A Quantitative Analysis of Promontory Cave 1: An Archaeological Study on Population Size, Occupation Span, Artifact Use-life, and Accumulation

by

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Abstract

Promontory Cave 1 on Great Salt Lake, Utah exhibits an incredible level of preservation rarely seen at archaeological sites. The high proportion of perishable materials provides a unique opportunity to study cultural remains that are usually lost to taphonomic processes. Extensive radiocarbon dating has defined a narrow occupation period of ca. 1250-1290 CE (Ives et al. 2014) and the bounded space of the cave allows for confident estimations of the total number of artifacts present. I have completed quantitative analyses that use several methods to study Cave 1 and its inhabitants, including: artifact density, three-dimensional modeling, proportional calculations, accumulation equations, and statistical equations. Archaeologists know surprisingly little about the rates at which artifacts enter the archaeological record and my analyses examine this factor along with related variables such as use-life and accumulation with the above methods. The above methods also allow for inferences to be made on population size, population composition, and occupation span and frequency.

Quantitative analyses of the Promontory Cave 1 assemblage can be linked directly to the exploration of Dene migration southward from Canada, as artifacts found in the cave point towards an identity of Apachean ancestors during their migration south. This research also has the potential for much broader application in archaeological investigations by increasing our awareness of what is usually missing; organic artifacts by far dominated past life but are often forgotten during site analysis. This research shows that consideration of the role of perishable artifacts is important in archaeological studies even when they are not present.

Preface

This thesis is original work by Jennifer Hallson. No part of this thesis has been previously published.

Dedication

For those who came before me and those who are with me now.

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Chapter 1: Introduction

Promontory Cave 1 is an archaeological site located on the shores of Great Salt Lake on Promontory Point, Utah (Figure 1). First excavated by Julian Steward in the 1930s, the dry nature of the cave served to preserve organic artifacts made of hide, wood, and plant material. This level of organic preservation is unusual for the archaeological record, and presents a unique opportunity to study almost all the material remains left behind by a group of people. Modern excavations have occurred and produced thousands of artifacts for study. These excavations occurred over four field seasons from 2011 to 2014 as a partnership between the University of Alberta and Brigham Young University, along with researchers from across North America.

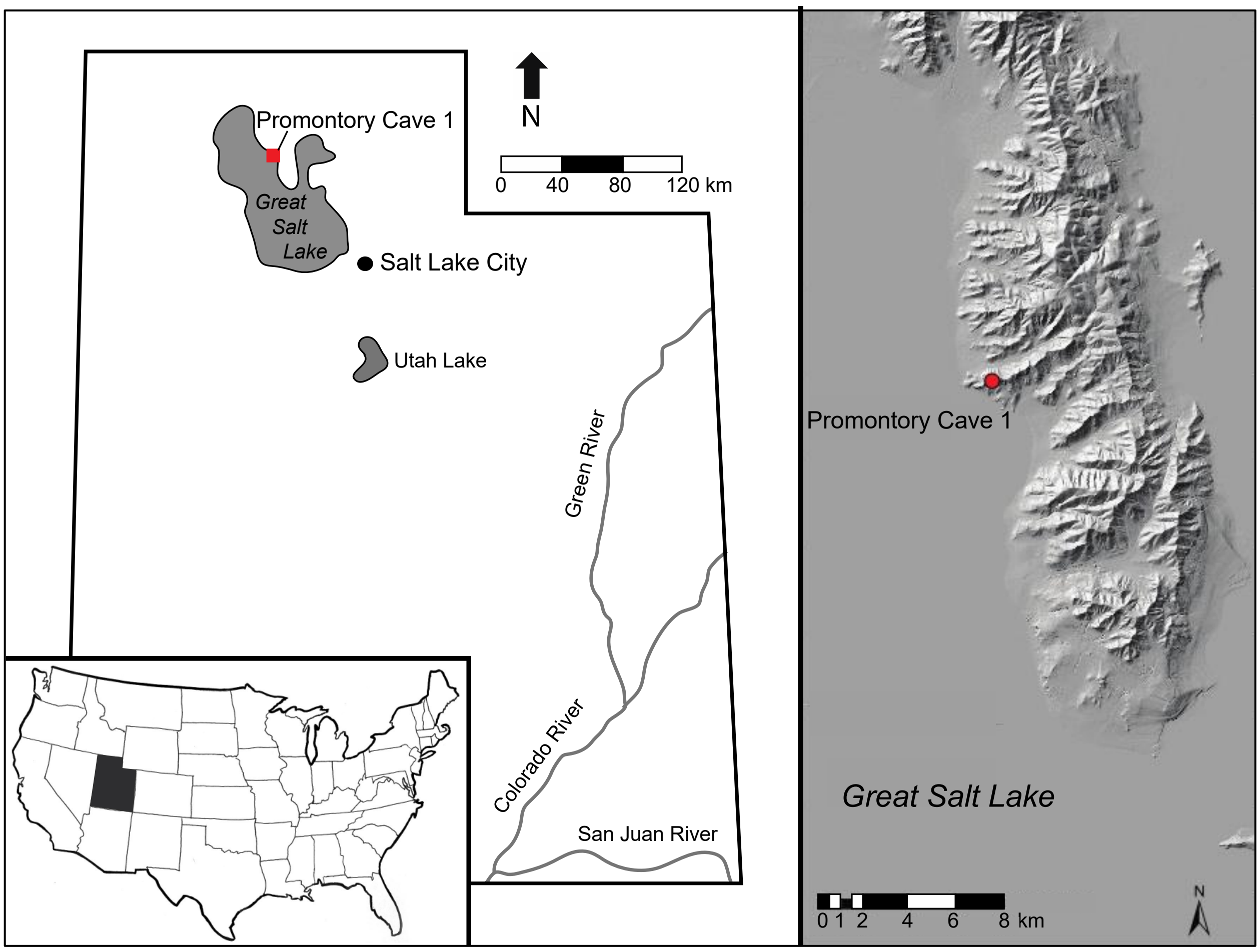

Figure 1: Location of Promontory Cave 1, relative to the state of Utah (left) and Promontory Point (right).

Steward's (1937) inclination after study of the artifacts he excavated was that they represented an intrusive population that came from the north, likely Athapaskan[1] migrants from the Canadian Subarctic on their journey southward to the America Southwest. Further study of the artifacts that Steward and we excavated supports this identification, especially the many moccasins, but also other tools such as those used in hide working. This identification allowed for a comparison with specific ethnographic and ethnoarchaeological accounts of Dene groups, although sources for other groups and sites from North America and around the world are also used. Dene migration and its connection to Promontory Cave 1 will be discussed in later chapters.

Many aspects of this site serve to provide unique opportunities for study. Radiocarbon dating has defined a narrow period of occupation, ca. 1250-1290 CE, representing only one or two human generations (Ives et al. 2014). The bounded space of the cave also serves to outline the size and scope of the occupation of the site. These elements, along with the exemplary preservation, allow for accurate calculations and projections to be made. These unique factors are described in detail in the next chapter, following a description of Promontory Cave 1.

This research is a quantitative analysis of the artifacts and cave space. Site area and volume is calculated using GIS (geographic information system) techniques, and the densities of artifacts are calculated based on the volume of excavated material. These calculations of site area, volume of cultural deposits, and artifact densities can be made with confidence because of the known boundaries of the cave. Mathematical methods are used to project the total number of artifacts the cave held. By examining the results of these calculations and comparing them to ethnographic and ethnoarchaeological sources, I make estimates of the number of people who

[1] I will use the term "Dene" to refer to Athapaskan peoples, unless other references require different uses. "Dene" is the term most favoured by these groups.

inhabited the cave and how long they stayed, as well as apply accumulation equations to study how artifacts were discarded.

The aim of this research is to provide more information about the life of the people inhabiting Promontory Cave 1, mainly in the form of population size and how artifacts were treated. I use multiple methods to calculate the likely size of the population group who inhabited this site, which before now has not been quantitatively determined. My examination of artifact use-lives and discard rates also provides new information that tells us about how this population was performing economically; i.e., whether they had to be frugal with the materials they had, or if they were a successful population with abundant resources. The results also indicate the extent to which artifacts were or were not curated; there may be curation in a thriving society due to other reasons such as sentimentality.

This research also has the potential to have a much broader impact by providing information about how artifacts accumulate and the ratio of non-perishable to perishable artifacts. A gap in archaeological research will always exist because we are studying people based only on their things and where they lived. We look at a snapshot in history and try to put together what life was like with only a couple of pieces of a one thousand-piece puzzle. At Promontory Cave 1, however, we have more pieces than usual to study what life was like at this site. I show that the presence of perishable materials immensely increases our ability to perform analyses on the contents of the cave. Having confidence that we were seeing essentially all the material culture discarded by this population, I was able to use the numbers of artifacts to obtain information on population size, occupation span and frequency, artifact use-lives, and the ratio of non-perishable to perishable materials.

Use of Ethnographic Analogy

Ethnographic analogy is "the determination of the use, meaning, or function of an artifact, complex, or pattern found in the archaeological record by reference to analogs existing in the actual or ethnographic present" (White 1976:98). Debate and discussion of the use and usefulness of ethnographic analogy is usually based on the whether recent populations can be used as comparisons to past populations. This method should be used with caution, as blindly using ethnographically derived theory simply reproduces these theories in a circular manner (Wobst 1978:303). Among the pitfalls of this method is that human behaviour based on modern or recent historical sources is extended back into the past, but these more recent cultures and populations may differ from ancient ones. We must also be cautious of "ethnographic tyranny;" recent ethnographic records do not cover all variations in culture and adaptations, and can therefore result in overlooking alternative strategies and explanations (Wobst 1978). However, while these factors need to be considered, ethnographic analogy remains a rich and practical source of information about past lives from which we can test ideas about the archaeological record (Ives 1990:356). This method cannot be tested; but, as more data is collected and more similarities found, the strength of analogy increases (Hodder 1982). I argue that, in certain cases, ethnographic analogy can be extremely useful, and I make use of it in this research.

Ethnoarchaeology is "the subfield of anthropology in which an archaeologist (or at least someone familiar with archaeological problems) does ethnographic fieldwork with the ultimate goal of providing ethnographic information of particular use to the archaeologist" (White 1976:100). This is not experimental archaeology, where archaeologists perform tests and experiments, typically with certain artifacts, to infer how they may have been used in the past. For instance, manufacturing scrapers and testing how long they can be used (e.g., Brink 1978).

Ethnoarchaeology can involve watching or participating in activities that occurred in the past and are still performed today, and using the information gathered to infer behaviour into the past (e.g., Clark and Kurashina 1981; Reilly 2015).

For my research, I use ethnographic analogy, along with ethnoarchaeological and experimental archaeology sources, to infer typical hunter-gatherer population size, demographics, and artifact usage. Arguably, a scraper was likely used the same way 1000 years ago as 100 years ago, and would wear out in similar times. My sources focus on western North America and the Subarctic, but I also discuss ethnographies and other sources from worldwide locations, such as Africa and Papua New Guinea. The majority of the ethnographic sources I use are from Dene societies because we have reasons to believe the population at Promontory Cave 1 was a migrating Dene group. I would argue that this site provides strong indicators that the population was Dene, but my methodology and analyses are valid regardless of the cultural identity of these people.

