalcedony	Late bifacial thinning
Clearview	UA2017-92-144	2.24	2	Rhyolite	Early thinning
Clearview	UA2017-92-145	0.09	1	Grey chert	Late bifacial thinning
Clearview	UA2017-92-146	0.06	1	Black chert	Microblade
Clearview	UA2017-92-146	0.12	1	Chalcedony	Edge preparation
Clearview	UA2017-92-147	0.04	1	Grey chert	Bifacial pressure flake
Clearview	UA2017-92-147	0.05	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0001	0.19	2	Black chert	Edge preparation
Clearview	UA2011-309-0007	1.26	3	Rhyolite	Early thinning
Clearview	UA2011-309-0009	0.26	2	Black chert	Microblade
Clearview	UA2011-309-0011	2.09	3	Grey chert	Early thinning
Clearview	UA2011-309-0012	0.24	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0013	0.12	1	Black chert	Edge preparation
Clearview	UA2011-309-0014	0.1	1	Black chert	Bifacial pressure flake
Clearview	UA2011-309-0014	0.2	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0014	0.29	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0014	0.71	2	Black chert	Early thinning
Clearview	UA2011-309-0014	1.12	2	Grey chert	Early thinning
Clearview	UA2011-309-0015	0.1	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0015	0.85	2	Grey chert	Early thinning
Clearview	UA2011-309-0015	1.76	2	Black chert	Early thinning
Clearview	UA2011-309-0015	2.89	2	White chert	Early thinning
Clearview	UA2011-309-0018	3.55	3	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0019	0.44	2	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0020	0.2	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0022	25.98	3	Grey banded chert	Interior
Clearview	UA2011-309-0024	0.47	2	White chert	Edge preparation
Clearview	UA2011-309-0031	1.2	2	Rhyolite	Early thinning
Clearview	UA2011-309-0032	0.06	1	Black chert	Microblade
Clearview	UA2011-309-0033	3.14	2	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0034	0.15	1	Grey chert	Edge preparation
Clearview	UA2011-309-0034	0.16	1	Grey chert	Edge preparation
Clearview	UA2011-309-0034	0.21	1	Grey chert	Alternate
Clearview	UA2011-309-0034	0.83	2	Grey chert	Early thinning
Clearview	UA2011-309-0034	0.95	2	Grey chert	Early thinning
Clearview	UA2011-309-0037	0.12	1	Grey chert	Edge preparation

Clearview	UA2011-309-0037	0.26	1	Black chert	Alternate
Clearview	UA2011-309-0038	1.24	1	Grey chert	Early thinning
Clearview	UA2011-309-0038	0.19	2	Grey chert	Edge preparation
Clearview	UA2011-309-0039	0.1	1	Grey chert	Microblade
Clearview	UA2011-309-0041	0.7	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0041	0.88	2	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0042	0.93	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0046	0.43	2	Grey chert	Edge preparation
Clearview	UA2011-309-0047	0.57	2	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0054	0.35	2	Grey chert	Edge preparation
Clearview	UA2011-309-0056	0.39	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0056	0.69	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0057	0.21	1	Black chert	Alternate
Clearview	UA2011-309-0057	0.24	1	Black chert	Edge preparation
Clearview	UA2011-309-0057	1.59	2	Grey chert	Early thinning
Clearview	UA2011-309-0057	7.49	3	Grey chert	Primary
Clearview	UA2011-309-0058	0.11	1	Black chert	Edge preparation
Clearview	UA2011-309-0058	0.15	1	Black chert	Edge preparation
Clearview	UA2011-309-0058	1.83	2	Grey chert	Primary
Clearview	UA2011-309-0058	5.75	2	Basalt	Interior
Clearview	UA2011-309-0059	0.06	1	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0059	0.11	1	Rhyolite	Microblade
Clearview	UA2011-309-0059	0.12	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2011-309-0059	0.2	1	Grey banded chert	Edge preparation
Clearview	UA2011-309-0059	0.3	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0059	0.44	2	Rhyolite	Microblade
Clearview	UA2011-309-0059	0.57	2	Grey banded chert	Late bifacial thinning
Clearview	UA2011-309-0059	0.58	2	Grey banded chert	Late bifacial thinning
Clearview	UA2011-309-0059	0.63	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0059	1.39	2	Grey banded chert	Primary
Clearview	UA2011-309-0060	0.08	1	Grey chert	Edge preparation
Clearview	UA2011-309-0060	0.08	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0060	0.1	1	Black chert	Bifacial pressure flake
Clearview	UA2011-309-0060	0.2	1	Chalcedony	Alternate
Clearview	UA2011-309-0060	0.27	1	Grey chert	Early thinning
Clearview	UA2011-309-0060	0.33	1	Chalcedony	Late bifacial thinning
Clearview	UA2011-309-0060	0.7	2	Rhyolite	Early thinning
Clearview	UA2011-309-0060	0.77	2	Rhyolite	Interior
Clearview	UA2011-309-0060	1.54	2	Basalt	Early thinning

Clearview	UA2011-309-0060	1.76	2	Rhyolite	Early thinning
Clearview	UA2011-309-0063	0.06	1	Chalcedony	Bifacial pressure flake
Clearview	UA2011-309-0063	0.06	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0063	0.08	1	Grey chert	Edge preparation
Clearview	UA2011-309-0063	0.11	1	Grey chert	Core Face Rejuvination
Clearview	UA2011-309-0063	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0063	0.15	1	Grey chert	Edge preparation
Clearview	UA2011-309-0063	0.2	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0063	0.2	1	Grey chert	Edge preparation
Clearview	UA2011-309-0064	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0064	0.02	1	Grey chert	Microblade
Clearview	UA2011-309-0064	0.03	1	Grey chert	Microblade
Clearview	UA2011-309-0064	0.05	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0064	0.05	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0064	0.08	1	Grey chert	Alternate
Clearview	UA2011-309-0064	0.08	1	Grey chert	Edge preparation
Clearview	UA2011-309-0064	0.1	1	Grey chert	Microblade
Clearview	UA2011-309-0064	0.11	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0064	0.12	1	Grey chert	Microblade
Clearview	UA2011-309-0064	0.13	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0064	0.24	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0064	0.11	2	Grey chert	Microblade
Clearview	UA2011-309-0065	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0065	0.04	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0065	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0065	0.14	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0065	0.16	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0066	0.1	2	Grey chert	Microblade
Clearview	UA2011-309-0067	0.1	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0067	0.12	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0067	0.12	1	Grey chert	Platform rejuvination
Clearview	UA2011-309-0067	0.15	1	Grey chert	Alternate
Clearview	UA2011-309-0067	0.16	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0067	0.19	1	Grey chert	Edge preparation
Clearview	UA2011-309-0067	0.23	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0067	0.23	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0068	0.06	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0068	0.17	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0070	0.27	1	Grey chert	Interior
Clearview	UA2011-309-0070	0.6	2	Grey chert	Interior

Clearview	UA2011-309-0072	0.06	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0074	0.05	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0075	0.33	2	Grey chert	Early thinning
Clearview	UA2011-309-0075	0.74	2	Grey chert	Early thinning
Clearview	UA2011-309-0075	0.91	2	Grey chert	Interior
Clearview	UA2011-309-0076	0.09	1	Grey chert	Edge preparation
Clearview	UA2011-309-0076	0.12	1	Grey chert	Edge preparation
Clearview	UA2011-309-0076	0.18	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0076	0.41	2	Grey chert	Early thinning
Clearview	UA2011-309-0076	0.5	2	Grey chert	Edge preparation
Clearview	UA2011-309-0076	0.51	2	Grey chert	Edge preparation
Clearview	UA2011-309-0076	0.83	2	Grey chert	Interior
Clearview	UA2011-309-0076	0.93	2	Grey chert	Early thinning
Clearview	UA2011-309-0076	1.07	2	Grey chert	Interior
Clearview	UA2011-309-0078	0.2	1	Grey chert	Alternate
Clearview	UA2011-309-0078	0.3	1	Grey chert	Edge preparation
Clearview	UA2011-309-0079	0.37	2	Grey chert	Edge preparation
Clearview	UA2011-309-0083	0.12	1	Black chert	Edge preparation
Clearview	UA2011-309-0083	0.6	2	Basalt	Edge preparation
Clearview	UA2011-309-0083	1.52	2	Basalt	Primary
Clearview	UA2011-309-0083	2.19	3	Basalt	Interior
Clearview	UA2011-309-0084	0.13	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0084	0.47	2	Black chert	Early thinning
Clearview	UA2011-309-0084	2.15	2	Basalt	Interior
Clearview	UA2011-309-0085	1.43	2	Black chert	Alternate
Clearview	UA2011-309-0088	0.12	1	Grey chert	Edge preparation
Clearview	UA2011-309-0088	0.61	2	Grey chert	Early thinning
Clearview	UA2011-309-0089	0.2	1	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0090	0.06	1	Grey chert	Edge preparation
Clearview	UA2011-309-0090	0.13	1	Grey chert	Edge preparation
Clearview	UA2011-309-0090	0.52	2	Grey chert	Secondary
Clearview	UA2011-309-0090	0.56	2	Grey chert	Alternate
Clearview	UA2011-309-0093	0.24	2	Black chert	Microblade
Clearview	UA2011-309-0094	0.27	2	Black chert	Bifacial pressure flake
Clearview	UA2011-309-0095	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0098	0.12	1	Black chert	Alternate
Clearview	UA2011-309-0100	0.35	2	White chert	Late bifacial thinning
Clearview	UA2011-309-0100	0.45	2	White chert	Late bifacial thinning
Clearview	UA2011-309-0106	0.59	2	Grey chert	Early thinning
Clearview	UA2011-309-0106	9.63	3	Grey chert	Interior

Clearview	UA2011-309-0107	0.12	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0107	0.98	2	Grey chert	Early thinning
Clearview	UA2011-309-0109	0.08	1	Black chert	Bifacial pressure flake
Clearview	UA2011-309-0110	0.16	2	Black chert	Late bifacial thinning
Clearview	UA2011-309-0111	0.2	1	Quartzite	Late bifacial thinning
Clearview	UA2011-309-0112	7.55	3	Grey chert	Interior
Clearview	UA2011-309-0114	2.34	2	Black chert	Early thinning
Clearview	UA2011-309-0118	2.15	2	Basalt	Interior
Clearview	UA2011-309-0120	0.56	1	Grey chert	Edge preparation
Clearview	UA2011-309-0122	0.15	1	Grey chert	Alternate
Clearview	UA2011-309-0123	1.34	2	Black chert	Primary
Clearview	UA2011-309-0124	0.07	1	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0124	0.1	1	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0124	0.11	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.12	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.14	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.14	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0124	0.15	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.17	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0124	0.18	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.2	1	Rhyolite	Alternate
Clearview	UA2011-309-0124	0.2	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0124	0.5	2	Black chert	Early thinning
Clearview	UA2011-309-0124	0.54	2	Rhyolite	Alternate
Clearview	UA2011-309-0124	0.59	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0124	0.61	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0124	0.66	2	Rhyolite	Early thinning
Clearview	UA2011-309-0124	0.69	2	Rhyolite	Alternate
Clearview	UA2011-309-0124	0.84	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0124	0.85	2	Rhyolite	Alternate
Clearview	UA2011-309-0124	0.99	2	Rhyolite	Early thinning
Clearview	UA2011-309-0124	1.54	2	Rhyolite	Alternate
Clearview	UA2011-309-0124	1.89	2	Rhyolite	Early thinning
Clearview	UA2011-309-0124	2.12	2	Rhyolite	Early thinning
Clearview	UA2011-309-0124	8.78	3	Basalt	Interior
Clearview	UA2011-309-0125	0.27	1	White chert	Edge preparation
Clearview	UA2011-309-0125	0.27	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0125	0.7	2	Black chert	Early thinning
Clearview	UA2011-309-0125	0.73	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0125	1.68	2	Rhyolite	Early thinning

Clearview	UA2011-309-0126	0.07	1	Black chert	Bifacial pressure flake
Clearview	UA2011-309-0126	0.35	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0126	0.57	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0127	0.22	1	Rhyolite	Microblade
Clearview	UA2011-309-0127	0.24	1	Rhyolite	Alternate
Clearview	UA2011-309-0127	1.11	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0128	0.07	1	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0128	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0128	0.11	1	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0128	0.12	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0128	0.16	1	Rhyolite	Edge preparation
Clearview	UA2011-309-0128	0.2	1	Rhyolite	Alternate
Clearview	UA2011-309-0128	0.21	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0128	0.22	1	Black chert	Edge preparation
Clearview	UA2011-309-0128	0.21	2	Rhyolite	Bifacial pressure flake
Clearview	UA2011-309-0128	0.23	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0128	0.37	2	Black chert	Late bifacial thinning
Clearview	UA2011-309-0128	0.37	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0128	0.44	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0128	0.44	2	Rhyolite	Edge preparation
Clearview	UA2011-309-0128	0.46	2	Black chert	Edge preparation
Clearview	UA2011-309-0128	0.47	2	Black chert	Late bifacial thinning
Clearview	UA2011-309-0128	0.6	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0128	0.76	2	Black chert	Early thinning
Clearview	UA2011-309-0128	1.68	2	Rhyolite	Alternate
Clearview	UA2011-309-0128	2.95	2	Black chert	Secondary
Clearview	UA2011-309-0128	4.58	3	Rhyolite	Early thinning
Clearview	UA2011-309-0129	0.21	1	Chalcedony	Alternate
Clearview	UA2011-309-0129	0.34	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-309-0129	0.36	2	Black chert	Alternate
Clearview	UA2011-309-0129	0.54	2	Black chert	Late bifacial thinning
Clearview	UA2011-309-0129	1.56	2	Black chert	Early thinning
Clearview	UA2011-309-0129	2.47	2	Rhyolite	Secondary
Clearview	UA2011-309-0129	29.06	3	Basalt	Secondary
Clearview	UA2011-309-0136	0.16	1	Red chert	Bifacial pressure flake
Clearview	UA2011-309-0136	0.35	1	Red chert	Edge preparation
Clearview	UA2011-309-0138	0.6	2	Chalcedony	Late bifacial thinning
Clearview	UA2011-309-0139	0.25	2	Black chert	Late bifacial thinning
Clearview	UA2011-309-0140	0.07	1	Red chert	Alternate
Clearview	UA2011-309-0140	1.05	2	Grey chert	Late bifacial thinning

Clearview	UA2011-309-0141	0.1	2	Grey banded chert	Microblade
Clearview	UA2011-309-0143	0.3	2	Black chert	Microblade
Clearview	UA2011-309-0144	0.21	2	Red chert	Microblade
Clearview	UA2011-309-0144	1.36	2	Grey chert	Late bifacial thinning
Clearview	UA2011-309-0146	0.35	2	Grey chert	Microblade
Clearview	UA2011-309-0148	0.23	1	Black chert	Late bifacial thinning
Clearview	UA2011-309-0150	0.1	1	Grey chert	Bifacial pressure flake
Clearview	UA2011-309-0150	0.7	2	Black chert	Early thinning
Clearview	UA2011-309-0150	0.73	2	Chalcedony	Edge preparation
Clearview	UA2011-309-0150	0.8	2	Grey chert	Early thinning
Clearview	UA2011-309-0150	2.75	2	Grey chert	Interior
Clearview	UA2011-309-0150	3.62	2	Grey chert	Early thinning
Clearview	UA2011-401-0005	0.09	1	Grey banded chert	Edge preparation
Clearview	UA2011-401-0005	0.15	1	Rhyolite	Edge preparation
Clearview	UA2011-401-0005	0.19	1	Grey banded chert	Edge preparation
Clearview	UA2011-401-0005	0.3	1	Rhyolite	Late bifacial thinning
Clearview	UA2011-401-0005	0.3	1	Rhyolite	Secondary
Clearview	UA2011-401-0005	0.39	1	Rhyolite	Edge preparation
Clearview	UA2011-401-0005	0.17	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-401-0005	0.39	2	Grey banded chert	Alternate
Clearview	UA2011-401-0005	0.4	2	Grey banded chert	Early thinning
Clearview	UA2011-401-0005	0.41	2	Grey banded chert	Alternate
Clearview	UA2011-401-0005	0.49	2	Rhyolite	Late bifacial thinning
Clearview	UA2011-401-0006	0.11	1	Rhyolite	Edge preparation
Clearview	UA2011-401-0006	0.17	1	Grey banded chert	Late bifacial thinning
Clearview	UA2011-401-0006	0.5	2	Grey banded chert	Alternate
Clearview	UA2011-401-0006	0.69	2	Rhyolite	Interior
Clearview	UA2011-401-0009	0.87	2	Grey chert	Early thinning
Clearview	UA2011-401-0010	2.29	2	Black chert	Interior
Clearview	UA2011-401-0012	0.13	1	Grey chert	Bifacial pressure flake
Clearview	UA2012-094-0002	0.7	1	Grey chert	Edge preparation
Clearview	UA2012-094-0002	2.19	3	Grey chert	Early thinning
Clearview	UA2012-094-0002	4.85	3	Black chert	Primary
Clearview	UA2012-094-0003	0.4	2	Chalcedony	Alternate
Clearview	UA2016-136-0005	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0005	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0005	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0006	0.07	1	Rhyolite	Edge preparation

Clearview	UA2016-136-0007	0.08	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0014	2.93	2	Rhyolite	Interior
Clearview	UA2016-136-0016	0.04	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0016	0.07	1	Black chert	Edge preparation
Clearview	UA2016-136-0016	0.64	1	Black chert	Interior
Clearview	UA2016-136-0018	0.11	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0021	0.11	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0025	0.12	1	Grey chert	Edge preparation
Clearview	UA2016-136-0028	0.13	1	Grey chert	Alternate
Clearview	UA2016-136-0029	0.22	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0030	0.2	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0033	2.42	2	Grey chert	Interior
Clearview	UA2016-136-0036	0.04	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0037	0.22	1	Black chert	Edge preparation
Clearview	UA2016-136-0038	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0039	2.51	2	Black chert	Secondary
Clearview	UA2016-136-0040	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0041	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0044	0.05	1	Black chert	Edge preparation
Clearview	UA2016-136-0048	0.36	1	Rhyolite	Interior
Clearview	UA2016-136-0060	0.1	1	Grey chert	Edge preparation
Clearview	UA2016-136-0061	0.1	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0062	0.01	1	Black chert	Edge preparation
Clearview	UA2016-136-0062	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0062	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0063	0.06	1	Black chert	Edge preparation
Clearview	UA2016-136-0065	0.05	1	Grey chert	Edge preparation
Clearview	UA2016-136-0066	0.52	1	Grey chert	Interior
Clearview	UA2016-136-0067	0.36	1	Rhyolite	Alternate
Clearview	UA2016-136-0069	2.04	2	Rhyolite	Secondary
Clearview	UA2016-136-0074	0.36	1	Grey chert	Interior
Clearview	UA2016-136-0075	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0082	0.07	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0083	0.48	1	Grey chert	Interior
Clearview	UA2016-136-0087	9.7	2	Grey chert	Interior
Clearview	UA2016-136-0088	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0090	0.44	1	Black chert	Interior
Clearview	UA2016-136-0093	0.45	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0094	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0096	0.47	1	Grey chert	Edge preparation

Clearview	UA2016-136-0100	0.9	2	Black chert	Alternate
Clearview	UA2016-136-0101	0.05	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0101	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0101	0.09	1	Black chert	Edge preparation
Clearview	UA2016-136-0101	0.11	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0101	0.14	1	Black chert	Edge preparation
Clearview	UA2016-136-0101	0.28	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0103	1.57	2	Black chert	Alternate
Clearview	UA2016-136-0104	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0108	0.39	1	Black chert	Alternate
Clearview	UA2016-136-0109	0.23	1	Grey chert	Edge preparation
Clearview	UA2016-136-0113	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0115	0.06	1	Grey chert	Edge preparation
Clearview	UA2016-136-0116	0.03	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0118	0.05	1	Black chert	Microblade
Clearview	UA2016-136-0121	0.45	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0123	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0127	0.31	1	Black chert	Alternate
Clearview	UA2016-136-0129	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0132	0.07	1	Black chert	Alternate
Clearview	UA2016-136-0134	0.01	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2016-136-0134	0.01	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2016-136-0134	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0134	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0135	0.05	1	Grey banded chert	Bifacial pressure flake
Clearview	UA2016-136-0135	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0135	0.4	1	Rhyolite	Interior
Clearview	UA2016-136-0137	0.05	1	Grey banded chert	Microblade
Clearview	UA2016-136-0138	0.56	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0140	0.11	1	Grey chert	Edge preparation
Clearview	UA2016-136-0144	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0145	0.16	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0146	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0148	0.6	1	Rhyolite	Interior
Clearview	UA2016-136-0153	2.02	2	Black chert	Interior
Clearview	UA2016-136-0154	0.18	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0155	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0156	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0156	0.08	1	Black chert	Late bifacial thinning

Clearview	UA2016-136-0156	0.29	1	Black chert	Edge preparation
Clearview	UA2016-136-0157	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0157	0.17	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0157	0.8	1	Black chert	Interior
Clearview	UA2016-136-0159	7.83	2	Black chert	Secondary
Clearview	UA2016-136-0163	0.5	1	Black chert	Interior
Clearview	UA2016-136-0166	0.19	1	Black chert	Alternate
Clearview	UA2016-136-0168	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0169	0.02	1	Chalcedony	Bifacial pressure flake
Clearview	UA2016-136-0169	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0169	0.04	1	Grey chert	Edge preparation
Clearview	UA2016-136-0169	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0169	0.11	1	Grey chert	Interior
Clearview	UA2016-136-0170	0.4	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0172	1.89	2	Black chert	Secondary
Clearview	UA2016-136-0173	0.2	2	Grey chert	Microblade
Clearview	UA2016-136-0178	0.37	1	Black chert	Edge preparation
Clearview	UA2016-136-0180	0.47	1	Black chert	Edge preparation
Clearview	UA2016-136-0181	0.56	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0183	0.57	1	Black chert	Edge preparation
Clearview	UA2016-136-0184	0.27	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0188	0.5	1	Black chert	Edge preparation
Clearview	UA2016-136-0190	0.79	1	Black chert	Interior
Clearview	UA2016-136-0193	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0195	4.96	2	Black chert	Secondary
Clearview	UA2016-136-0196	35.9	3	Grey chert	Secondary
Clearview	UA2016-136-0197	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0197	0.07	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0197	0.08	1	Grey chert	Alternate
Clearview	UA2016-136-0197	0.13	1	Grey chert	Alternate
Clearview	UA2016-136-0197	0.35	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0202	0.98	1	Rhyolite	Interior
Clearview	UA2016-136-0204	0.13	1	Rhyolite	Core Face Rejuvination
Clearview	UA2016-136-0205	0.03	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0205	0.1	1	Red chert	Late bifacial thinning
Clearview	UA2016-136-0205	0.15	1	Red chert	Late bifacial thinning
Clearview	UA2016-136-0206	0.27	1	Black chert	Edge preparation
Clearview	UA2016-136-0210	0.42	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0212	0.27	1	Black chert	Interior
Clearview	UA2016-136-0214	0.1	2	Grey chert	Microblade

Clearview	UA2016-136-0216	0.36	2	Rhyolite	Secondary
Clearview	UA2016-136-0217	0.05	1	Red chert	Bifacial pressure flake
Clearview	UA2016-136-0219	0.05	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0221	0.1	1	Grey chert	Alternate
Clearview	UA2016-136-0223	0.08	1	Rhyolite	Alternate
Clearview	UA2016-136-0223	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0223	0.1	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0224	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0226	0.92	2	Rhyolite	Interior
Clearview	UA2016-136-0227	0.72	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0231	0.02	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0231	0.07	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0231	0.08	1	Black chert	Early thinning
Clearview	UA2016-136-0231	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0232	0.16	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0232	2.21	2	Black chert	Interior
Clearview	UA2016-136-0233	0.15	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0235	0.02	1	Black chert	Microblade
Clearview	UA2016-136-0236	0.23	1	Black chert	Early thinning
Clearview	UA2016-136-0237	1.34	2	Black chert	Secondary
Clearview	UA2016-136-0240	0.62	1	Grey chert	Early thinning
Clearview	UA2016-136-0243	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0245	5.71	2	Grey chert	Primary
Clearview	UA2016-136-0246	0.08	1	Black chert	Alternate
Clearview	UA2016-136-0247	0.08	1	Grey banded chert	Alternate
Clearview	UA2016-136-0248	1.24	2	Rhyolite	Microblade
Clearview	UA2016-136-0249	1	1	Black chert	Early thinning
Clearview	UA2016-136-0250	0.5	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0251	0.05	2	Rhyolite	Microblade
Clearview	UA2016-136-0252	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0252	0.05	1	Red chert	Bifacial pressure flake
Clearview	UA2016-136-0252	0.56	1	Chalcedony	Edge preparation
Clearview	UA2016-136-0253	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0253	0.67	1	Grey chert	Early thinning
Clearview	UA2016-136-0256	0.49	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0260	0.05	2	Rhyolite	Microblade
Clearview	UA2016-136-0262	3.95	2	Rhyolite	Early thinning
Clearview	UA2016-136-0263	0.2	1	Black chert	Alternate
Clearview	UA2016-136-0267	11.62	3	Basalt	Interior
Clearview	UA2016-136-0268	24.16	3	Basalt	Secondary