My use of ethnographic analogy, ethnoarchaeological interpretations, and experimental archaeology is nevertheless informed by Steward's and our suspicion that an ancestral Apachean population inhabited the cave. This is similar to the direct-historical approach, which is a way of using ethnographic analogy within a specific area. As originally defined, this approach involves working backwards in time, from the known to the unknown (White 1976:106; Steward 1942). This generally involves using ethnography, historical data, or modern information and projecting it into the past in the same area and, hopefully, with the same cultural group. The direct-historical approach has been used successfully in many of the areas in North America and produced previously unknown information (Steward 1942). In the Promontory Caves case, while we have suspicions of the cultural identity, linguistic, oral tradition, and genetic data all indicate that an ancestral Apachean population at a migratory midpoint will not be the same as a Subarctic population, nor just like a Navajo or Apache group (Ives 2014; Sapir 1936; Seymour 2012b). Dene sources, however, are the closest approximation to the Promontory Cave 1 population, based on the present information available.

Research Questions

The nearly complete preservation present in Promontory Cave 1 allows for unique and precise research on the site and its artifacts. By completing quantitative analyses, I answer the following research questions:

1. What is the density of individual artifact classes within the excavated portions of Promontory Cave 1, and how many artifacts of each class can be projected to exist in the entire cave? How do these values contribute to the study of who and how many people lived in this cave?
2. What is the accumulation rate of artifacts, and what patterns exist in these rates for various artifact classes?
3. How do different areas within Cave 1 compare in the types and amounts of artifacts present?
4. What is the ratio of non-perishable to perishable artifacts, and how can this ratio help us to interpret sites that do not preserve organic material (the normal case for archaeological sites)?

Due to the bounded space of the cave, the densities and accumulation rates of certain artifacts can lead to confident inferences of population size as well as occupation time within the cave. By comparing the livable areas, I identify differences in how the areas were used. Investigating the ratio of non-perishable to perishable material will result in a better idea of just how much of the archaeological record we are usually missing at typical sites. The answers to all these questions will be connected to our understanding of Dene migration, but also have a much broader application in archaeological investigations regardless of cultural identity.

Thesis Overview

Chapter 2 begins by placing Promontory Cave 1 on the landscape, describing the surrounding area and the resources available on it. I then move on to describe the excavations that have occurred here, and what research has been completed so far. An overview of the evidence for Dene migration is given to provide background into the most likely culture that left behind the artifacts we are now studying. A discussion on hunter-gatherer populations serves to identify what the migrating population would have looked like, and what the population may have been in Cave 1 according to previous studies and estimations.

Chapter 3 is an overview of what archaeologists know about accumulation and artifact discard rates, outlining some of the methods and equations I will use. This chapter discusses how and when artifacts enter the archaeological record, and what processes act on these artifacts before they are excavated. An examination of the use-lives of various artifact types is concentrated on artifacts similar to those that were excavated from Cave 1. This analysis is extended into a discussion of non-perishable versus perishable artifacts, supplemented with ethnographic accounts of material culture.

Chapter 4 describes the various methods I used in this study, and Chapter 5 provides the results of the calculations and methods described in Chapter 4. Chapter 5 focuses on the quantitative results with little interpretation. Figures and tables provide a simple overview of the results from the calculations made. Chapter 6 discusses the results in more depth, making inferences on the population that lived in Cave 1. Here I discuss the results from artifacts such as moccasins, hide working tools, and hunting tools in order to examine variables such as population size and composition, occupation time, and artifact discard rates. The accumulation rates for various artifact types are examined along with how these results can be used to infer population. The ratio of non-perishable to perishable artifacts is also discussed based on the ratio obtained from the Cave 1 collection and comparing this to other well-preserved sites. Along with this, the importance of organic artifacts such as clothing and footwear to identity is also discussed.

Finally, Chapter 7 concludes this study, bringing together the overarching themes and summarizing the key results I obtained. Here I will return to my research questions, summarizing my results to answer the questions posed. I will take the current study and connect it to the larger research project. This review includes discussing Dene migration again, now with the results and interpretations that I made. Next, I connect this research to the broader study of archaeology, and address how the results can be used to improve our interpretations of other archaeological sites that do not allow for such incredible preservation of material culture. I also discuss how this research can inform future work on the Promontory Caves, and propose where this research can be taken next. Few other sites in North America are like Promontory Cave 1. We can learn from sites such as these by using the ratio of non-perishable to perishable artifacts as a proxy for other sites.

<u>**Chapter 2: Background Information**</u>

This chapter serves to describe Promontory Cave 1 and the excavations that have occurred there, as well as to place it in the context of the surrounding area and current research. Although this cave has produced incredible artifacts, it has not been a focus of research since Steward (1937) initially reported on it. The current research project run by Dr. John Ives (University of Alberta) and Dr. Joel Janetski (Professor Emeritus, Brigham Young University) aims to study the deposits of this cave in more detail in order to learn about the people who lived there, where they came from, and their lifestyle.

Promontory Caves: Environment

Julian Steward (1937) identified twelve caves around Promontory Point, the majority of which were small and yielded few artifacts. He chose to excavate in Caves 1 and 2, the largest and richest. Caves 1 and 2 overlook Great Salt Lake, providing majestic views of the lake and surrounding landforms (Figure 2). Promontory Cave 1 is the largest of the Promontory caves, measuring 38 m deep and 47 m wide, with an opening 23 m across. It has produced the largest amount of Promontory Culture material. Cave 2 is located below and west of Cave 1, and has produced Promontory Culture material as well as earlier material from the Archaic Period.

Figure 2: Locations of Promontory Caves 1 and 2 relative to each other, looking approximately northwest. Kumeroa's Saddle is seen to the right of the caves.

Cave 1 faces slightly southeast and is located just below the Stansbury Terrace, which represents the first and largest regression of Lake Bonneville and is 1350 m above sea level (McGee et al. 2012:184). It provides excellent views towards the southeast where other known archaeological sites are located. Throughout the Holocene, lake levels have been below 1287 m, close to the present average levels of Great Salt Lake (McGee et al. 2012:184); therefore, Promontory Cave 1 was dry and available for occupation throughout this time period. The oldest dates obtained from Cave 1 are around 5000 radiocarbon years before present (RCYBP), from a sample at the bottom of the main excavation unit. This older occupation has not yet been studied, as the focus has been on the Promontory Culture population, and artifacts are scarce at this depth in the excavation.

A large rock fall in the centre of the cave created three main areas: A, B, and C (Figure 3 and Figure 4). The presence of tufa (rock created by precipitation of calcium carbonate out of water) on these large rocks indicates that they had fallen prior to or during the time the cave was submerged by Lake Bonneville and therefore prior to any human occupation. Some of the smaller rocks without tufa on the periphery of this central rock fall likely fell after human occupation, as there is some evidence of fibrous material and artifacts under these rocks. The large boulders that fell from the ceiling give the cave a high, peaked roof which allows some, but not much, light to reach the back of the cave. The corridors around the rock fall also allow for excellent airflow. The temperature difference is immediately noticeable once inside the mouth of the cave. During excavations that occurred in May the temperature could reach over 30°C outside but inside the cave was cool and comfortable, the airflow around the rock fall acting as natural air conditioning. In the winter the cave would provide shelter from snow and wind. The rock fall and the shape of the cave also affect sound. Sound was muffled, and as a result it was not possible to hear conversation level sound between the different areas. This feature could have been desirable for past populations living here, as it provided privacy. The layout of Cave 1 allows for large areas of livable space, and provides shelter from environmental conditions. These factors created an excellent habitat for the population who lived here; and, as I will discuss in the next chapter, also provided an excellent environment for organic artifacts to be preserved.

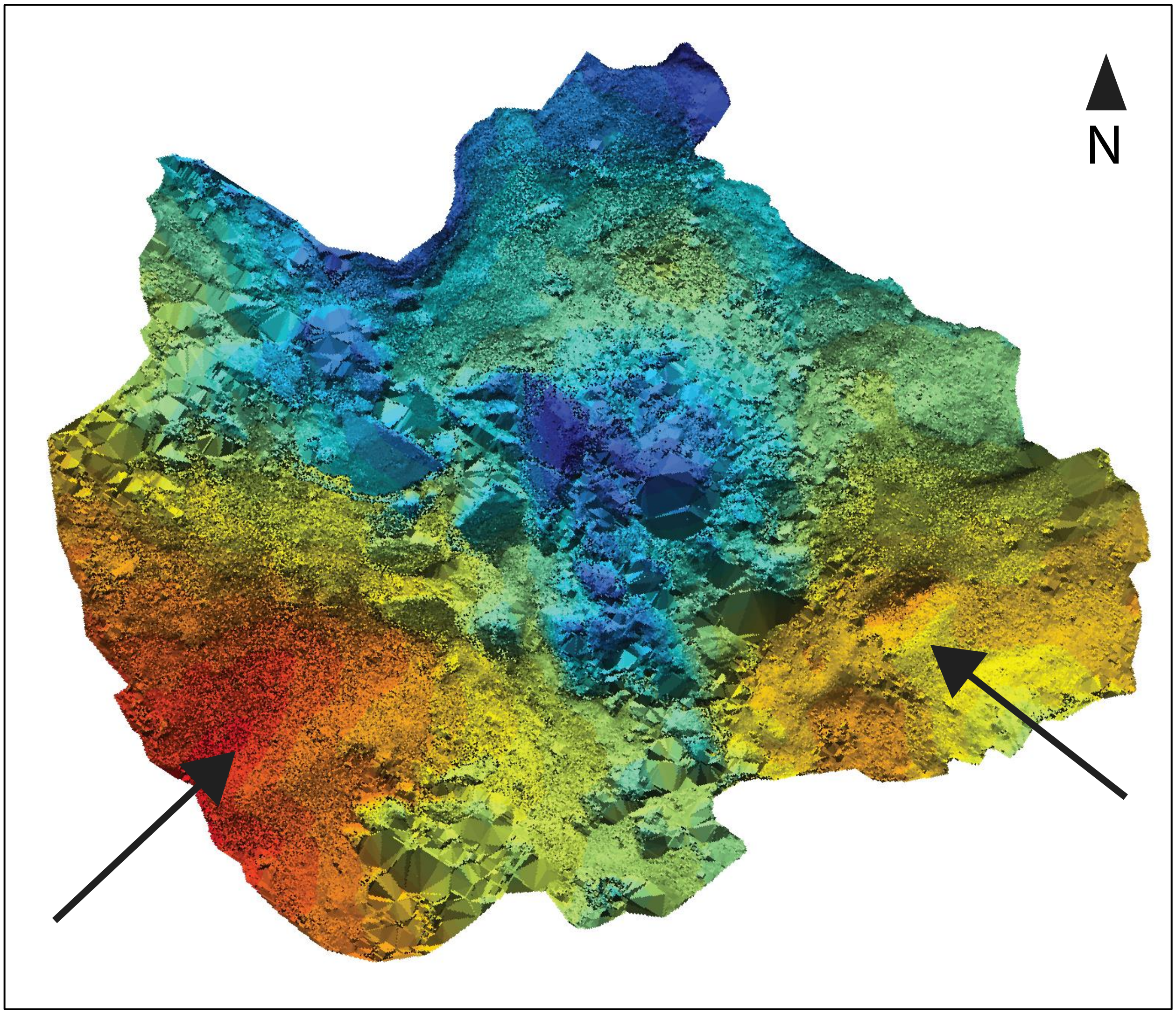

Figure 3: TIN (triangulated irregular network) of Cave 1, looking from above. Relative heights are shown by blue (highest) to red (lowest). Arrows point to Steward's areas of excavation in both Area A and Area B that are visible as depressions.