Clearview	UA2016-136-0269	0.93	1	Basalt	Edge preparation
Clearview	UA2016-136-0270	0.16	1	Basalt	Edge preparation
Clearview	UA2016-136-0270	0.24	1	Basalt	Late bifacial thinning
Clearview	UA2016-136-0271	0.13	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0271	0.24	1	Black chert	Edge preparation
Clearview	UA2016-136-0271	0.78	1	Black chert	Alternate
Clearview	UA2016-136-0272	1.3	1	Rhyolite	Interior
Clearview	UA2016-136-0275	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0276	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0277	0.71	1	Rhyolite	Alternate
Clearview	UA2016-136-0278	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0279	0.19	1	Rhyolite	Microblade
Clearview	UA2016-136-0279	0.99	2	Grey chert	Microblade
Clearview	UA2016-136-0279	5.76	2	Rhyolite	Primary
Clearview	UA2016-136-0279	10	2	Basalt	Interior
Clearview	UA2016-136-0280	0.12	1	Black chert	Microblade
Clearview	UA2016-136-0280	0.18	1	Chalcedony	Interior
Clearview	UA2016-136-0280	0.23	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0280	0.28	1	Grey chert	Alternate
Clearview	UA2016-136-0281	1.31	1	Rhyolite	Early thinning
Clearview	UA2016-136-0281	0.27	2	Grey chert	Early thinning
Clearview	UA2016-136-0281	9.75	2	Black chert	Primary
Clearview	UA2016-136-0282	0.11	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0287	0.22	1	Black chert	Alternate
Clearview	UA2016-136-0295	0.09	1	Black chert	Alternate
Clearview	UA2016-136-0299	0.02	1	Black chert	Alternate
Clearview	UA2016-136-0300	0.16	1	Black chert	Alternate
Clearview	UA2016-136-0301	0.03	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0301	0.03	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0303	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0305	0.17	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0306	0.25	1	Black chert	Edge preparation
Clearview	UA2016-136-0312	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0313	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0313	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0314	0.02	1	Grey chert	Edge preparation
Clearview	UA2016-136-0314	0.02	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0323	0.02	1	Black chert	Edge preparation
Clearview	UA2016-136-0328	0.58	1	Black chert	Interior
Clearview	UA2016-136-0328	0.98	1	Grey chert	Alternate

Clearview	UA2016-136-0332	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0337	0.84	2	Black chert	Interior
Clearview	UA2016-136-0338	1.15	2	Rhyolite	Secondary
Clearview	UA2016-136-0340	0.49	1	Rhyolite	Interior
Clearview	UA2016-136-0344	0.05	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0346	0.29	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0347	0.04	1	Grey chert	Edge preparation
Clearview	UA2016-136-0347	0.46	1	Grey chert	Alternate
Clearview	UA2016-136-0349	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0351	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0357	0.15	1	Grey chert	Alternate
Clearview	UA2016-136-0357	0.37	1	Black chert	Early thinning
Clearview	UA2016-136-0357	2.19	2	Rhyolite	Primary
Clearview	UA2016-136-0358	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0359	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0359	0.07	1	Black chert	Alternate
Clearview	UA2016-136-0360	0.02	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0360	0.02	1	Black chert	Microblade
Clearview	UA2016-136-0360	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0360	0.07	1	Black chert	Alternate
Clearview	UA2016-136-0360	0.76	1	Brown chert	Microblade
Clearview	UA2016-136-0361	0.25	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0361	0.47	1	Grey chert	Early thinning
Clearview	UA2016-136-0361	1.44	2	Grey chert	Interior
Clearview	UA2016-136-0362	0.16	1	Grey chert	Edge preparation
Clearview	UA2016-136-0362	0.2	1	Grey chert	Edge preparation
Clearview	UA2016-136-0362	0.3	1	Grey chert	Early thinning
Clearview	UA2016-136-0362	0.5	1	Black chert	Early thinning
Clearview	UA2016-136-0362	1.29	2	Black chert	Interior
Clearview	UA2016-136-0363	0.05	1	Chalcedony	Bifacial pressure flake
Clearview	UA2016-136-0364	0.12	1	Black chert	Edge preparation
Clearview	UA2016-136-0365	0.97	1	Grey chert	Alternate
Clearview	UA2016-136-0365	1.25	2	Grey chert	Interior
Clearview	UA2016-136-0365	3.54	2	Grey chert	Primary
Clearview	UA2016-136-0366	0.11	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0367	0.1	1	Black chert	Edge preparation
Clearview	UA2016-136-0368	0.04	1	Black chert	Alternate
Clearview	UA2016-136-0371	0.38	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0372	0.11	1	Black chert	Edge preparation
Clearview	UA2016-136-0373	0.01	1	Black chert	Bifacial pressure flake

Clearview	UA2016-136-0373	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0373	0.02	1	Grey chert	Edge preparation
Clearview	UA2016-136-0373	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0373	0.04	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0374	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0374	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0374	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0374	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0374	0.04	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0374	0.06	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0375	0.85	1	Red chert	Interior
Clearview	UA2016-136-0377	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.16	1	Black chert	Edge preparation
Clearview	UA2016-136-0377	0.19	1	Black chert	Interior
Clearview	UA2016-136-0377	0.19	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.2	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0377	0.27	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.29	1	Black chert	Alternate
Clearview	UA2016-136-0377	0.33	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0377	0.36	1	Rhyolite	Interior
Clearview	UA2016-136-0377	0.4	1	Black chert	Interior
Clearview	UA2016-136-0377	0.5	1	Black chert	Secondary
Clearview	UA2016-136-0377	0.53	1	Grey chert	Interior
Clearview	UA2016-136-0377	0.6	1	Black chert	Alternate
Clearview	UA2016-136-0377	0.76	1	Black chert	Interior
Clearview	UA2016-136-0377	0.78	1	Grey chert	Alternate
Clearview	UA2016-136-0377	0.79	1	Basalt	Interior
Clearview	UA2016-136-0378	0.09	1	Black chert	Edge preparation
Clearview	UA2016-136-0378	0.2	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0378	1.17	1	Grey chert	Early thinning
Clearview	UA2016-136-0379	0.44	1	Rhyolite	Microblade
Clearview	UA2016-136-0380	0.49	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0382	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0382	0.09	1	Black chert	Alternate
Clearview	UA2016-136-0382	0.47	1	Black chert	Early thinning
Clearview	UA2016-136-0384	0.75	1	Red chert	Late bifacial thinning
Clearview	UA2016-136-0386	0.04	1	Black chert	Edge preparation

Clearview	UA2016-136-0386	0.06	1	Red chert	Late bifacial thinning
Clearview	UA2016-136-0386	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0386	0.14	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0386	0.23	1	Black chert	Early thinning
Clearview	UA2016-136-0386	0.38	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0387	0.41	1	Black chert	Interior
Clearview	UA2016-136-0388	0.2	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0389	0.07	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0389	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0389	0.13	1	Black chert	Early thinning
Clearview	UA2016-136-0389	0.24	1	Black chert	Early thinning
Clearview	UA2016-136-0389	0.35	1	Black chert	Early thinning
Clearview	UA2016-136-0389	0.43	1	Black chert	Alternate
Clearview	UA2016-136-0394	0.17	1	Black chert	Edge preparation
Clearview	UA2016-136-0394	0.21	1	Black chert	Interior
Clearview	UA2016-136-0394	0.34	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0395	0.05	1	Black chert	Edge preparation
Clearview	UA2016-136-0395	0.35	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0396	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0397	0.01	1	Black chert	Edge preparation
Clearview	UA2016-136-0397	0.06	1	Red chert	Late bifacial thinning
Clearview	UA2016-136-0398	0.01	1	Black chert	Edge preparation
Clearview	UA2016-136-0399	0.35	1	Black chert	Alternate
Clearview	UA2016-136-0399	1.86	2	Grey chert	Interior
Clearview	UA2016-136-0399	1.95	2	Basalt	Interior
Clearview	UA2016-136-0400	0.07	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0400	0.07	1	Chalcedony	Microblade
Clearview	UA2016-136-0400	0.09	1	Grey chert	Microblade
Clearview	UA2016-136-0400	0.15	1	Chalcedony	Interior
Clearview	UA2016-136-0400	0.26	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0400	0.27	1	Chalcedony	Edge preparation
Clearview	UA2016-136-0400	0.4	1	Grey chert	Early thinning
Clearview	UA2016-136-0400	0.49	1	Black chert	Secondary
Clearview	UA2016-136-0400	0.56	1	Chalcedony	Secondary
Clearview	UA2016-136-0400	1.47	2	Grey chert	Interior
Clearview	UA2016-136-0400	2.5	2	Basalt	Early thinning
Clearview	UA2016-136-0400	32.42	3	Basalt	Secondary
Clearview	UA2016-136-0401	2.79	2	Basalt	Secondary
Clearview	UA2016-136-0403	0.53	1	Grey chert	Early thinning
Clearview	UA2016-136-0404	0.02	1	Rhyolite	Edge preparation

Clearview	UA2016-136-0404	0.13	1	Chalcedony	Early thinning
Clearview	UA2016-136-0404	0.21	1	Grey chert	Alternate
Clearview	UA2016-136-0407	19.55	3	Grey chert	Interior
Clearview	UA2016-136-0408	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0408	1.4	2	Grey chert	Early thinning
Clearview	UA2016-136-0408	1.63	2	Basalt	Edge preparation
Clearview	UA2016-136-0412	0.12	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0413	0.32	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0414	0.31	1	Black chert	Early thinning
Clearview	UA2016-136-0414	0.37	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0417	0.12	1	Rhyolite	Interior
Clearview	UA2016-136-0418	0.07	1	Grey chert	Microblade
Clearview	UA2016-136-0418	0.45	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0419	0.9	1	Grey chert	Microblade
Clearview	UA2016-136-0423	0.03	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0423	0.06	1	Grey chert	Interior
Clearview	UA2016-136-0424	0.06	1	Grey chert	Edge preparation
Clearview	UA2016-136-0424	0.07	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0424	0.22	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0424	0.24	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0424	0.43	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0425	0.04	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0425	0.07	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0425	0.14	1	Black chert	Edge preparation
Clearview	UA2016-136-0425	0.15	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0428	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0428	0.42	1	Jasper	Late bifacial thinning
Clearview	UA2016-136-0428	0.86	1	Grey chert	Microblade
Clearview	UA2016-136-0428	1.37	1	Basalt	Early thinning
Clearview	UA2016-136-0429	0.37	1	Black chert	Alternate
Clearview	UA2016-136-0429	0.69	1	Black chert	Interior
Clearview	UA2016-136-0429	1.05	1	Basalt	Interior
Clearview	UA2016-136-0429	0.64	2	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0429	13.33	2	Grey chert	Primary
Clearview	UA2016-136-0430	5.69	2	Black chert	Secondary
Clearview	UA2016-136-0432	0.19	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0435	0.04	1	Chalcedony	Edge preparation
Clearview	UA2016-136-0435	1.47	2	Basalt	Alternate
Clearview	UA2016-136-0436	3.11	2	Black chert	Edge preparation
Clearview	UA2016-136-0436	6.22	2	Basalt	Secondary

Clearview	UA2016-136-0436	8.26	2	Grey chert	Secondary
Clearview	UA2016-136-0438	0.22	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0439	0.12	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0440	0.11	1	Granite	Edge preparation
Clearview	UA2016-136-0440	2.63	2	Grey chert	Interior
Clearview	UA2016-136-0440	4.27	2	Granite	Early thinning
Clearview	UA2016-136-0441	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0441	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0441	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0441	0.34	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0441	0.44	1	Black chert	Early thinning
Clearview	UA2016-136-0442	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0442	0.26	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0442	0.4	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0442	1.4	2	Basalt	Early thinning
Clearview	UA2016-136-0443	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0443	0.04	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0443	0.11	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0443	0.24	1	Rhyolite	Microblade
Clearview	UA2016-136-0443	0.33	1	Jasper	Late bifacial thinning
Clearview	UA2016-136-0445	0.38	1	Basalt	Early thinning
Clearview	UA2016-136-0445	1.51	2	Basalt	Early thinning
Clearview	UA2016-136-0445	2.42	2	Basalt	Secondary
Clearview	UA2016-136-0445	2.94	2	Basalt	Secondary
Clearview	UA2016-136-0446	0.15	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0447	0.1	1	Black chert	Edge preparation
Clearview	UA2016-136-0450	0.22	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0452	0.45	1	Basalt	Interior
Clearview	UA2016-136-0453	0.22	1	Grey chert	Early thinning
Clearview	UA2016-136-0454	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0457	2.94	2	Grey chert	Interior
Clearview	UA2016-136-0458	0.1	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0459	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0459	6.38	3	Rhyolite	Primary
Clearview	UA2016-136-0460	0.83	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0461	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0461	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0461	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0461	0.1	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0461	0.25	1	Black chert	Late bifacial thinning

Clearview	UA2016-136-0461	0.28	1	Black chert	Edge preparation
Clearview	UA2016-136-0462	0.06	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0462	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0462	0.12	1	Black chert	Edge preparation
Clearview	UA2016-136-0462	0.39	1	Grey chert	Early thinning
Clearview	UA2016-136-0462	0.59	1	Rhyolite	Early thinning
Clearview	UA2016-136-0463	0.1	1	Black chert	Microblade
Clearview	UA2016-136-0465	0.07	1	Grey chert	Edge preparation
Clearview	UA2016-136-0465	1.86	2	Black chert	Interior
Clearview	UA2016-136-0465	2.83	2	Black chert	Interior
Clearview	UA2016-136-0473	6.9	2	Grey chert	Interior
Clearview	UA2016-136-0475	0.38	1	Grey chert	Interior
Clearview	UA2016-136-0477	0.05	1	Grey chert	Edge preparation
Clearview	UA2016-136-0480	0.46	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0480	1.44	2	Black chert	Early thinning
Clearview	UA2016-136-0480	30.71	3	Basalt	Secondary
Clearview	UA2016-136-0481	0.02	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0481	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0481	0.04	1	Black chert	Edge preparation
Clearview	UA2016-136-0481	0.23	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0481	0.28	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0481	0.3	1	Black chert	Edge preparation
Clearview	UA2016-136-0481	0.37	1	Rhyolite	Early thinning
Clearview	UA2016-136-0481	0.79	2	Black chert	Late bifacial thinning
Clearview	UA2016-136-0485	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0491	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0491	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0491	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0491	0.01	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.02	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0491	0.02	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.02	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.03	1	Black chert	Alternate
Clearview	UA2016-136-0491	0.03	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.03	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0491	0.04	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0491	0.05	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0491	0.05	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0491	0.05	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.06	1	Black chert	Late bifacial thinning

Clearview	UA2016-136-0491	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0491	0.07	1	Grey chert	Edge preparation
Clearview	UA2016-136-0491	0.07	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.08	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.1	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0491	0.11	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.12	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0491	0.13	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.13	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0491	0.15	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.15	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0491	0.16	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.17	1	Black chert	Early thinning
Clearview	UA2016-136-0491	0.2	1	Rhyolite	Alternate
Clearview	UA2016-136-0491	0.2	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.23	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.29	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.32	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0491	0.5	1	Grey chert	Early thinning
Clearview	UA2016-136-0491	0.54	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0491	0.55	1	Black chert	Edge preparation
Clearview	UA2016-136-0491	0.73	1	Black chert	Early thinning
Clearview	UA2016-136-0491	1.61	2	Grey chert	Early thinning
Clearview	UA2016-136-0492	0.01	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0492	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0492	0.04	1	Rhyolite	Bifacial pressure flake
Clearview	UA2016-136-0492	0.05	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0492	0.07	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0492	0.09	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0492	0.12	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0492	0.15	1	Black chert	Edge preparation
Clearview	UA2016-136-0492	0.25	1	Black chert	Edge preparation
Clearview	UA2016-136-0493	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0493	0.13	1	Grey chert	Edge preparation
Clearview	UA2016-136-0493	0.14	1	Rhyolite	Alternate
Clearview	UA2016-136-0493	0.17	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0493	0.2	1	Grey chert	Late bifacial thinning

Clearview	UA2016-136-0493	0.21	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0493	0.26	1	Rhyolite	Early thinning
Clearview	UA2016-136-0496	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0500	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0500	0.07	1	Black chert	Edge preparation
Clearview	UA2016-136-0500	0.15	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0500	0.23	1	Black chert	Edge preparation
Clearview	UA2016-136-0500	0.23	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0500	0.48	1	Black chert	Early thinning
Clearview	UA2016-136-0500	0.55	1	Black chert	Alternate
Clearview	UA2016-136-0500	0.61	1	Black chert	Early thinning
Clearview	UA2016-136-0500	0.86	2	Black chert	Alternate
Clearview	UA2016-136-0501	0.03	1	Black chert	Edge preparation
Clearview	UA2016-136-0501	0.03	1	Rhyolite	Microblade
Clearview	UA2016-136-0501	0.06	1	Rhyolite	Alternate
Clearview	UA2016-136-0501	0.06	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0501	0.15	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0501	0.29	1	Black chert	Edge preparation
Clearview	UA2016-136-0502	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0502	0.04	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0506	0.01	1	Brown chert	Bifacial pressure flake
Clearview	UA2016-136-0506	0.03	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0506	0.54	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0506	2.66	2	Grey chert	Interior
Clearview	UA2016-136-0507	0.06	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0507	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0508	0.04	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0509	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0509	0.05	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0509	0.8	1	Grey chert	Interior
Clearview	UA2016-136-0509	0.77	2	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0511	0.13	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0512	0.02	1	Black chert	Edge preparation
Clearview	UA2016-136-0514	0.17	1	Grey chert	Early thinning
Clearview	UA2016-136-0515	0.03	1	Grey chert	Edge preparation
Clearview	UA2016-136-0515	0.13	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0516	0.31	1	Grey chert	Early thinning
Clearview	UA2016-136-0518	0.52	1	Grey chert	Early thinning
Clearview	UA2016-136-0519	0.72	1	Grey chert	Secondary
Clearview	UA2016-136-0521	0.1	2	Rhyolite	Microblade

Clearview	UA2016-136-0522	0.1	1	Rhyolite	Interior
Clearview	UA2016-136-0527	0.18	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0530	0.1	2	Chalcedony	Microblade
Clearview	UA2016-136-0531	0.12	1	Rhyolite	Edge preparation
Clearview	UA2016-136-0534	0.05	2	Grey banded chert	Microblade
Clearview	UA2016-136-0536	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0537	0.06	1	Grey chert	Unifacial pressure flake
Clearview	UA2016-136-0539	0.02	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0541	0.21	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0543	0.17	1	Black chert	Edge preparation
Clearview	UA2016-136-0545	0.76	1	Rhyolite	Early thinning
Clearview	UA2016-136-0549	0.03	1	Grey chert	Edge preparation
Clearview	UA2016-136-0553	0.1	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0554	0.93	1	Grey chert	Alternate
Clearview	UA2016-136-0556	0.05	1	Grey chert	Alternate
Clearview	UA2016-136-0559	0.77	2	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0561	0.13	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0562	0.09	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0562	0.11	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0563	0.09	1	Rhyolite	Late bifacial thinning
Clearview	UA2016-136-0563	0.17	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0564	0.14	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0565	0.02	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0565	0.03	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0565	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0565	0.04	1	Grey chert	Edge preparation
Clearview	UA2016-136-0565	0.05	1	Grey chert	Edge preparation
Clearview	UA2016-136-0565	0.07	1	Grey chert	Alternate
Clearview	UA2016-136-0566	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2016-136-0566	0.17	1	Grey chert	Alternate
Clearview	UA2016-136-0567	0.05	1	Brown chert	Late bifacial thinning
Clearview	UA2016-136-0568	0.82	1	Grey chert	Early thinning
Clearview	UA2016-136-0569	0.02	1	Red chert	Bifacial pressure flake
Clearview	UA2016-136-0569	0.2	1	Grey chert	Alternate
Clearview	UA2016-136-0571	1.82	2	Red chert	Early thinning
Clearview	UA2016-136-0580	0.39	1	Quartz	Interior
Clearview	UA2016-136-0580	0.62	1	Quartz	Edge preparation
Clearview	UA2016-136-0580	0.73	1	Quartz	Edge preparation
Clearview	UA2016-136-0580	0.99	1	Quartz	Early thinning
Clearview	UA2016-136-0580	1.67	1	Quartz	Secondary

Clearview	UA2016-136-0586	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2016-136-0588	1.67	2	Grey chert	Secondary
Clearview	UA2016-136-0589	0.14	1	Black chert	Alternate
Clearview	UA2016-136-0590	0.35	1	Grey chert	Edge preparation
Clearview	UA2016-136-0592	0.06	1	Black chert	Microblade
Clearview	UA2016-136-0593	0.26	1	Black chert	Early thinning
Clearview	UA2016-136-0593	0.34	1	Black chert	Early thinning
Clearview	UA2016-136-0595	0.93	1	Grey chert	Alternate
Clearview	UA2016-136-0596	0.04	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0598	0.02	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0598	0.06	1	Grey chert	Edge preparation
Clearview	UA2016-136-0602	0.05	1	Chalcedony	Alternate
Clearview	UA2016-136-0602	0.06	1	Chalcedony	Alternate
Clearview	UA2016-136-0602	0.17	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0602	0.19	1	Chalcedony	Edge preparation
Clearview	UA2016-136-0602	0.49	1	Rhyolite	Early thinning
Clearview	UA2016-136-0602	0.62	1	Grey chert	Edge preparation
Clearview	UA2016-136-0602	0.74	1	Grey chert	Edge preparation
Clearview	UA2016-136-0602	0.88	2	Black chert	Early thinning
Clearview	UA2016-136-0602	1.13	2	Black chert	Early thinning
Clearview	UA2016-136-0602	1.75	2	Grey chert	Interior
Clearview	UA2016-136-0602	4.68	2	Basalt	Interior
Clearview	UA2016-136-0602	5.59	2	Basalt	Interior
Clearview	UA2016-136-0603	0.22	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0603	0.25	1	Grey chert	Late bifacial thinning
Clearview	UA2016-136-0603	1.77	2	Grey chert	Early thinning
Clearview	UA2016-136-0604	0.12	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0604	0.15	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0604	0.2	1	Chalcedony	Late bifacial thinning
Clearview	UA2016-136-0604	0.41	1	Grey chert	Early thinning
Clearview	UA2016-136-0604	0.55	1	Grey chert	Early thinning
Clearview	UA2016-136-0605	0.72	2	Chalcedony	Alternate
Clearview	UA2016-136-0606	0.38	1	Grey chert	Early thinning
Clearview	UA2016-136-0606	2.1	2	Basalt	Early thinning
Clearview	UA2016-136-0607	0.34	1	Grey chert	Microblade
Clearview	UA2016-136-0608	0.19	1	Grey chert	Microblade
Clearview	UA2016-136-0609	0.12	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0610	0.42	1	Black chert	Late bifacial thinning
Clearview	UA2016-136-0611	0.1	2	Rhyolite	Microblade
Clearview	UA2016-136-0612	0.05	2	Rhyolite	Microblade