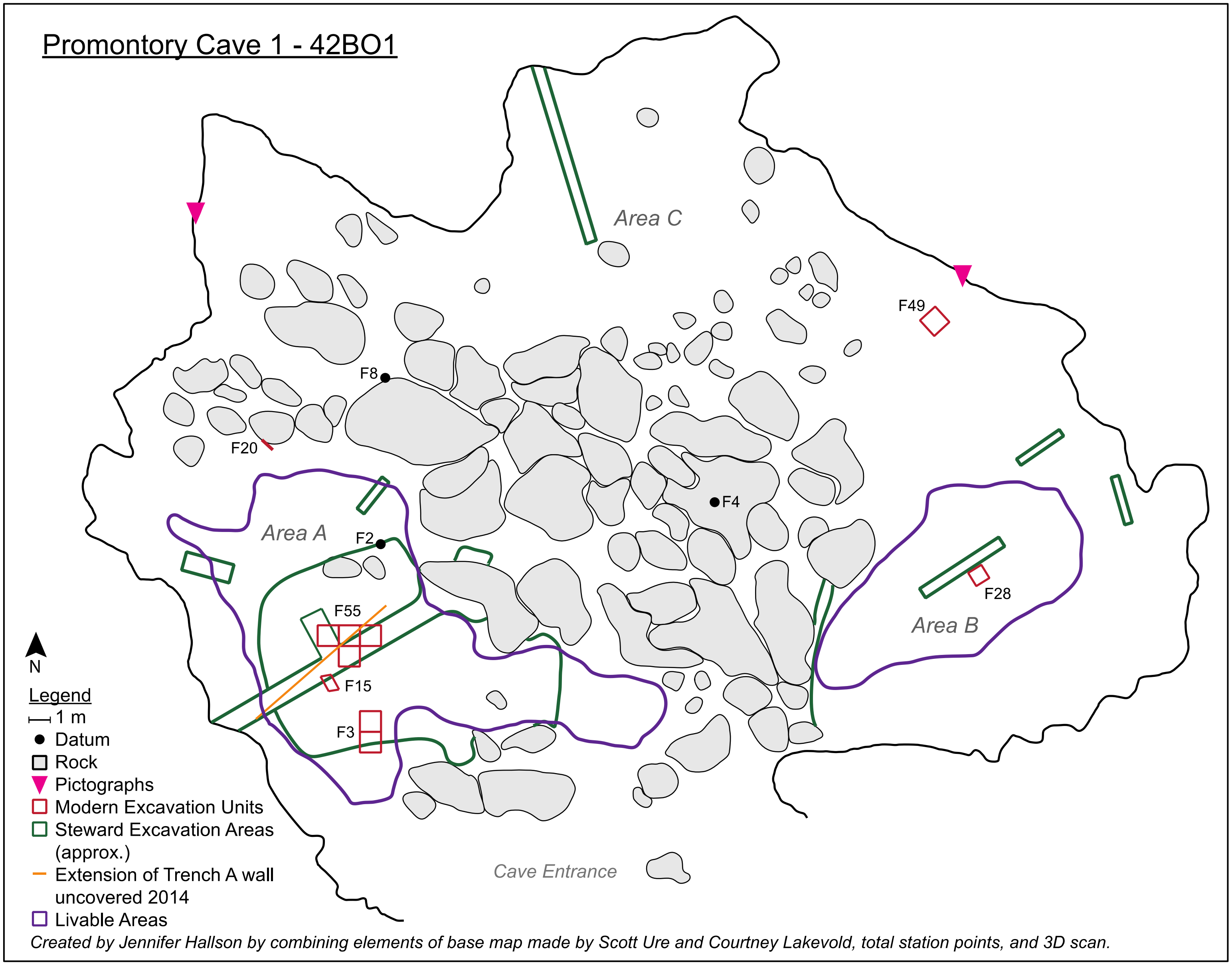

Figure 4: Plan map of Promontory Cave 1.

Subsistence

The faunal remains collected from Cave 1 are predominantly large mammals, with a likely predominance of bison. Steward took only a sample of faunal bones to be identified; bison and pronghorn antelope dominated his assemblage, followed by small quantities of small to medium sized mammals and some birds (Steward 1937:81-82). Johansson's (2013:40) study of the faunal remains collected in the 2011 field season at Cave 1 reported that the majority of the identifiable elements were bison (*Bison bison).* The majority of the sample collected (6387 out of 8871 bones) was identifiable only to large or small artiodactyl (bison, elk, deer, mountain sheep, or pronghorn antelope). The fur collected from Cave 1 is also predominantly bison. Steward (1927:83) concluded that the people living in Cave 1 were "primarily hunters" focused on large animals, and this interpretation holds true with more recent data. This observation is in contrast to the Fremont Culture groups that surrounded them, most of whom, at this time, had reverted to foraging with less emphasis on large game hunting (discussed in more detail below).

The area around the northeastern Great Basin contained populations of bison during the time of the cave's occupation, but these populations declined after about 1300 CE (Grayson 2006; Lupo and Schmitt 1997). The articulated bison remains and low utility elements (such as skulls) found in Cave 1 indicate that bison were in the Promontory Point area while the cave was being inhabited, and were hunted nearby. The decline in bison populations after 1300 CE may have contributed to the abandonment of the cave. It is likely that most of the hunting was done nearby, as carrying articulated lower limbs and other elements is a heavy task and these elements provide little or no food value. To the east of the cave is a grassy "saddle" area (42BO2177, Kumeroa's Saddle) that would have been an ideal location for ambush hunting in a pass funnelling movement along the west side of Promontory Point. A stone feature resembling a hunting blind is present on the north side of this saddle area. Surface artifacts have been collected in the saddle: these include projectile points, a drill fragment, a piece esquillée, and retouched flakes, consistent with hunting and hunting stand activities, although their contemporaneity with Promontory Culture materials in the caves cannot be proven.

Seasonality

Steward (1937:10) believed that the Promontory Culture occupation was a winter occupation, as the closest fresh water sources are springs over two kilometres (miles) away. Johansson (2013) analyzed age at death for 14 individual animals from the 2011 faunal assemblage. Antler butts present on two mule deer skulls reflect a winter occupation, and bison tooth eruption data indicated occupation from December to February as well as late spring to early fall (Johansson 2013:42). These results suggest use of Cave 1 nearly year-round. Analysis of Promontory Cave 2 faunal remains corroborates year-round occupations (Johansson 2013:55). Further analysis by Johansson of a burned bone layer (F62/F65) recovered in 2014 also supports this reasoning, as there were unfused specimens representing juveniles. These remains were highly fragmentary and while the animals could have been taken any time of the year, there was overlap in the fall (Johansson 2014). Rhode (2016) reports that bulrush seeds are abundant, an observation which likely indicates that whole stems with their seeds were being transported to the caves for mat construction; this interpretation would be consistent with a summer occupation. These estimates of seasonal occupation time are summarized and illustrated in Table 1. Ideally, more faunal remains will be examined for age at death in order to indicate more definitively the seasons in which hunting was occurring, and therefore when the cave was being inhabited. So far, these broad indications of seasonality coupled with such extensive cultural debris suggest the

Promontory Culture population made intensive use of the cave and may have been moderately sedentary.

Month	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Antler butts (Mule deer)												
Tooth eruption (Bison)												
Bulrush seeds												
Faunal remains F62/F65												

Table 1: Seasonality estimates based on faunal remains (Johansson 2013; 2014) and bulrush seeds (Rhode 2016). Shaded boxes indicate possible months of habitation (darker shading represents more likely times).

Conversely, there is also evidence that the population at Cave 1 made the cave part of their seasonal round, or was a site to which they returned frequently. Dung from various animals was excavated from all units in Cave 1. Bison rarely shelter in caves (Vandy Bower, personal communication 2016), so the presence of bison dung suggests that perhaps it was being brought in for fuel. However, the sheep, antelope, and other dung would not be brought in through human activity. These animals would not enter the cave while people were in it, so the presence of this dung throughout the occupation indicates periods of time when the cave was not being occupied. While we do not have precise vertical provenience for the dung, it was found in features (levels) throughout our excavation units. This is an indication that occupation was seasonal and not permanently year-round.

A recently described seasonal campsite in southeast Idaho, 10OA275, contains Promontory ceramics (Promontory Gray), and temper, paste, and geochemical analysis has revealed a relationship between this site and Promontory Cave 1 (Arkush 2014:35). Radiocarbon dates on bone collagen from this site range from 325 to 925 radiocarbon years before present (Arkush 2014:21); the habitation of Cave 1 falls within this range. Some of the ceramics also tested positive for maize residue, which could represent interaction between these people and Fremont farmers (Arkush 2014:35). Arkush (2014) suggests that 10OA275 was a site that may have been included on the Promontory peoples' seasonal round; this site would have allowed good access to the Malad obsidian source and supported artiodactyl hunting.

Surrounding Landscape and Cultures

The Promontory Caves are located on the west side of Promontory Point, overlooking Great Salt Lake. The terrain around these caves is rocky and rough, and getting to the caves is not an easy task. The slope from the caves to the shore is steep, and approaching the caves must be done slowly and carefully. We approached Cave 1 from the east, walking parallel to the shore, at first gradually increasing in elevation, and then descending down slightly to the mouth of Cave 1. On this landscape, grass and juniper trees dominate. More varieties of plants grow along the shore and by the nearby springs.

In the areas of the Great Basin surrounding Promontory Cave 1, the Fremont Culture was dominant from approximately 2000 to 700 years ago (Janetski and Talbot 2014:118). This culture is generally associated with a sedentary lifestyle focused on maize horticulture; however, there was a great deal of diversity within this culture (Coltrain and Leavitt 2002; Madsen and Simms 1998). Archaeologically, there is great variability among Fremont sites, as some groups were full-time farmers, some were full-time foragers, some maintained a mixture of the two, and some who switched between farming and foraging (Madsen and Simms 1998). Madsen and Simms (1998) saw foraging as a consistent aspect of Fremont lifestyles, expressed in varying degrees in different areas. Bone chemistry studies of human remains show a heavy reliance on maize from 400-850 CE, a shift to a more diverse diet after 850 CE, and a return to foraging after 1150 CE (Coltrain and Leavitt 2002). The commonalities among Fremont groups were: the manufacture of specific pottery forms; permanent housing; some degree of maize agriculture; and distinctive figurines, rock art, and incised stones. However, Fremont populations were as diverse as the environments around them, and these material culture commonalities linked otherwise separate Fremont populations (Madsen and Simms 1998:256). Noted differences between sites with Promontory ceramics versus those with Fremont ceramics are the location of sites and the types of projectile points (Forsyth 1986:190). Sites with Promontory ceramics are more likely to be on lakeshores and have Cottonwood Triangular and Desert Side-notched points, versus the river sites with Fremont ceramics that have Uinta Side-notched and Rosegate points (Forsyth 1986:190; Janetski 1994). It is believed that the decline of the Fremont culture was brought about by a shift to a hotter and drier climate that brought droughts to the area. The fate of the Fremont people is largely speculative; there are no known direct descendants (Madsen and Simms 1998:258), so they may have relocated or been absorbed into surrounding areas, but how and where remains poorly understood.