Clearview	UA2016-136-0613	0.1	2	Grey chert	Microblade
Clearview	UA2016-136-0614	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0615	0.1	2	Grey chert	Microblade
Clearview	UA2016-136-0616	0.01	1	Grey chert	Microblade
Clearview	UA2016-136-0620	0.1	2	Grey chert	Microblade
Clearview	UA2016-136-0621	0.05	2	Grey chert	Microblade
Clearview	UA2016-136-0623	0.2	2	Rhyolite	Microblade
Clearview	UA2016-136-0624	0.1	2	Obsidian	Microblade
Clearview	UA2016-136-0625	0.1	2	Obsidian	Microblade
Clearview	UA2016-136-0626	0.4	2	Obsidian	Microblade
Clearview	UA2016-136-0627	0.2	2	Obsidian	Microblade
Clearview	UA2016-136-0628	0.1	2	Rhyolite	Microblade
Clearview	UA2016-136-0629	0.3	2	Black chert	Microblade
Clearview	UA2016-136-0630	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0631	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0632	0.05	2	Obsidian	Microblade
Clearview	UA2016-136-0633	0.05	2	Obsidian	Microblade
Clearview	UA2016-136-0634	0.1	2	Obsidian	Microblade
Clearview	UA2016-136-0635	0.4	2	Black chert	Microblade
Clearview	UA2016-136-0636	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0637	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0638	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0639	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0640	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0641	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0642	0.05	2	Obsidian	Microblade
Clearview	UA2016-136-0643	0.05	2	Obsidian	Microblade
Clearview	UA2016-136-0644	0.1	2	Obsidian	Microblade
Clearview	UA2016-136-0645	0.2	2	Grey chert	Microblade
Clearview	UA2016-136-0646	0.4	2	Grey chert	Microblade
Clearview	UA2016-136-0649	0.2	2	Rhyolite	Microblade
Clearview	UA2016-136-0650	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0651	0.5	2	Black chert	Microblade
Clearview	UA2016-136-0652	0.05	2	Black chert	Microblade
Clearview	UA2016-136-0653	0.3	2	Black chert	Microblade
Clearview	UA2016-136-0654	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0655	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0656	0.2	2	Black chert	Microblade
Clearview	UA2016-136-0657	0.05	2	Black chert	Microblade
Clearview	UA2016-136-0658	0.1	2	Black chert	Microblade

Clearview	UA2016-136-0659	0.1	2	Black chert	Microblade
Clearview	UA2016-136-0660	0.1	2	Grey chert	Microblade
Clearview	UA2016-136-0661	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0018	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0029	0.3	2	Black chert	Microblade
Clearview	UA2017-92-0029	0.3	2	Black chert	Microblade
Clearview	UA2017-92-0048	0.2	2	Rhyolite	Microblade
Clearview	UA2017-92-0154	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0155	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0156	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0157	0.1	2	Grey chert	Microblade
Clearview	UA2017-92-0158	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0159	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0160	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0161	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0162	0.1	2	Black chert	Microblade
Clearview	UA2017-92-0163	0.1	2	Rhyolite	Microblade
Clearview	UA2017-92-0165	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0166	0.1	2	Obsidian	Microblade
Clearview	UA2017-92-0167	0.22	2	Rhyolite	Microblade
Clearview	UA2017-92-0168	0.2	2	Brown chert	Microblade
Clearview	UA2017-92-0169	0.07	2	Black chert	Microblade
Clearview	UA2017-92-0170	0.05	2	Black chert	Microblade
Clearview	UA2017-92-0172	0.04	2	Grey chert	Microblade
Clearview	UA2017-92-0173	0.07	2	Black chert	Microblade
Clearview	UA2018-71-12	0.1	1	White chert	Edge preparation
Clearview	UA2018-71-16	0.02	1	White chert	Bifacial pressure flake
Clearview	UA2018-71-20	0.02	1	Rhyolite	Edge preparation
Clearview	UA2018-71-21	0.06	1	Chalcedony	Alternate
Clearview	UA2018-71-24	0.11	1	Black chert	Edge preparation
Clearview	UA2018-71-25	3.93	3	Basalt	Interior
Clearview	UA2018-71-26	0.37	2	Black chert	Late bifacial thinning
Clearview	UA2018-71-27	0.1	1	Black chert	Edge preparation
Clearview	UA2018-71-28	0.35	2	Black chert	Early thinning
Clearview	UA2018-71-29	1.08	3	Grey chert	Interior
Clearview	UA2018-71-31	0.4	1	Black chert	Interior
Clearview	UA2018-71-32	0.1	1	Rhyolite	Bifacial pressure flake
Clearview	UA2018-71-34	0.1	2	Black chert	Microblade
Clearview	UA2018-71-35	0.06	1	Chalcedony	Bifacial pressure flake
Clearview	UA2018-71-36	0.05	1	Black chert	Edge preparation

Clearview	UA2018-71-36	0.2	1	Black chert	Edge preparation
Clearview	UA2018-71-37	0.18	2	Grey chert	Edge preparation
Clearview	UA2018-71-38	0.04	1	Grey chert	Microblade
Clearview	UA2018-71-39	0.03	1	Grey chert	Bifacial pressure flake
Clearview	UA2018-71-40	0.03	1	Black chert	Bifacial pressure flake
Clearview	UA2018-71-40	0.24	2	Grey chert	Alternate
Clearview	UA2018-71-41	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2018-71-42	0.26	2	Obsidian	Late bifacial thinning
Clearview	UA2018-71-42	109.6	3	Grey chert	Primary
Clearview	UA2018-71-43	0.22	1	Grey chert	Secondary
Clearview	UA2018-71-44	0.03	1	Black chert	Microblade
Clearview	UA2018-71-44	0.29	1	Grey chert	Platform rejuvination
Clearview	UA2018-71-47	0.19	1	Chalcedony	Late bifacial thinning
Clearview	UA2018-71-52	0.06	1	Grey chert	Edge preparation
Clearview	UA2018-71-52	0.12	1	Grey chert	Alternate
Clearview	UA2018-71-52	0.19	1	Grey chert	Alternate
Clearview	UA2018-71-53	0.5	2	Grey chert	Primary
Clearview	UA2018-71-54	0.25	2	Grey chert	Early thinning
Clearview	UA2018-71-55	0.02	1	Rhyolite	Bifacial pressure flake
Clearview	UA2018-71-57	56.9	3	Black chert	Secondary
Clearview	UA2018-71-58	0.13	2	Rhyolite	Late bifacial thinning
Clearview	UA2018-71-59	0.73	2	Grey chert	Bifacial pressure flake
Clearview	UA2018-71-6	0.53	2	Black chert	Alternate
Clearview	UA2018-71-60	0.22	2	Grey chert	Late bifacial thinning
Clearview	UA2018-71-61	0.42	2	Grey chert	Primary
Clearview	UA2018-71-62	0.04	1	Obsidian	Bifacial pressure flake
Clearview	UA2018-71-66	0.05	1	Obsidian	Bifacial pressure flake
Clearview	UA2018-71-67	0.33	1	Grey chert	Primary
Clearview	UA2018-71-68	0.33	2	Grey chert	Alternate
Clearview	UA2018-71-69	0.01	1	Grey chert	Bifacial pressure flake
Clearview	UA2018-71-69	0.02	1	Grey chert	Bifacial pressure flake
Clearview	UA2018-71-69	0.03	1	Grey chert	Late bifacial thinning
Clearview	UA2018-71-69	0.05	1	Grey chert	Edge preparation
Clearview	UA2018-71-69	0.07	1	Grey chert	Edge preparation
Clearview	UA2018-71-7	0.3	2	Black chert	Alternate
Clearview	UA2018-71-70	11.9	2	Grey chert	Primary
Clearview	UA2018-71-71	32.1	2	Grey chert	Interior
Clearview	UA2018-71-72	12.8	2	Grey chert	Early thinning
Clearview	UA2018-71-73	0.14	1	Grey chert	Edge preparation
Clearview	UA2018-71-74	0.04	1	Grey chert	Bifacial pressure flake

Clearview	UA2018-71-74	0.08	1	Grey chert	Late bifacial thinning
Clearview	UA2018-71-74	0.1	1	Grey chert	Late bifacial thinning
Clearview	UA2018-71-74	0.48	2	Rhyolite	Alternate
Clearview	UA2018-71-75	0.01	1	Rhyolite	Bifacial pressure flake
Clearview	UA2018-71-75	0.04	1	Grey chert	Alternate
Clearview	UA2018-71-75	0.06	1	Obsidian	Bifacial pressure flake
Clearview	UA2018-71-75	0.06	1	Rhyolite	Late bifacial thinning
Clearview	UA2018-71-75	0.1	2	Rhyolite	Late bifacial thinning
Clearview	UA2018-71-75	0.13	2	Obsidian	Late bifacial thinning
Delta Creek	UA2018-70-438	0.04	1	Chalcedony	Bifacial pressure flake
Delta Creek	UA2018-70-10	0.06	1	Black chert	Late bifacial thinning
Delta Creek	UA2017-70-11	0.06	1	Black chert	Alternate
Delta Creek	UA2017-091-0001	0.14	1	Grey chert	Late bifacial thinning
Delta Creek	UA2017-091-0082	0.01	1	Black chert	Alternate
Delta Creek	UA2017-091-0082	0.02	1	Grey chert	Edge preparation
Delta Creek	UA2017-091-0082	0.1	1	Black chert	Edge preparation
Delta Creek	UA2017-091-0082	0.16	1	Black chert	Late bifacial thinning
Delta Creek	UA2017-091-0082	1.69	2	Grey chert	Interior
Delta Creek	UA2017-091-0082	1.96	3	Black chert	Late bifacial thinning
Delta Creek	UA2017-091-0089	0.29	1	Black chert	Alternate
Delta Creek	UA2017-091-0090	0.01	1	Black chert	Alternate
Delta Creek	UA2017-091-0090	0.02	1	Black chert	Alternate
Delta Creek	UA2017-091-0090	0.09	1	Black chert	Interior
Delta Creek	UA2017-091-0090	0.16	1	Black chert	Edge preparation
Delta Creek	UA2017-091-0090	0.23	1	Black chert	Late bifacial thinning
Delta Creek	UA2017-091-0093	4.43	1	Grey chert	Secondary
Delta Creek	UA2017-091-0097	1.36	2	Jasper	Early thinning
Delta Creek	UA2017-091-0098	0.09	1	Black chert	Edge preparation
Delta Creek	UA2017-091-0098	0.14	1	Black chert	Edge preparation
Delta Creek	UA2017-091-0098	0.36	1	Black chert	Late bifacial thinning
Delta Creek	UA2017-091-0099	0.01	1	Black chert	Early thinning
Delta Creek	UA2017-091-0099	0.11	1	Black chert	Bifacial pressure flake
Delta Creek	UA2017-091-0102	0.01	1	Black chert	Interior
Delta Creek	UA2017-091-0105	0.03	1	Grey chert	Late bifacial thinning
Delta Creek	UA2017-091-0127	0.03	1	Chalcedony	Bifacial pressure flake
Delta Creek	UA2017-091-0134	0.04	1	Black chert	Late bifacial thinning
Klein Lower Locus	UA2012-177-57	1.8	3	Rhyolite	Early thinning
Klein Lower Locus	UA2012-177-59	0.05	1	Obsidian	Early thinning
Klein Lower Locus	UA2012-177-609	0.05	1	Grey chert	Bifacial pressure flake
Klein Lower Locus	UA2012-177-665	0.05	1	Grey chert	Bifacial pressure flake

Klein Lower Locus	UA2012-177-665	0.05	1	Grey chert	Bifacial pressure flake
Klein Lower Locus	UA2012-177-70	0.5	2	Grey chert	Early thinning
Klein Lower Locus	UA2012-177-709	0.4	2	Obsidian	Edge preparation
Klein Lower Locus	UA2012-177-9	1.2	2	Black chert	Secondary
Klein Lower Locus	UA2012-177-9	17.8	4	Black chert	Primary
Klein Lower Locus	UA2014-057-0008	2.1	3	Black chert	Early thinning
Klein Lower Locus	UA2014-057-0032	0.3	2	Black chert	Platform rejuvination
Klein Lower Locus	UA2014-057-0032	0.7	2	Black chert	Microblade
Klein Lower Locus	UA2014-057-0032	1	2	Obsidian	Late bifacial thinning
Klein Lower Locus	UA2014-057-0032	4.6	3	Black chert	Early thinning
Klein Lower Locus	UA2014-057-0041	11.4	3	Black chert	Secondary
Klein Lower Locus	UA2014-057-0045	6.6	3	Black chert	Secondary
Klein Lower Locus	UA2014-057-0053	11.2	3	Black chert	Secondary
Klein Lower Locus	UA2014-057-0054	28	4	Black chert	Secondary
Klein Lower Locus	UA2014-057-0068	3.6	2	Black chert	Interior
Klein Lower Locus	UA2018-061-0084	0.05	1	Red chert	Bifacial pressure flake
Klein Lower Locus	UA2018-061-0102	0.05	1	Black chert	Bifacial pressure flake
Klein Lower Locus	UA2018-061-0103	0.6	2	Black chert	Interior
Klein Lower Locus	UA2018-061-0115	1.5	2	Obsidian	Secondary
Klein Lower Locus	UA2018-061-0127	11.6	4	Black chert	Secondary
Klein Lower Locus	UA2018-61-220	0.5	2	Obsidian	Alternate
Klein Lower Locus	UA2018-61-220	0.8	3	Black chert	Late bifacial thinning
Klein Lower Locus	UA2018-61-259	0.05	1	Grey chert	Bifacial pressure flake
Klein Lower Locus	UA2018-61-304	1.3	2	Black chert	Secondary
Klein Lower Locus	UA2018-61-307	4.1	3	Quartz	Primary
Klein Lower Locus	UA2018-61-313	0.3	2	Quartz	Unifacial pressure flake
Klein Lower Locus	UA2018-61-323	0.05	1	Black chert	Edge preparation
Klein Lower Locus	UA2018-61-323	0.05	1	Red chert	Edge preparation
Klein Lower Locus	UA2018-61-323	0.05	1	Red chert	Late bifacial thinning
Klein Lower Locus	UA2018-61-323	0.1	2	Black chert	Alternate
Klein Lower Locus	UA2018-61-344	1.4	1	Black chert	Edge preparation
Klein Lower Locus	UA2018-61-353	10.4	3	Black chert	Secondary
Klein Lower Locus	UA2018-61-396	0.1	1	Red chert	Microblade
Klein Lower Locus	UA2018-61-449	1.2	2	Black chert	Primary
Klein Lower Locus	UA2018-61-451	0.05	1	Rhyolite	Bifacial pressure flake
Klein Lower Locus	UA2018-61-451	0.05	1	Black chert	Unifacial pressure flake
Klein Lower Locus	UA2018-61-456	0.4	2	Black chert	Primary
Klein Lower Locus	UA2018-61-460	0.05	1	Black chert	Bifacial pressure flake
Klein Lower Locus	UA2018-61-460	0.05	1	Red chert	Edge preparation
Klein Lower Locus	UA2018-61-462	0.1	1	Red chert	Alternate

Klein Upper Locus	UA2019-154-23	1.77	3	Grey chert	Secondary
Klein Upper Locus	UA2019-154-51	0.51	2	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-58	1.18	2	Black chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-102	0.35	2	Obsidian	Microblade
Klein Upper Locus	UA2019-154-126	42.94	4	Black chert	Primary
Klein Upper Locus	UA2019-154-129	175.93	4	Basalt	Primary
Klein Upper Locus	UA2019-154-133	2.61	3	Black chert	Secondary
Klein Upper Locus	UA2019-154-135	4.89	3	Black chert	Early thinning
Klein Upper Locus	UA2019-154-149	2.35	3	Black chert	Interior
Klein Upper Locus	UA2019-154-158	0.21	1	Black chert	Edge preparation
Klein Upper Locus	UA2019-154-175	0.19	2	Obsidian	Late bifacial thinning
Klein Upper Locus	UA2019-154-219	8.57	3	Quartz	Secondary
Klein Upper Locus	UA2019-154-231	0.05	1	Quartz	Edge preparation
Klein Upper Locus	UA2019-154-231	0.65	2	Quartz	Edge preparation
Klein Upper Locus	UA2019-154-279	22.52	3	Granite	Secondary
Klein Upper Locus	UA2019-154-280	0.26	2	Black chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-286	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-286	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-286	0.13	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-315	0.33	2	Grey chert	Core tablet
Klein Upper Locus	UA2019-154-316	23.7	3	Quartz	Secondary
Klein Upper Locus	UA2019-154-336	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-336	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-336	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-336	0.16	1	Grey chert	Interior
Klein Upper Locus	UA2019-154-336	0.48	2	Quartz	Alternate
Klein Upper Locus	UA2019-154-343	1.15	2	Grey chert	Secondary
Klein Upper Locus	UA2019-154-358	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-358	0.13	1	Quartz	Edge preparation
Klein Upper Locus	UA2019-154-358	0.29	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-358	0.34	2	Quartz	Secondary
Klein Upper Locus	UA2019-154-367	0.31	1	Granite	Secondary
Klein Upper Locus	UA2019-154-367	0.42	2	Granite	Alternate
Klein Upper Locus	UA2019-154-384	17.96	4	Granite	Primary
Klein Upper Locus	UA2019-154-417	2.35	3	Quartz	Interior

Klein Upper Locus	UA2019-154-433	5.21	3	Granite	Interior
Klein Upper Locus	UA2019-154-436	0.17	1	Black chert	Edge preparation
Klein Upper Locus	UA2019-154-438	0.07	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-448	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-448	0.05	1	Chalcedony	Bifacial pressure flake
Klein Upper Locus	UA2019-154-448	0.08	1	Granite	Edge preparation
Klein Upper Locus	UA2019-154-448	0.13	1	Granite	Bifacial pressure flake
Klein Upper Locus	UA2019-154-448	0.22	1	Granite	Edge preparation
Klein Upper Locus	UA2019-154-448	0.27	1	Granite	Secondary
Klein Upper Locus	UA2019-154-448	0.28	1	Granite	Secondary
Klein Upper Locus	UA2019-154-448	0.24	2	Chalcedony	Microblade
Klein Upper Locus	UA2019-154-448	1.23	3	Granite	Alternate
Klein Upper Locus	UA2019-154-453	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-453	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-453	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-453	0.06	1	Black chert	Edge preparation
Klein Upper Locus	UA2019-154-462	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	0.05	2	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-462	2.04	2	Granite	Secondary
Klein Upper Locus	UA2019-154-480	5.43	3	Granite	Secondary
Klein Upper Locus	UA2019-154-481	20.79	4	Granite	Secondary
Klein Upper Locus	UA2019-154-488	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-488	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-488	0.05	1	Quartz	Bifacial pressure flake
Klein Upper Locus	UA2019-154-488	0.22	2	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-489	0.97	2	Rhyolite	Edge preparation
Klein Upper Locus	UA2019-154-495	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-495	0.14	1	Granite	Secondary
Klein Upper Locus	UA2019-154-502	0.05	1	Black chert	Edge preparation
Klein Upper Locus	UA2019-154-502	0.17	2	Grey chert	Alternate
Klein Upper Locus	UA2019-154-505	0.05	1	Grey chert	Microblade
Klein Upper Locus	UA2019-154-505	0.06	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-507	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-507	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake

Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Microblade
Klein Upper Locus	UA2019-154-508	0.05	1	Grey chert	Microblade
Klein Upper Locus	UA2019-154-510	8.17	3	Granite	Secondary
Klein Upper Locus	UA2019-154-514	5.66	3	Granite	Secondary
Klein Upper Locus	UA2019-154-526	0.22	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-528	0.05	1	Obsidian	Microblade
Klein Upper Locus	UA2019-154-545	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-545	0.05	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-545	0.05	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-545	0.05	1	Grey chert	Microblade
Klein Upper Locus	UA2019-154-545	0.05	1	Grey chert	Microblade
Klein Upper Locus	UA2019-154-555	0.37	2	Grey chert	Early thinning
Klein Upper Locus	UA2019-154-556	0.32	2	Grey chert	Late bifacial thinning

Klein Upper Locus	UA2019-154-561	0.28	2	Grey chert	Alternate
Klein Upper Locus	UA2019-154-565	0.08	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-566	0.17	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-566	0.21	2	Grey chert	Alternate
Klein Upper Locus	UA2019-154-567	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-567	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-567	0.08	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.09	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.12	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.12	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.13	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.21	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-567	0.22	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-568	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-568	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-568	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-568	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-569	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-571	0.26	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-573	0.23	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-574	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-574	0.06	1	Grey chert	Edge preparation
Klein Upper Locus	UA2019-154-574	0.07	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-574	0.09	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-574	0.15	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-579	0.24	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-583	3.47	3	Granite	Secondary
Klein Upper Locus	UA2019-154-584	0.13	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2019-154-600	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-600	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-600	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2019-154-600	0.15	1	Grey chert	Early thinning
Klein Upper Locus	No catalog #	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	No catalog #	0.05	1	Rhyolite	Microblade
Klein Upper Locus	No catalog #	0.1	1	Black chert	Edge preparation

Klein Upper Locus	No catalog #	0.2	2	Grey chert	Alternate
Klein Upper Locus	UA2012-177-204	0.4	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2012-177-279	0.2	2	Black chert	Microblade
Klein Upper Locus	UA2012-177-350	0.5	3	Black chert	Edge preparation
Klein Upper Locus	UA2012-177-422	0.05	1	Black chert	Edge preparation
Klein Upper Locus	UA2012-177-429	1.4	3	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2012-177-520	0.05	1	White chert	Edge preparation
Klein Upper Locus	UA2012-177-520	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2012-177-522	0.2	2	Grey chert	Edge preparation
Klein Upper Locus	UA2012-177-522	0.5	2	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2012-177-522	1	2	Grey chert	Secondary
Klein Upper Locus	UA2012-177-522	1.3	2	Grey chert	Early thinning
Klein Upper Locus	UA2012-177-550	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2012-177-557	5.5	3	Grey chert	Interior
Klein Upper Locus	UA2012-177-578	1.9	3	Grey chert	Interior
Klein Upper Locus	UA2012-177-581	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2012-177-607	1.1	2	Grey chert	Interior
Klein Upper Locus	UA2012-177-79	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2012-177-85	0.3	2	Grey chert	Edge preparation
Klein Upper Locus	UA2012-177-89	0.3	2	Rhyolite	Late bifacial thinning
Klein Upper Locus	UA2016-60-0030	0.2	2	Grey chert	Microblade
Klein Upper Locus	UA2016-60-0143	0.2	2	Black chert	Late bifacial thinning
Klein Upper Locus	UA2016-60-193	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	UA2016-60-193	0.05	1	Black chert	Bifacial pressure flake
Klein Upper Locus	UA2017-66-0032	0.05	1	Grey chert	Bifacial pressure flake
Klein Upper Locus	UA2017-66-0084	0.2	1	Grey chert	Platform rejuvination
Klein Upper Locus	UA2017-66-0096	2.2	3	Grey chert	Interior
Klein Upper Locus	UA2017-66-0159	4.3	3	Black chert	Core tablet
Klein Upper Locus	UA2017-66-0165	0.5	2	Black chert	Platform rejuvination
Klein Upper Locus	UA2017-66-0167	234.5	5	Basalt	Primary
Klein Upper Locus	UA2017-66-0168	0.8	2	Black chert	Secondary
Klein Upper Locus	UA2018-61-299	0.2	2	Black chert	Interior
Klein Upper Locus	UA2018-61-524	0.05	1	Obsidian	Bifacial pressure flake
Klein Upper Locus	UA2018-61-524	0.05	1	Obsidian	Edge preparation
Klein Upper Locus	UA2018-61-568	0.05	1	Obsidian	Late bifacial thinning
Klein Upper Locus	UA2018-61-611	5.9	3	Grey chert	Core tablet
Klein Upper Locus	UA2018-61-622	0.2	2	Grey chert	Edge preparation
Klein Upper Locus	UA2018-61-658	0.05	1	Grey chert	Late bifacial thinning
Klein Upper Locus	UA2018-61-659	0.8	2	Rhyolite	Early thinning
Klein Upper Locus	UA2018-61-661	2.1	3	Rhyolite	Secondary

Klein Upper Locus	UA2018-61-667	0.05	1	Obsidian	Bifacial pressure flake
Klein Upper Locus	UA2018-61-667	0.1	1	Red chert	Early thinning
Klein Upper Locus	UA2018-61-668	6.9	3	Grey chert	Secondary

Appendix C – Results of Geospatial Analysis

Appendix C includes data from the analysis of site placement and chronology conducted by the author and Senna Catenacci. Database generation, radiocarbon calibration, and analysis methods are described in Chapter 6.