Rockshelters, hunting blind sites, and lithic scatters surround Cave 1, including Kumeroa's Saddle (42BO2177) and a rockshelter to the north (42BO1916). The closest known residential campsite is Chournos Springs (42BO1915), about two kilometres away. This site is located right on the shore of Great Salt Lake, near freshwater springs (likely the ones Steward mentioned as the closest freshwater source to the cave). Chournos Springs was excavated in 2013 and 2014 by the same team as the Promontory Caves excavations. The assemblage from this site contains ceramics, lithics, and some small faunal remains. The excavation uncovered what was likely a Fremont pit house, and the artifacts found corroborate this identification. Bayesian modelling of the radiocarbon dates from this site show that the terminal stages of the occupation were contemporaneous with the Promontory Caves 1 and 2 occupations (Yanicki and Ives, in press). It is likely these two populations interacted as they were located so close to each other, and there are indications of Fremont contact within Cave 1 (Yanicki 2014).

There are many lines of evidence that suggest the inhabitants of the Promontory caves interacted with nearby Fremont people, whether it was at Chournos Springs or across Bear River Bay. Though there is no way to date it, the rock art in Cave 1 is done in a Fremont style, with triangular bodies (Simms and Gohier 2010). Cave 1 ceramics indicate that from the beginning of occupation there was well-made pottery, a technology that was not used by Dene people in the north (Ives 2003:277). Additionally, Fremont pottery styles such as Great Salt Gray have been found in Cave 1, and Promontory pottery is found at Chournos Springs (Yanicki 2014).

The few pieces of basketry found in Cave 1 are all typical of ancient Great Basin styles (including Fremont) in this time range, save for one much later Shoshone winnowing basket fragment (Ives et al. 2014). Adovasio and Illingworth (2014) re-examined Fremont basketry, including the 12 pieces Steward collected from Promontory Caves, and discovered that there may have been some sharing between the Fremont cultures and ancestral Puebloan societies. One explanation they provide for this interpretation is the marriage of Fremont women into Puebloan communities, bringing their basketry-making knowledge into these other groups (Adovasio and Illingworth 2014). As the pieces of basketry found in Promontory Cave 1 are Fremont in style, it is quite possible that something similar occurred here. Genetic evidence corroborates that women and men were being incorporated into migrating Dene groups (Malhi 2012). Fremont women marrying into the travelling Dene groups would have brought their knowledge of ceramics and basketry manufacture with them. The Fremont culture lasted until ca. 1300 CE (Janetski and Talbot 2014; Madsen and Simms 1998), so contact would have been with nearly terminal Fremont groups. It appears that the Promontory Cave 1 inhabitants were a successful population with a high birth rate and growing numbers (Billinger and Ives 2015). The success of this population, probably owing to their effectiveness in hunting bison and other large game, may have been attractive to members of failing Fremont societies. It appears that while terminal Fremont populations were struggling, the Promontory Cave inhabitants were thriving.

Currently, the Promontory Caves are located in Shoshone territory. Steward (1937) discussed a first person account of Shoshone habitation of Cave 1; this inference is also supported by a Shoshone winnowing basket found in the cave that dates to 165 ± 25 BP, much later than the Promontory Culture occupation (Ives et al. 2014). There is little evidence of other cultures in Cave 1; after the use by the Promontory Culture people, the cave was not inhabited to the same degree again. Earlier than the Promontory Culture, there are some traces of occupation in the 2000-5000 year old range; these occupations are sparse and have not been a focus of our research. The Promontory Culture is integral to my analysis; knowing that the material I am working with was left behind by the same culture means that I could complete my analyses and interpretations without considering the actions of different groups with different material cultures.

Promontory Caves: Excavations

Julian Steward's Excavations

Julian Steward's University of Utah expedition was the first to excavate the Promontory caves in 1930-31. The caves had been known for some time before that by both scholars and the public, the latter causing extensive looting issues. Steward feared the heavy looting would ultimately destroy the sites. This concern was the impetus behind his excavations of Caves 1 and 2, in which he concentrated his work, while doing only simple survey and test pits in the ten other Promontory caves (Steward 1937). He conducted excavations with limited provenience data and ceased screening early in the first field season (likely resulting in the overlooking of small artifacts) (Steward 1930). Unfortunately, his field notes have been lost so we are unsure the exact details of his excavations beyond what is noted in his 1937 publication *Ancient Caves of the Great Salt Lake Region*, and a short report written after the 1930 field season (Steward 1930). This first year he dug trenches throughout Cave 1, finding cultural material only in Trenches A and B (Steward 1930). The map published in *Ancient Caves* shows further areas of excavation (Figure 5); however, our experience excavating in Area A suggests that this map is more impressionistic than precise. Steward (1937:9) wrote:

> "…trenches were dug at several points down to the lacustrine beach deposits of stratified sands and gravels, but only the slightest traces of human occupation were noted below a depth of 2 feet…Attention was therefore devoted to the upper 2 feet of culture-bearing deposits, to rock crannies, and such other areas as test pits indicated to be worth investigating. The lower deposits still remain undisturbed, except for the test trenches…"

In mapping Area A, Steward marked Trench A, then also filled in a large area surrounding this trench that would have been excavated in 1931, presumably only the top two feet of material culture-bearing sediment. I believe this expanded map area is overestimated. Our main excavation unit was placed within his drawn boundary, yet we found intact deposits (Figure 4). In fact, examining the strata in Figure 8 and the ground surface in Figure 16 leads to the suggestion that the northern portion of F3 may have overcut by Steward's expansion, which indicates he dug a basin shaped expansion rather than uniformly excavating the top two feet across the entire area. It is also possible that hooved animals moving across the F3 area may have disturbed strata there, and moved material downhill towards Steward's area of excavation.

In the back of the cave (Area B), his figure shows a narrower trench that appears not to have been expanded; however, Trench B presently looks like a basin that is wider than what is drawn on the map (see Figure 3 and Figure 19). In Trench A he found approximately 150 moccasins (Steward 1930), leading us to believe the remaining 98 were from Trench B and the basin excavated around Trench A. It is unknown whether he backfilled any material, but likely did some backfilling as Area A does not appear emptied. Eighty years of animal traffic and disturbance also resulted in originally intact materials making their way downslope into his trenches and helping to fill them, creating the surface we see today.

Steward (1937:9-10) reported eight strata and only one (Stratum 2) held cultural material. This stratum contained the two feet of Promontory material. Steward (1937:9) reported a main hearth in this stratum in Area A that was two feet deep and evidently used throughout the occupation. Hearth features may correlate with the black, carbon-rich staining on the ceiling that is present in both Area A (see Figure 6) and B. He saw Area A as the main living area, with juniper bark being brought in to lay on the ground surface, and with the "refuse of meals and manufacturing being dropped on the spot" (Steward 1937:9). He noted that the majority of the artifacts excavated came from this area. The remaining strata, a further nearly five feet, were all sterile, save for charcoal that may or may not represent earlier human occupation.

Steward (1937:10) suggested that Cave 1 was occupied in the winter but he did not speculate on the duration of occupation. He noted that there was no evidence of horticulture and an abundance of bison remains, which led him to call this population hunters rather than farmers (1937:10). Given the lack of evidence of Puebloan or "Basket Maker" (a term now subsumed under Fremont in this region) materials, Steward (1937:83) determined that the Promontory occupation must have been later than 1000 CE. He also saw no connection to the current inhabitants of the area around Promontory Point, the Shoshone. He listed traits that are indicative of a northern association, most notably the moccasins, as well as southern traits, such as the ceramics (1937:84). His major conclusion was that this population represented a northern hunting people who were in Utah long enough to acquire southern traits, likely an "Athapascan-

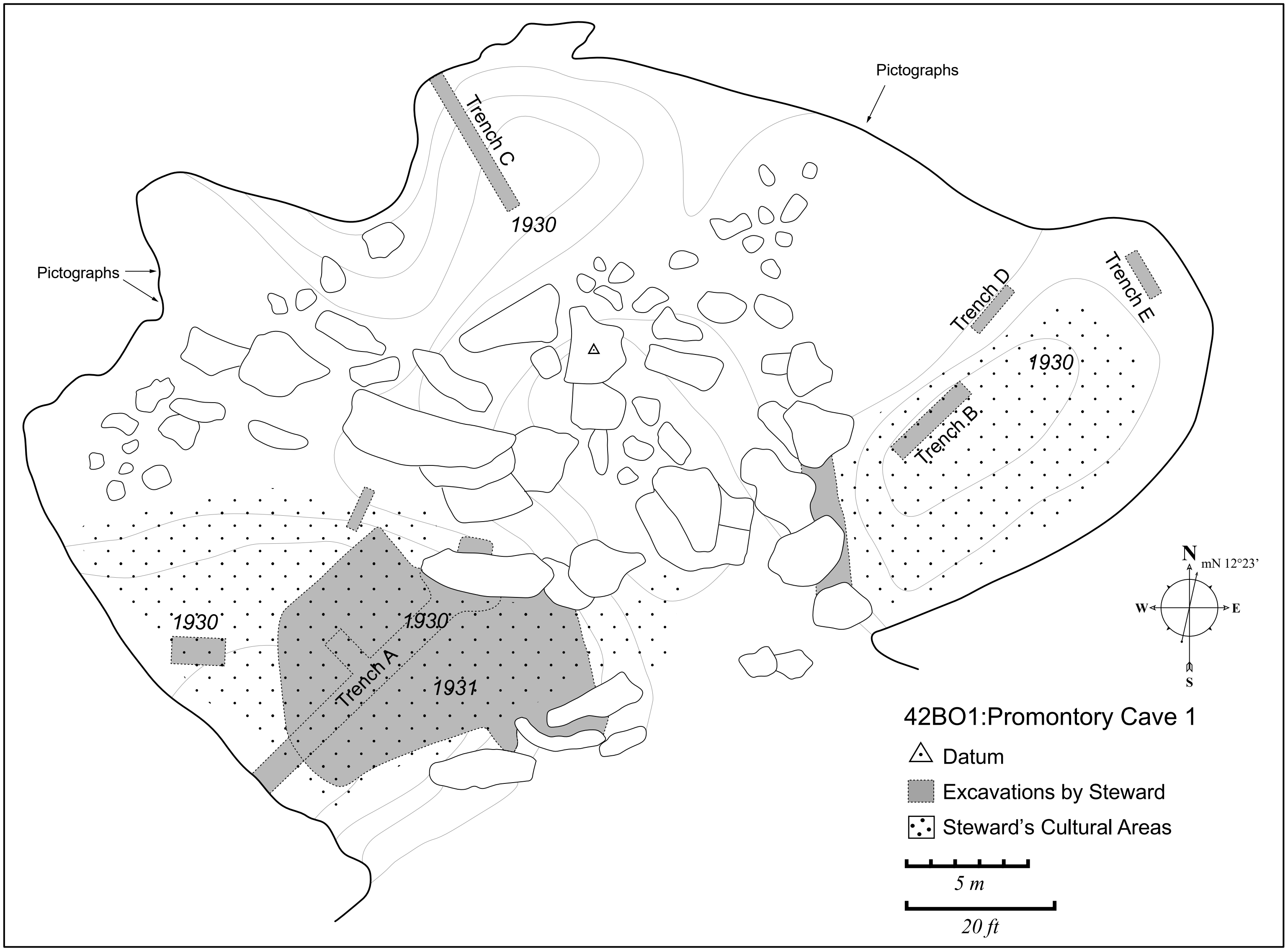

Figure 5: Promontory Cave 1 map redrawn from Steward (1937); adapted from Johansson (2013: Figure 3.1) and Steward (1930). Dates indicate when each portion of the cave was excavated. This map represents Steward's rendering, which is less precise than our modern maps made using total stations and three-dimensional scanning.

speaking tribe" (1937:86-87). This conclusion is consistent with what we have observed doing further excavations in Caves 1 and 2.