Site ID	C^{14} Years BP	Error	Calibrated Years BP (2σ)	Median Probability	Landform Diameter (m)	Ecozone	Nearest River (m)	Nearest Lake (m)	Database	Reference
AKMSE-154	450	120	280 – 670	470	300	Upland	1950	2120	CARD	Long, 1965
BET-00041	1930	145	1700 – 2060	1880	30	Lowland	660	31890	AHRS	Schneider, R.W. 2010
BET-00041	4445	140	4880 – 5290	5090	30	Lowland	660	31890	AHRS	Schneider, R.W. 2010
BET-00042	835	205	560 – 960	800	150	Upland	0	18840	AHRS	Grieser et al. 2013
BLR-00006	3570	90	3720 – 3980	3870	50	Lowland	120	9760	AHRS	Dixon E.J. et al. 1980
CIR-00029	200	50	140 – 300	180	20	Upland	60	61100	AHRS	Mills, R. 2003
CIR-00029	800	50	660 – 750	720	20	Upland	60	61100	AHRS	Mills, R. 2003
COL-00046	220	50	150 – 310	200	33	Lowland	70	5920	AHRS	Betts, R.C. and M. Standley 1984
FAI-00035	1120	90	950 – 1170	1050	175	Lowland	10	6810	AHRS	Maitland, R.E. 1986
FAI-00206	5680	50	6400 – 6510	6470	457	Lowland	290	34540	AHRS	Pearson, G.A. 1999
FAI-01661	800	50	660 – 750	720	30	Lowland	1960	19030	AHRS	Potter, B.A. et al. 2006
FAI-01751	250	40	150 – 420	300	10	Lowland	20	12370	AHRS	Potter, B.A. et al. 2006
FAI-02043	6460	40	7330 – 7330	7370	100	Lowland	430	5350	AHRS	Goebel T.E. et al. 2017
FAI-02047	1430	40	1300 – 1350	1330	75	Lowland	3090	4490	AHRS	Esdale, J.A. et al. 2012
FAI-02064	2170	40	2120 – 2300	2200	50	Lowland	50	100	AHRS	Esdale, J.A. et al. 2012
FAI-02094	5620	40	6320 – 6390	6400	50	Lowland	1830	34710	AHRS	Esdale, J.A. et al. 2012
HEA-00001	3650	150	3760 – 4160	3990	20	Upland	70	18990	AHRS	West F.H. 1996
HEA-00001	5340	90	6000 – 6210	6120	20	Upland	70	18990	AHRS	West F.H. 1996
HEA-00005	3430	75	3590 – 3830	3690	80	Upland	30	28830	AHRS	Powers, W.R. et al. 1983

HEA-00038	1825	70	1630 – 1860	1760	70	Upland	3070	26810	AHRS	Hoffecker J.F. and W.R. Powers 1996
HEA-00062	460	115	290 – 670	480	50	Upland	480	34410	AHRS	Plaskett, D.C. 1976
HEA-00128	3195	295	3030 – 3730	3420	20	Upland	1650	32120	AHRS	Hoffecker, J.F. 1985.
HEA-00137	4510	95	5040 – 5310	5150	40	Upland	30	26950	AHRS	Powers, W.R. and H.E. Maxwell 1986
JaUu-3	1510	145	1170 – 1740	1430	340	Upland	160	10890	CARD	Morlan et al. 1996
JbUm-1	570	110	430 – 730	580	140	Upland	350	200	CARD	Morlan et al. 1996
JbUm-1	1035	250	540 – 1410	970	140	Upland	350	200	CARD	Morlan et al. 1996
JcUr-3	810	80	650 – 920	750	360	Upland	1520	260	CARD	Gotthardt, R.M. 1998
JcUr-3	1490	100	1260 – 1610	1400	360	Upland	1520	260	CARD	Gotthardt, R.M. 1998
JcUr-3	2795	65	2770 – 3060	2900	360	Upland	1520	260	CARD	Gotthardt, R.M. 1998
JcUr-3	6230	70	6950 – 7280	7130	360	Upland	1520	260	CARD	Gotthardt, R.M. 1998
JdUr-5	1760	40	1570 – 1740	1670	170	Upland	260	1300	CARD	Stephenson et al. 2001
JdVa-10	3330	110	3340 – 3860	3570	200	Upland	1090	1380	CARD	Morlan et al. 1996
JdVa-5	4490	130	4840 – 5470	5140	300	Upland	1030	610	CARD	Stephenson et al. 2001
JdVa-5	5380	100	5930 – 6320	6150	300	Upland	1030	610	CARD	Stephenson et al. 2001
JdVa-5	1150	50	Post-WRA Relative Date	1000	300	Upland	1030	610	CARD	Stephenson et al. 2001
JdVf-2	2900	180	2710 – 3510	3060	200	Upland	580	0	CARD	Morrison, 1991
JdVf-2	1150	50	Post-WRA Relative Date	1000	200	Upland	580	0	CARD	Morrison, 1991
JeVb-15	2660	40	2740 – 2850	2780	50	Upland	460	13450	CARD	Gotthardt, R.M. 1998
JeVb-15	3480	70	3580 – 3920	3750	50	Upland	460	13450	CARD	Gotthardt, R.M. 1998
JeVu-1	1110	50	930 – 1100	1020	300	Upland	29480	40200	CARD	Arthurs D. 1998
JfVg-1	3740	300	2960 – 4530	3770	100	Upland	820	12760	CARD	Arthurs D. 1998
JfVg-1	4730	320	4780 – 6180	5400	100	Upland	820	12760	CARD	Arthurs D. 1998
JgVf-2	4590	150	4870 – 5590	5260	400	Upland	270	0	CARD	Wilmeth, 1978
JgVu-2	320	70	280 – 510	390	150	Upland	360	740	CARD	Wilmeth, 1978
JgVu-2	1760	70	1530 – 1830	1680	150	Upland	360	740	CARD	Wilmeth, 1978
JgVu-2	1860	90	1610 – 1950	1790	150	Upland	360	740	CARD	Wilmeth, 1978
JgVu-2	4090	60	4440 – 4820	4610	150	Upland	360	740	CARD	Wilmeth, 1978

JgVu-27	790	60	650 – 800	720	200	Upland	210	710	CARD	Arthurs, 1995
JgVu-3	610	75	520 – 680	600	70	Upland	170	1040	CARD	Arthurs, 1995
JgVu-3	1800	80	1550 – 1890	1730	70	Upland	170	1040	CARD	Arthurs, 1995
JgVu-3	2110	80	1920 – 2310	2090	70	Upland	170	1040	CARD	Arthurs, 1995
JgVu-3	1820	70	2960 – 3400	3200	70	Upland	170	1040	CARD	Arthurs, 1995
JhVq-1	800	60	660 – 800	730	170	Upland	970	230	CARD	Wilmeth, 1978
JhVq-1	1890	50	1710 – 1940	1830	170	Upland	970	230	CARD	Wilmeth, 1978
JhVu-2	3660	80	3820 – 4240	3990	80	Upland	870	420	CARD	Arthurs, 1995
JiVq-2	615	85	510 – 690	600	200	Upland	2670	0	CARD	Arthurs, 1995
JiVr-1	3220	140	3080 – 3730	3450	170	Upland	3820	0	CARD	MacNeish, 1964
JjVi-7	1190	130	900 – 1340	1110	100	Upland	1230	460	CARD	Wilmeth, 1978
JjVi-7	2900	130	2870 – 3180	3050	100	Upland	1230	460	CARD	Wilmeth, 1978
JjVi-7	6420	110	7160 – 7570	7340	100	Upland	1230	460	CARD	Wilmeth, 1978
JjVi-7	1150	50	Post-WRA Relative Date	1000	100	Upland	1230	460	CARD	Wilmeth, 1978
KaVa-3	5870	40	6620 – 6790	6690	100	Upland	880	20530	CARD	Gotthardt, R.M. 1998
KaVa-3	1150	50	Post-WRA Relative Date	1000	100	Upland	880	20530	CARD	Gotthardt, R.M. 1998
KaVn-2	1720	80	1510 – 1820	1640	200	Upland	2460	12540	CARD	Gotthardt, R.M. 1998
KaVn-2	3740	170	3640 – 4570	4110	200	Upland	2460	12540	CARD	Gotthardt, R.M. 1998
KaVn-2	4740	60	5320 – 5590	5480	200	Upland	2460	12540	CARD	Gotthardt, R.M. 1998
KbTx-2	1340	360	630 – 2010	1270	150	Upland	560	2570	CARD	Morlan et al. 1996
KbVo-1	1790	50	1570 – 1830	1720	150	Upland	220	2600	CARD	Walde, 1994
KdVa-8	3630	140	3610 – 4300	3960	220	Upland	40	940	CARD	Gotthardt, R.M. 1992
KdVi-1	3390	60	3480 – 3730	3640	300	Upland	3030	52260	CARD	Handly, et al. 1994
KdVo-3	810	80	650 – 920	750	350	Upland	3890	11690	CARD	Walde, 1994
KeVd-6	480	80	320 – 650	510	170	Upland	320	28020	CARD	Gotthardt, R.M. 1998
KeVd-7	600	70	520 – 670	600	300	Upland	60	27840	CARD	Gotthardt, R.M. 1998
KeVe-10	2990	130	2840 – 3460	3160	400	Upland	4740	32300	CARD	Gotthardt, R.M. 1998
KeVe-2	300	50	280 – 490	380	120	Upland	2960	30800	CARD	Gotthardt, R.M. and Easton, 1989

KfVd-2	2920	140	2770 – 3380	3080	300	Upland	1860	24800	CARD	Gotthardt, R.M. and Easton, 1989
KfVd-2	3100	70	3140 – 3460	3300	300	Upland	1860	24800	CARD	Gotthardt, R.M. and Easton, 1989
KlVi-1	1465	85	1260 – 1550	1380	100	Upland	10300	38140	CARD	Matheus, 1995
LaVk-14	1630	70	1380 – 1700	1530	400	Upland	3130	17240	CARD	Morlan et al. 1996
LaVk-2	1405	60	1230 – 1410	1320	200	Upland	4630	13620	CARD	Wilmeth, 1978
LaVk-2	5625	80	6290 – 6570	6410	200	Upland	4630	13620	CARD	Wilmeth, 1978
LIM-00063	480	60	480 – 550	520	200	Lowland	640	5040	AHRS	Ackerman, R.E. 1996
LIV-00041	5845	246	6400 – 6960	6680	40	Lowland	510	8100	AHRS	Grieser et al. 2013
LIV-00539	240	40	150 – 320	290	260	Lowland	850	11890	AHRS	Proue, M. and A. Higgs 2012
MCG-00035	3760	180	3910 – 4410	4140	67	Lowland	1360	8470	AHRS	Reuther, J.D. et al. 2013
MCG-00060	2800	50	2840 – 2970	2900	100	Upland	490	20510	AHRS	Reuther, J.D. et al. 2012
MCG-00060	4800	50	5480 – 5590	5520	100	Upland	490	20510	AHRS	Reuther, J.D. et al. 2013
MCG-00061	3660	125	3830 – 4160	4000	200	Upland	390	19950	AHRS	Reuther, J.D. et al. 2013
MCG-00064	1480	30	1340 – 1390	1360	170	Upland	550	19570	AHRS	Reuther, J.D. et al. 2014
MCG-00065	1330	30	1190 – 1300	1270	200	Upland	680	19520	AHRS	Reuther, J.D. et al. 2015
MCG-00066	2230	70	2050 – 2360	2230	50	Upland	450	20630	AHRS	Reuther, J.D. et al. 2016
MfVa-154	2530	50	2460 – 2750	2600	450	Upland	3670	30570	CARD	Gotthardt, R.M. 1998
MfVa-14	905	100	670 – 980	830	300	Upland	1400	29350	CARD	Gotthardt, R.M. 1998
MfVa-14	1870	180	1400 – 2180	1810	300	Upland	1400	29350	CARD	Gotthardt, R.M. 1998
MfVa-9	7180	60	7930 – 8160	8000	400	Upland	2980	30220	CARD	Rutherford et al. 1984
MfVb-7	4580	60	5050 – 5470	5260	150	Upland	2290	26830	CARD	Gotthardt, R.M. 1998
MfVb-7	5010	110	5580 – 5990	5760	150	Upland	2290	26830	CARD	Gotthardt, R.M. 1998
MiVl-1	1880	140	1520 – 2150	1820	150	Lowland	4830	980	CARD	Burke and Cinq-Mars, 1996
MjVg-1	570	65	510 – 660	590	450	Lowland	790	9320	CARD	Le Blanc, 1984
MjVg-1	950	90	690 – 1000	860	450	Lowland	790	9320	CARD	Le Blanc, 1984
MjVg-1	1150	60	940 – 1180	1070	450	Lowland	790	9320	CARD	Le Blanc, 1984
MjVg-1	1510	80	1290 – 1560	1410	450	Lowland	790	9320	CARD	Le Blanc, 1984
MjVg-1	2430	60	2350 – 2710	2510	450	Lowland	790	9320	CARD	Le Blanc, 1984
MjVk-4	1330	100	1050 – 1410	1240	100	Lowland	7030	2930	CARD	Rutherford et al. 1984