Modern Excavations

The caves were left alone by archaeologists after Steward's excavation, although looters, boy scouts, and other members of the public were known to make occasional use of the cave, including writing graffiti on the cave walls. The current landowners have striven to protect the Promontory Caves, and this has prevented further looting. Eighty years after Steward's expedition, Dr. John Ives and Dr. Joel Janetski were able to meet the landowning family, George and Kumeroa Chournos, and gain access to the caves. Excavations were conducted in Caves 1 and 2 in 2011, 2013, and 2014. This project is a joint effort between researchers at the University of Alberta and Brigham Young University, along with several other researchers. The immediate aim of these renewed excavations was to gain a better understanding of the complex stratigraphy in the cave deposits and test Steward's conclusions about the age and nature of the Promontory deposits by applying modern analytical procedures. A key goal was to provide precise radiocarbon dating for the apparently short period of time that this cave was inhabited by Promontory Culture people. A larger aim is to establish a better understanding of the Promontory Culture in the caves. Efforts have also been devoted to determining whether the people inhabiting the caves were indeed of Dene descent, making use of the cave during their migration southward.

The original plan for the renewed excavations in Promontory Cave 1 was to identify in situ deposits so that the stratigraphy could be better understood. A 2 m by 1 m unit (F3) was opened in May 2011 near the front of the cave (Area A) for this purpose. It became apparent to those working there that the stratigraphy was intact, and that it was more complicated and deeper than initially thought (John Ives, personal communication 2015). A small 0.6 by 0.4 test pit (F15) was opened on the sloping surface below F3 to preview strata that might be encountered; after some surface debris was removed, it was clear that this small test also contained in situ deposits with strata aligned similarly to F3. Another period of excavation took place in November 2011, and the site continued to produce many well-preserved artifacts. In May 2013, a larger group of researchers participated in excavations, including myself. A 0.75 m by 0.75 m unit (F28) was opened in the back of the cave (Area B) alongside Steward's Trench B. This unit also contained intact deposits, but produced less material than F3. In May 2014 we returned for a final season of excavation. A third area (F55) was opened for excavation with four 1 m x 1 m units. The purpose of these four units was to locate Steward's Trench A. The material excavated here was not intact; instead it had likely fallen into Steward's excavation, or been pushed in by the sheep, cattle, and wild animals that make use of the cave, along with some human traffic. The material in F55 was much looser than the intact deposits, but it was still artifact-rich, suggesting that it contained material that had fallen into Steward's excavation area, and not backfill. It contained many artifacts, such as moccasins, that Steward would have collected. Figure 7 is a layout of the Area A excavation units, and Figure 6 is a photograph of this area.

Excavations were conducted using Brigham Young University's feature system for recording features, stratigraphic layers, and artifacts. Everything in the excavation is given a feature (F) number, including layers, units, and areas; for example, the Area A datum is F2 while the main 2 m x 1 m unit is F3. Each stratigraphic layer was assigned an "F" number (see profile, Figure 8). All the material from each layer was screened and put into paper bags organized by class of artifact (for example: faunal bone, lithics, hide, fur, etc.). All artifacts of one type were put into one bag together, so provenience is only as specific as to which stratigraphic layer (feature) the artifacts were found in. Each bag is assigned an individual field specimen (FS) number. Artifacts are then identified through this number; e.g., FS 100.1, FS 100.2, etc. (catalogue numbers are then assigned as 42BO1.100.1, etc.). The majority of the artifacts were not assigned three-point proveniences because it was extremely difficult to excavate and see small artifacts in the dusty juniper bark-rich strata, a circumstance meaning that most artifacts were recovered in the screen. Exceptions to this situation were larger artifacts such as moccasins, arrows, and mat fragments for which precise proveniences were occasionally taken.

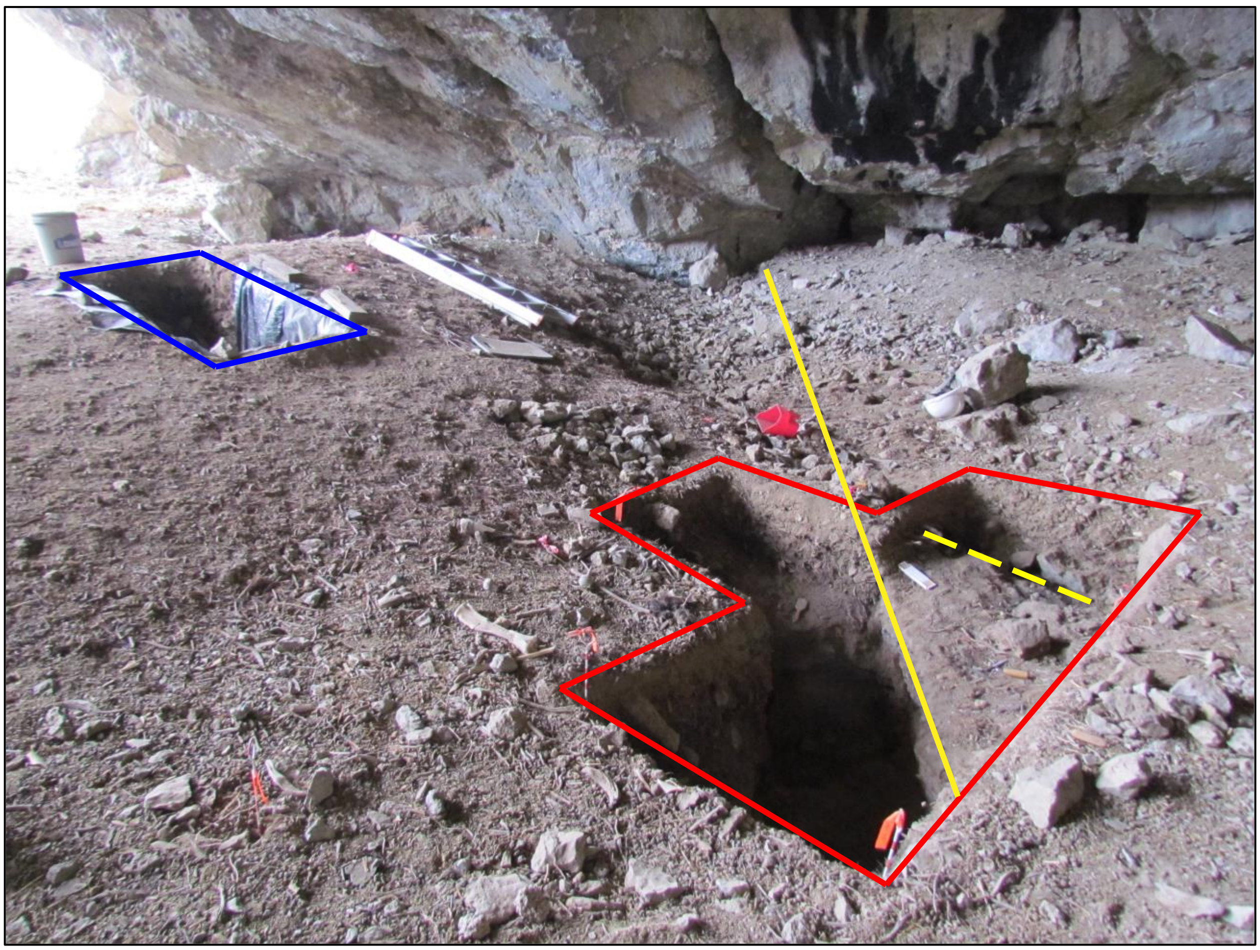

Figure 6: Photograph of Area A, facing southwest. F3 outlined in blue, F55 in red, and Steward's trench walls and extension of this trench in yellow. The dotted line represents another possible edge of Steward's trench, where we encountered a hard edge that fell off into softer substrate, but large rocks hindered excavation.

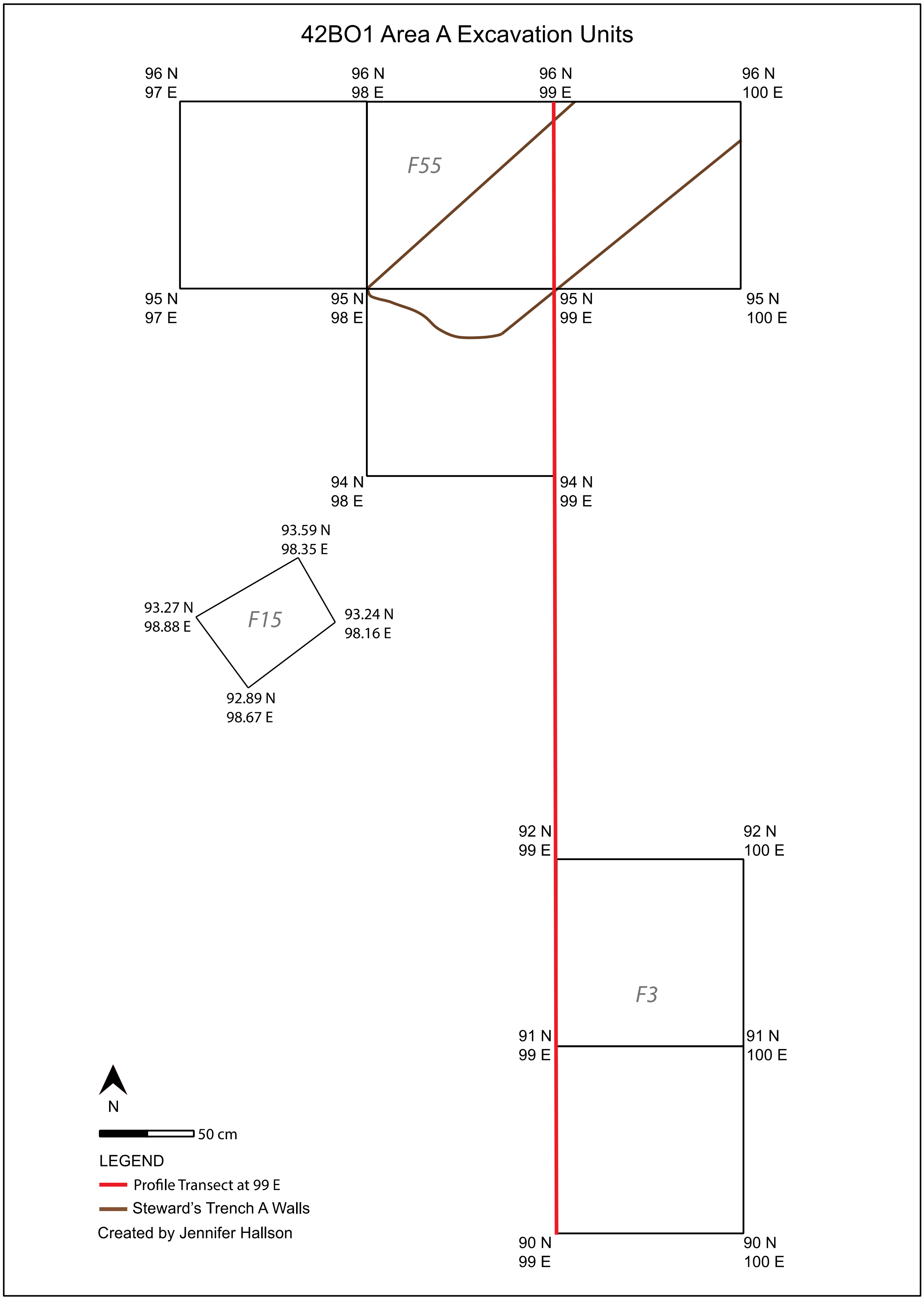

Figure 7: Plan map of Area A excavation units.

Excavation Units:

Unit F3:

This unit produced the bulk of the material collected from Cave 1. Excavation reached 2.25 m below surface before it was determined unsafe to continue. Considering the many radiocarbon dates obtained, along with diagnostic items including Promontory pottery and moccasins, it was determined that the Promontory layers end around 1.90 m below surface. The great depth of the Promontory material here compared to Steward's (1937) finding of only 0.6 m indicates that this area of the cave is different from the rest. The material in this unit was intact and not disturbed by Steward's excavation. As this deposit is much thicker than what Steward encountered elsewhere in both Areas A and B, the F3 deposits may represent a midden-type area, where material was pushed to the front of the cave during cleaning of the living area. Apart from the churning of cave deposits we would expect, a midden in this area would also explain why the radiocarbon dates are not simply youngest to oldest, as we see in Figure 8 and Figure 15. If material was periodically pushed or dumped into this area, it would generally be in chronological order, but could reflect mixing of artifacts as the area was cleaned periodically. The stratigraphy and distribution of dates will be discussed further below.

The cave deposits were dry, silty sediments with juniper bark mixed throughout, factors which made conventional excavation very difficult. The F3 walls slope inwards: what started as a 2 m x 1 m unit became much smaller at the bottom because the strips of juniper bark were difficult to cut through vertically, and because excavators left intact bison robe fragments, cordage, and other materials extending into the F3 walls (Figure 8). The constrained digging area and the depth of this unit were deemed too unsafe to continue during the last field season, and the unit was backfilled before reaching the cave floor. Below the Promontory material, we reached deposits with sparse, fragmentary bone and lithics that are just over 5000 radiocarbon years old (Figure 8).

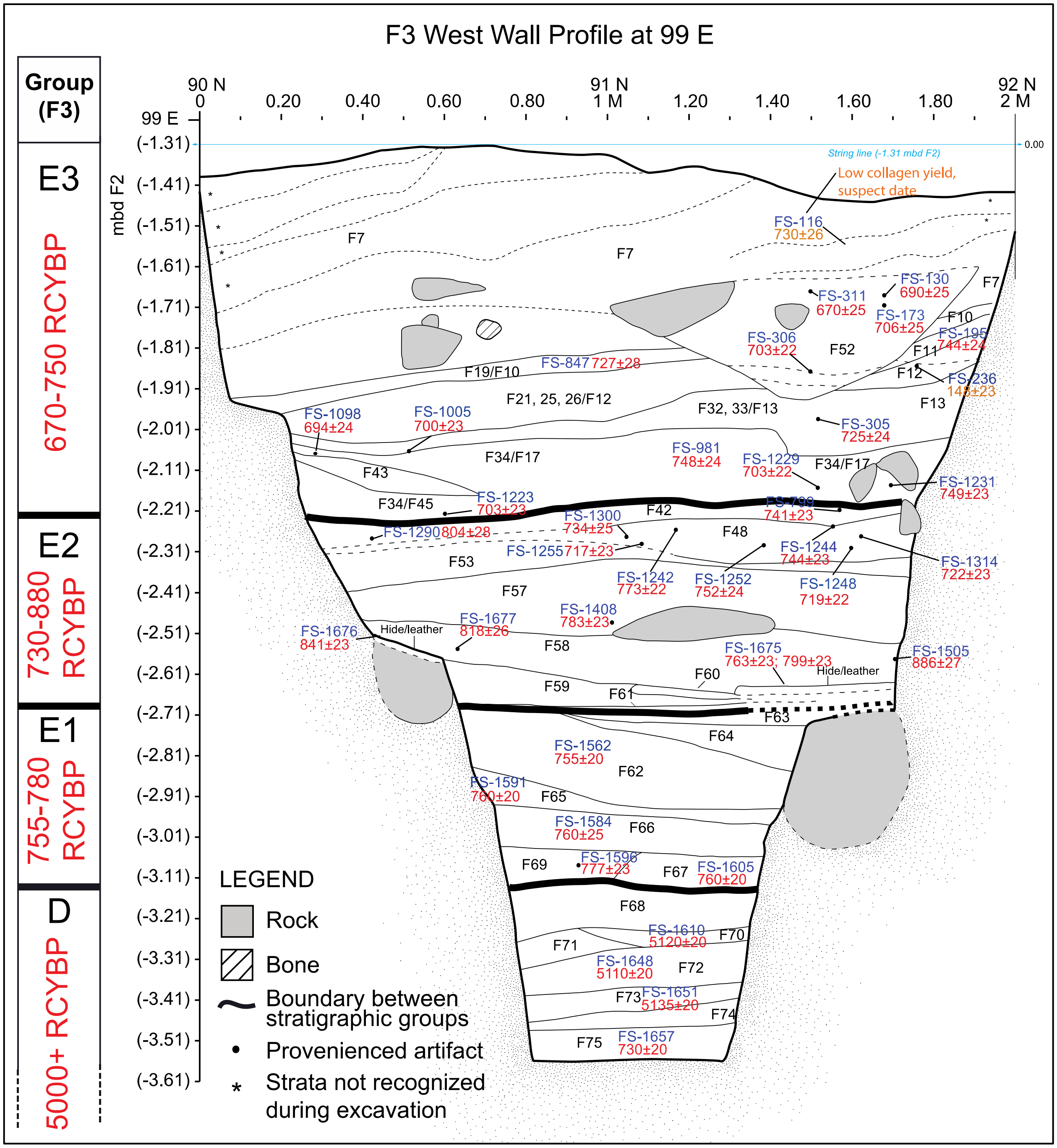

Figure 8: West wall profile of F3 with radiocarbon dates plotted.

Unit F28:

This unit was placed on the east edge of Steward's Trench B to get a better idea of the stratigraphy in the back area of the cave, as well as to provide a comparison for Area A. It is 0.75 m by 0.75 m, but slopes towards the west, likely due to material falling into Steward's Trench B. A small square was excavated east of this unit to retrieve a larger piece of bison hide. The deposits here were similar to those in Area A, but thinner and more similar to what Steward (1937) reported (Figure 10). The maximum depth of this unit was about 0.80 m below surface, and the Promontory material ended around 0.50-0.60 m below surface (Figure 9).

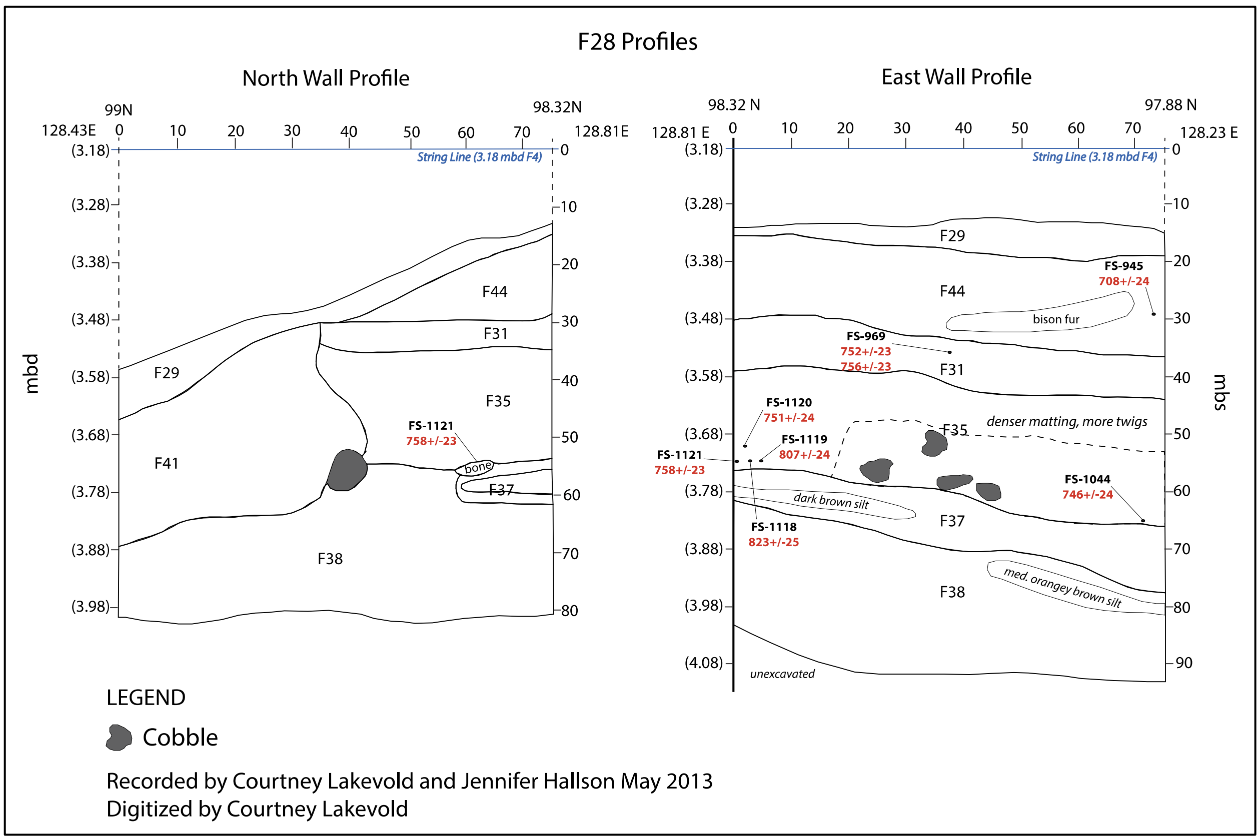

Figure 9: Profiles of F28. Adapted from image created by Courtney Lakevold.