MjVk-4	1700	120	1360	–	1870	1620	100	Lowland	7030	2930	CARD	Rutherford et al. 1984
MjVk-7	700	80	540	–	770	650	200	Lowland	3870	3610	CARD	Wilmeth, 1978
MjVk-7	1250	90	970	–	1310	1170	200	Lowland	3870	3610	CARD	Wilmeth, 1978
MjVk-7	1690	80	1410	–	1740	1600	200	Lowland	3870	3610	CARD	Wilmeth, 1978
MjVk-7	2770	80	2750	–	3070	2880	200	Lowland	3870	3610	CARD	Wilmeth, 1978
MjVk-7	3210	100	3210	–	3640	3440	200	Lowland	3870	3610	CARD	Wilmeth, 1978
MjVl-1	540	140	460	–	830	630	120	Lowland	3210	2500	CARD	Kigoshi et al. 1969
MjVl-1	855	100	650	–	960	790	120	Lowland	3210	2500	CARD	Kigoshi et al. 1969
MjVl-1	1790	160	1360	–	2060	1720	120	Lowland	3210	2500	CARD	Kigoshi et al. 1969
MkVl-12	1220	60	1050	–	1280	1150	200	Lowland	0	3420	CARD	Irving et al. 1977
MkVm-1	550	80	470	–	670	580	300	Lowland	190	6450	CARD	Rutherford et al. 1984
MkVm-1	880	75	690	–	930	810	300	Lowland	190	6450	CARD	Rutherford et al. 1984
MlVm-4	593	40	540	–	660	600	200	Lowland	390	1700	CARD	Cinq-Mars, 1991
MlVm-4	984	40	800	–	960	880	200	Lowland	390	1700	CARD	Cinq-Mars, 1991
MLZ-00011	1465	75	1290	–	1410	1370	30	Lowland	1690	730	AHRS	Andrews, E. F. 1977.
MLZ-00011	1500	90	1310	–	1520	1410	30	Lowland	1690	730	AHRS	Andrews, E. F. 1977.
MLZ-00013	285	95	280	–	480	340	40	Lowland	2550	660	AHRS	Andrews, E. F. 1977.
MLZ-00013	1360	90	1180	–	1350	1280	40	Lowland	2550	660	AHRS	Andrews, E. F. 1977.
MLZ-00045	1000	50	830	–	960	910	45	Lowland	2840	1660	AHRS	Clark, D. W. and A.M. Clark 1993
MLZ-00045	5550	50	6300	–	6400	6350	45	Lowland	2840	1660	AHRS	Clark, D. W. and A.M. Clark 1993
MLZ-00050	1200	50	1060	–	1180	1130	100	Lowland	2910	190	AHRS	Clark, D.W. and A. McFadyen Clark 1993
MLZ-00050	1400	50	1290	–	1350	1320	100	Lowland	2910	190	AHRS	Clark, D.W. and A. McFadyen Clark 1993
MLZ-00050	1700	50	1550	–	1690	1610	100	Lowland	2910	190	AHRS	Clark, D.W. and A. McFadyen Clark 1993
MMK-00004	2565	140	2330	–	2970	2620	100	Lowland	200	110	AHRS	Holmes, C.E. 1976
MMK-00004	1140	120	900	–	1290	1070	100	Lowland	200	110	AHRS	Holmes, C.E. 1976
MMK-00004	1610	150	1270	–	1870	1530	100	Lowland	200	110	AHRS	Holmes, C.E. 1976
MMK-00005	640	95	550	–	670	610	150	Lowland	450	50	AHRS	Andrews, E. F. 1977.
MMK-00012	665	125	540	–	700	640	30	Lowland	510	160	AHRS	Holmes C.E. 1986
MMK-00012	1910	120	1710	–	1990	1850	30	Lowland	510	160	AHRS	Holmes C.E. 1986

MMK-00066	2230	70	2150	–	2330	2230	40	Upland	1030	10450	AHRS	Saleeby, B.M. 2000
MMK-00071	2230	70	2150	–	2330	2230	40	Upland	970	10370	AHRS	Saleeby, B.M. 2000
NAB-00316	1500	50	1320	–	1510	1390	150	Upland	3450	1370	AHRS	Kelly, M.S. 2011
NAB-00316	1900	50	1740	–	1900	1840	150	Upland	3450	1370	AHRS	Kelly, M.S. 2011
NAB-00399	2700	40	2750	–	2870	2810	300	Upland	3090	280	AHRS	O'Leary, M. and W. Sheppard 2007
NAB-00399	4000	40	4400	–	4580	4480	300	Upland	3090	280	AHRS	O'Leary, M. and W. Sheppard 2007
NAB-00401	1840	40	1700	–	1880	1780	200	Upland	3340	170	AHRS	O'Leary, M. and W. Sheppard 2007
SLT-00088	400	40	330	–	510	460	35	Lowland	10	55570	AHRS	Hays, J. 2009
TAL-00151	3580	40	3840	–	3960	3880	150	Upland	260	1230	AHRS	Reuther, J.D. et al. 2011
TAL-00151	3650	40	3900	–	4070	3970	150	Upland	260	1230	AHRS	Reuther, J.D. et al. 2011
TAL-00163	290	30	300	–	430	380	50	Upland	860	7670	AHRS	Reuther, J.D. et al. 2012
TAL-00164	290	30	300	–	430	380	50	Upland	490	6780	AHRS	Reuther, J.D. et al. 2013
TAL-00164	3570	30	3830	–	3900	3870	50	Upland	490	6780	AHRS	Reuther, J.D. et al. 2014
TNX-00004	340	50	320	–	470	400	50	Upland	40	1240	AHRS	Shinkwin, A.D. 1979
TNX-00004	2470	60	2460	–	2710	2560	50	Upland	40	1240	AHRS	Shinkwin, A.D. 1979
TNX-00033	370	60	310	–	510	410	600	Lowland	1140	15010	AHRS	DePew, A.D. and R. Horner 2006
TNX-00033	4120	300	3840	–	5330	4630	600	Lowland	1140	15010	AHRS	DePew, A.D. and R. Horner 2006
TNX-00080	3500	50	3710	–	3840	3770	150	Upland	4160	2490	AHRS	Thompson, D.R. 2008
TNX-00187	1700	200	1500	–	1900	1700	100	Upland	2750	4340	AHRS	Hays, J. 2013
TYO-00277	320	30	310	–	470	390	300	Lowland	30	8100	AHRS	Reuther, J.D. et al. 2014
TYO-00278	3770	25	4090	–	4220	4130	150	Upland	350	13360	AHRS	Reuther, J.D. et al. 2014
TYO-00278	4750	30	5470	–	5580	5520	150	Upland	350	13360	AHRS	Reuther, J.D. et al. 2014
TYO-00278	6310	30	7180	–	7270	7240	150	Upland	350	13360	AHRS	Reuther, J.D. et al. 2014
TYO-00279	3860	50	4180	–	4400	4290	100	Upland	60	13660	AHRS	Reuther, J.D. et al. 2014
TYO-00279	3940	30	4300	–	4440	4390	100	Upland	60	13660	AHRS	Reuther, J.D. et al. 2014
TYO-00362	3820	30	4140	–	4300	4210	700	Lowland	3700	13730	AHRS	Proue, M. et al. 2016
UKT-00051	130	40	10	–	270	130	120	Lowland	800	5190	AHRS	Blanchard, J.H. 2012
UKT-00051	420	40	340	–	520	480	120	Lowland	800	5190	AHRS	Blanchard, J.H. 2012
UKT-00073	160	40	0	–	280	170	30	Lowland	250	2090	AHRS	O'Leary, M. 2009

UKT-00073	360	40	320	–	490	410	30	Lowland	250	2090	AHRS	O'Leary, M. 2009
WIS-00136	550	90	510	–	650	570	150	Upland	2860	5060	AHRS	Kunz, M.L. 1985
XBD-00020	900	90	680	–	960	820	200	Lowland	590	340	AHRS	Cook, J. P. and R. A. McKennan 1970
XBD-00020	1360	80	1170	–	1410	1280	200	Lowland	590	340	AHRS	Cook, J. P. and R. A. McKennan 1970
XBD-00020	3020	50	3220	–	3360	3220	200	Lowland	590	340	AHRS	Cook, J. P. and R. A. McKennan 1970
XBD-00020	5000	60	5640	–	5900	5740	200	Lowland	590	340	AHRS	Cook, J. P. and R. A. McKennan 1970
XBD-00106	2090	130	1780	–	2350	2070	30	Lowland	3680	310	AHRS	Bacon, G.H. and C.E. Holmes 1980
XBD-00110	2645	50	2740	–	2840	2770	50	Lowland	50	4020	AHRS	Doering B. et al 2019
XBD-00110	4030	50	4430	–	4570	4510	50	Lowland	50	4020	AHRS	Doering B. et al 2019
XBD-00131	2280	40	2180	–	2350	2290	30	Lowland	110	5570	AHRS	Holmes C.E. 2001
XBD-00131	4545	90	5050	–	5320	5190	30	Lowland	110	5570	AHRS	Holmes C.E. 2001
XBD-00156	1570	70	1390	–	1540	1470	30	Lowland	2060	1170	AHRS	Holmes C.E. 2001
XBD-00156	4620	40	5310	–	5450	5400	30	Lowland	2060	1170	AHRS	Holmes C.E. 2001
XBD-00159	201	31	140	–	300	180	120	Lowland	4650	530	AHRS	Gelvin-Reymiller et al. 2011
XBD-00163	4290	285	4520	–	5290	4760	50	Lowland	90	7330	AHRS	VanderHoek R. et al. 1997
XBD-00281	2760	40	2790	–	2880	2850	120	Lowland	2180	5480	AHRS	Potter B.A. et al. 2007
XBD-00286	1860	50	1730	–	1860	1800	40	Lowland	2000	5300	AHRS	Potter B.A. et al. 2007
XBD-00290	1170	40	1060	–	1170	1100	70	Lowland	480	5590	AHRS	Potter B.A. et al. 2007
XBD-00296	2010	40	1900	–	2000	1960	20	Lowland	190	4130	AHRS	Potter B.A. et al. 2007
XBD-00297	3620	50	3860	–	3980	3940	100	Lowland	510	8030	AHRS	Potter B.A. et al. 2007
XBD-00301	4360	50	4860	–	4970	4940	175	Lowland	1060	6200	AHRS	Potter B.A. et al. 2007
XBD-00316	4050	50	4440	–	4580	4540	50	Lowland	1450	8730	AHRS	Potter B.A. et al. 2007
XBD-00324	2070	50	1920	–	2150	2040	140	Lowland	2900	3290	AHRS	Potter B.A. et al. 2007
XBD-00361	120	40	20	–	270	130	80	Lowland	4480	440	AHRS	Gelvin-Reymiller, C. et al. 2011
XBD-00361	1920	40	1820	–	1920	1870	80	Lowland	4480	440	AHRS	Gelvin-Reymiller, C. et al. 2012
XBD-00446	1080	20	940	–	1050	980	150	Lowland	3500	120	AHRS	Reuther et al. 2018
XBD-00448	4540	25	5050	–	5310	5150	150	Lowland	3920	460	AHRS	Reuther et al. 2018
XMH-00246	3800	80	4080	–	4300	4200	40	Lowland	610	8990	AHRS	Potter, B.A. 2000
XMH-00246	6220	80	7020	–	7250	7120	40	Lowland	610	8990	AHRS	Potter, B.A. 2000

XMH-00252	1280	150	1010 – 1320	1190	100	Upland	1390	33590	AHRS	Reger R.D. et al. 1964
XMH-00252	2300	180	2120 – 2700	2340	100	Upland	1390	33590	AHRS	Reger R.D. et al. 1964
XMH-00838	1750	40	1800 – 1810	1660	400	Lowland	380	18270	AHRS	Esdale, J.A. et al. 2013
XMH-00945	1320	40	1180 – 1300	1260	300	Lowland	970	770	AHRS	Robertson et al. 2013
XMH-01303	1540	30	1350 – 1520	1420	300	Lowland	1740	240	AHRS	Doering B. et al 2019
XMH-01520	4250	60	4610 – 4970	4800	110	Lowland	1760	12380	AHRS	Bowman, R. 2017
XMH-917	1420	40	1280 – 1390	1330	200	Lowland	3300	770	AHRS	Robertson et al. 2013

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