Figure 10: East profile of F28. More typical of what Steward (1937) described, this unit held around 0.6 m of Promontory material.

Figure 11: F55 (red) with a focus on F78, Steward's trench wall (yellow). The dashed line represents another section where there is a drop off into softer substrate. This feature possibly represents an offshoot of Steward's Trench A.

Unit F55:

This collection of units was opened with the intent to try and uncover Steward's Trench A. Using his maps and profile, we placed the units where we believed they would intersect his trench. A total of four 1 m by 1 m units were opened (Figure 7). Across parts of these units we came down upon a very hard, compact matrix that was not possible to trowel through (see Figure 11). Between these areas, we found what we believe are the edges of Steward's trench (Figure 6 and Figure 7). This trench is approximately 0.9 m wide. The material excavated from this unit was all loose and not in situ. It is likely that this material fell into Steward's excavation area over the years (likely affected by animal trampling) since the contents of this unit were still artifact-rich. What is peculiar is that in Unit 94 N 98 E, there is a hard matrix like that in the units around Steward's trench, and the trench does not appear to continue (shown in Figure 6 and Figure 7). There is a possibility that rocks were used as backfill and were hindering our excavations. Steward (1937) does describe strata that were composed of rocks and boulders; we did not find evidence of these on the surface so he likely used them to backfill. Figure 6 is a photograph of the main part of Area A with the two large excavation areas outlined. Steward's Trench A walls are outlined and extended (in yellow). This photo also shows the depression along this yellow line, which was likely Steward's Trench A. He then excavated out from this trench, possibly cutting into the top of F3 (see strata in Figure 8).

Figure 12 and Figure 13 show the profile of Steward's Trench A wall, in photograph and profile form, respectively. We have been unable to make a precise reconciliation of the layers in this profile with the strata that Steward (1937) described. Our excavations and Steward's (1937:9) explanation suggest that Steward dug Trench A down to lake deposits, but elsewhere he excavated only the two feet of Promontory material (Stratum 2). Therefore, this profile we uncovered should start at his next strata, Stratum 3. Within this stratum he describes gravel and dust with some layers of charcoal and fibre, but not in exactly the order we see here (Steward 1937:10). Stratum 4 is then large boulders that he assumes are rockfall from the ceiling (Steward 1937:10). I suggest that some of these boulders were used for backfilling, and these are what we encountered at the bottom of F55 and in 94 N 98 E. The strata underlying the Promontory Culture deposits in F55 are therefore similar but not identical to those Steward described, making the exact stratigraphy of Cave 1 more difficult to reconcile than we hoped.

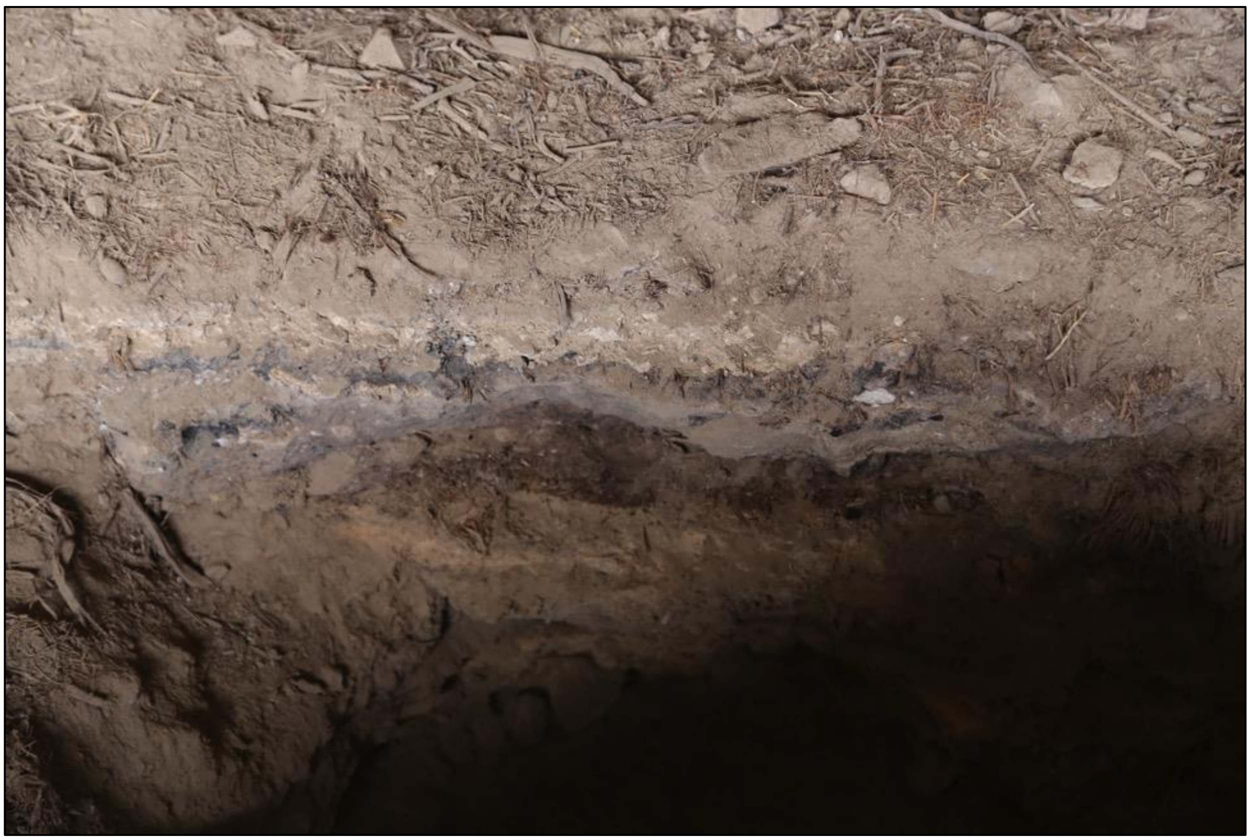

Figure 12: Close-up of F78, Steward's Trench A wall. Two charcoal layers (F79 and F80) are visible, along with one fibrous layer beneath them (F81).

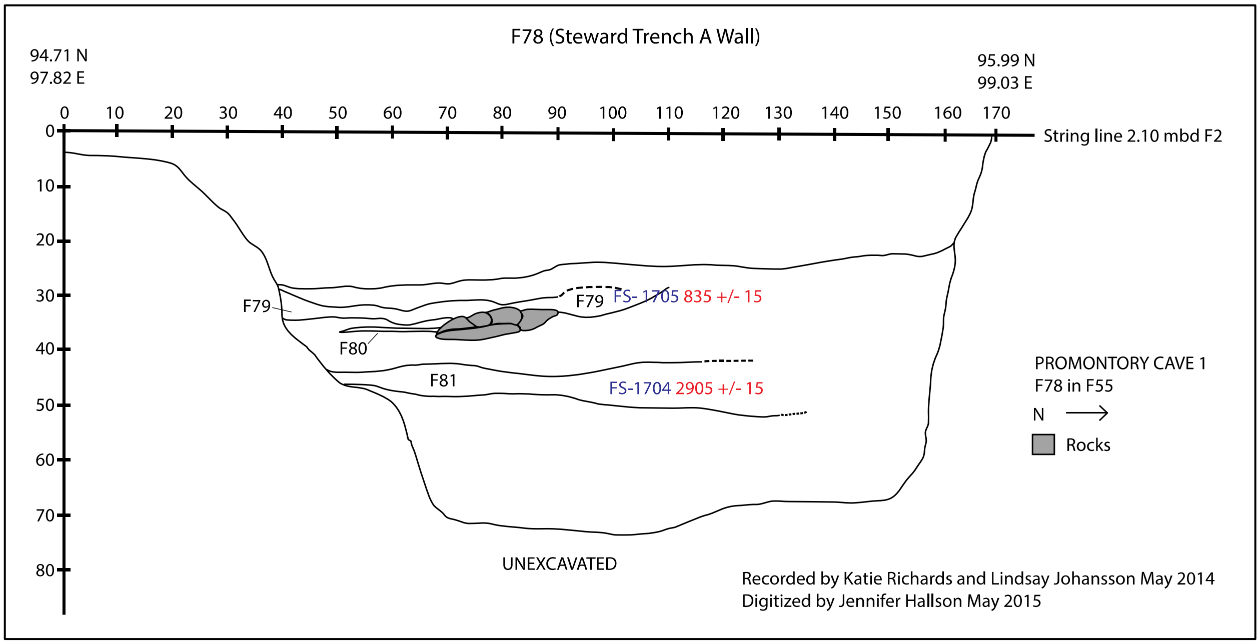

Figure 13: Portion of Steward's Trench A profile (F78) visible in F55 with radiocarbon dates plotted.

Other Excavation Units:

In 2011 a small 0.4 m by 0.6 m test pit (F15) was opened in order to determine the depth of fibrous deposits after it was realised how complicated the stratigraphy in F3 was. This test went only 0.50 m below surface before it was abandoned. While the sloping surface of F15 likely contained displaced surface materials, the underlying deposits had intact materials, such as a Promontory moccasin lying in the same plane as the F3 deposits. This small unit was located between F3 and F55. A 1 m by 1 m unit (F49) was opened under one of the pictographs in the cave in Area C, but the excavation immediately hit cave floor with only one microflake found. A small profile (F20) was cleaned and sampled on the west side of the cave, under one of the newer rock falls. Surface finds were also collected and included artifacts such as ceramics, lithics, faunal bone, and leather (the surface of the cave was denoted “F5”).

Radiocarbon Dating and Stratigraphy

The exemplary preservation of Cave 1 has provided abundant samples for radiocarbon dating. Ives et al. (2014) dated 45 samples from Steward’s collections and used Bayesian modeling to determine that the Promontory occupations of Caves 1 and 2 centre on 1250-1290 CE, and may have been even shorter in duration: possibly 20 years (Figure 14). This interval represents only one or two human generations. An additional 50 Promontory Culture era AMS dates from our excavations in Cave 1 also align with this time period (John Ives, personal communication 2016, and as presented in figures throughout this chapter). This precise dating creates a unique analytical opportunity to study the material culture left behind by a group of people over a very short period of time. What is typical in many archaeological contexts is a few dates with large error ranges, or even no directly datable material. Here, we have a precise dating record that better allows me to analyse the Promontory Culture in Cave 1.

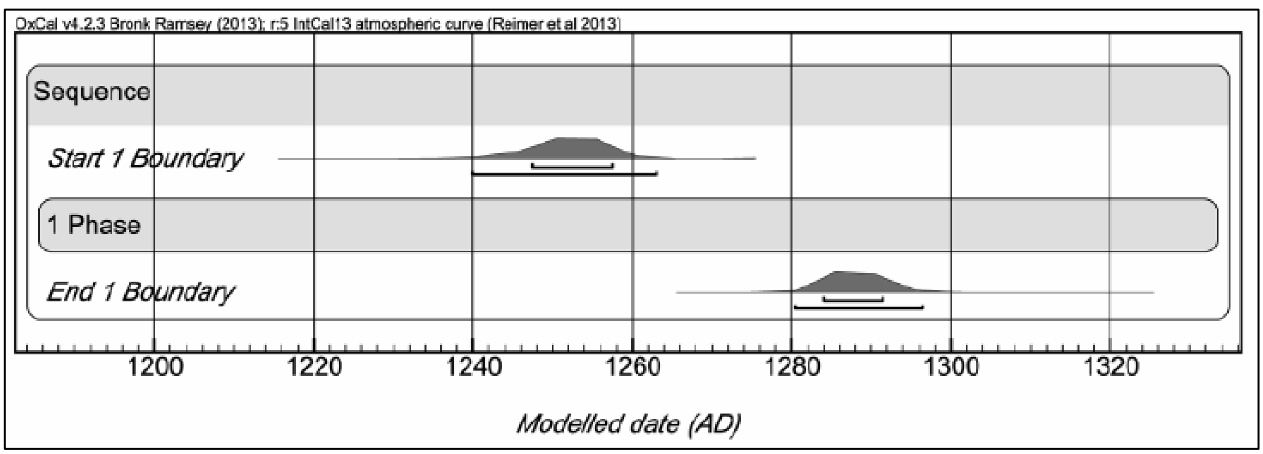

Figure 14: Figure 8 from Ives et al. (2014) demonstrating Bayesian modeling of the Promontory Phase in Caves 1 and 2, using dates taken from artifacts in Steward's collections.

Ives et al. (2014) completed Bayesian analysis of two subsets of artifacts from Caves 1 and 2: those with northern associations (such as the moccasins), and those with southern associations (such as the basketry). Their results indicate that the start date for the northern-associated artifacts overlaps with but tends to predate the start date for the southern ones (Ives et al. 2014: Figure 9). Ives et al. (2014:632) also examined the moccasins uncovered, and determined that the entire range of sewing skills (from highly to less refined) existed from the beginning of the occupation, indicating that the initial population already had expert sewers.

Both findings are consistent with Steward's (1937) interpretation of a northern population moving into the area and staying sufficiently long enough to acquire some southern traits.

The majority of the radiocarbon dates from the modern excavations are from F3. Figure 15 shows the radiocarbon dates in order by depth, using the margins of error to show the overlapping date ranges. Figure 8 and Figure 16 both show coarser stratigraphic groupings that have been made based on the dates and stratigraphy that aim to reflect site formation processes. These figures show that the deposition of material is in general chronological order, although there are some inconsistencies (mainly FS 1676, 1677, and 1505 in Group E2 with ages that are over 800 years old). This configuration would be consistent with F3 representing a midden-type area where material was being pushed aside or deposited. Since our excavations suggest this area was originally deeper than the rest of Area A, material could accumulate differently here. The initial occupation of Area A might have consisted of a smaller group of people who lived in the middle of the area, and as the population grew, material accumulating in the central area might have been pushed into this deeper area. The deepest Promontory Culture AMS samples came from F62, F65, F66, F67, and F69 (Group E1). Four dates in these layers suggest a specific event occurring, as they span just 755-760 RCYBP. The F62 and F65 layers consisted almost entirely of burned bone and may represent a single burn event to clean up the central hearth, or bone that burned in situ at this location, as the occupation area expanded. As time passed, midden debris of mixed ages was deposited in the F3 area. Periodically, people likely cleared debris from the main living space of Area A into the F3 depression. Depending on how this cleaning occurred, it could result in the generally but not fully ordered sequence of radiocarbon ages that we see.

Binford (1983:153) reported that a "toss zone" is created around a hearth, from individuals tossing larger objects behind them. Smaller artifacts such as flaking debris are left in

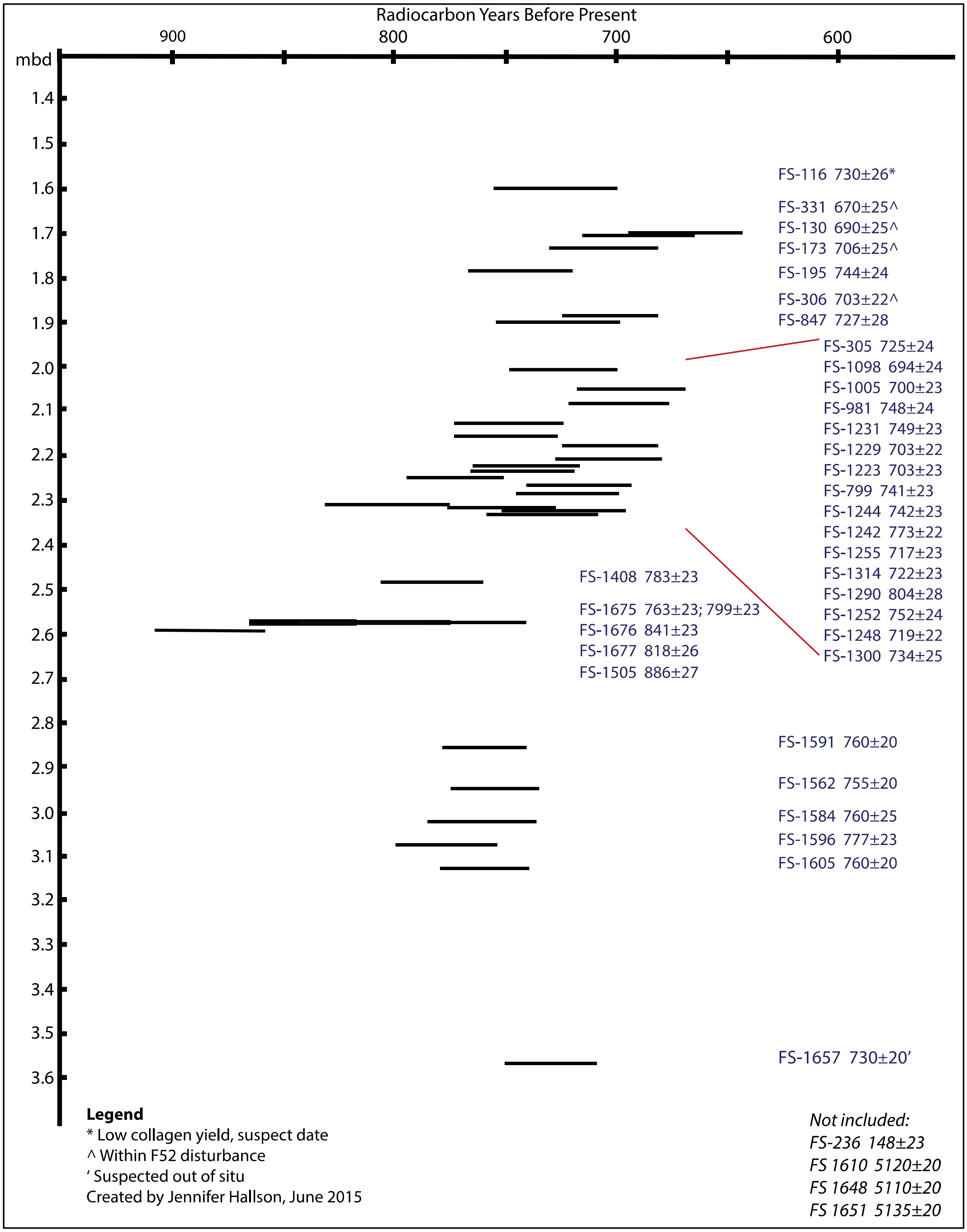

Figure 15: Depth distribution of radiocarbon dates from F3.

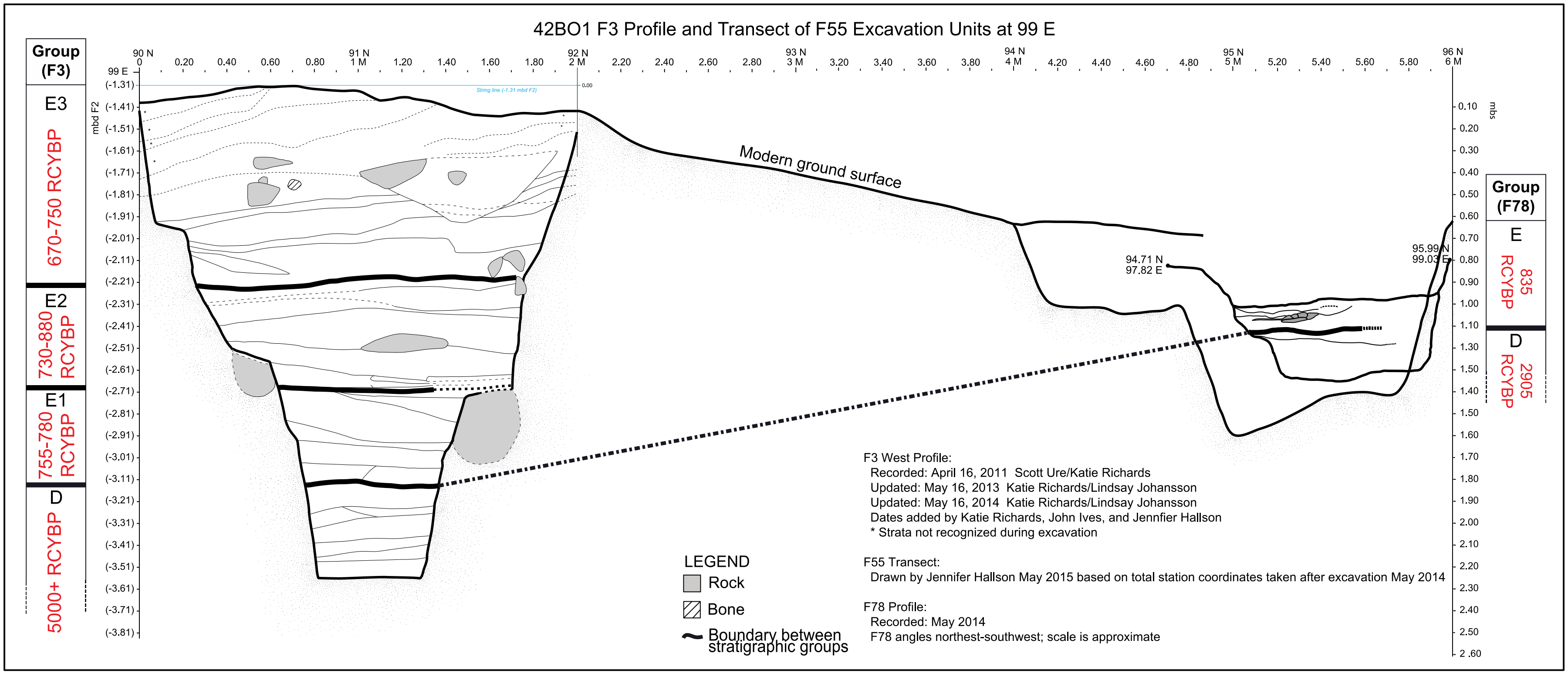

Figure 16: F3 and F55 profiles showing connecting ground surface and comparing depths of Promontory material. Components of image created by Katie Richards, Jennifer Hallson, and Gabriel Yanicki.

situ (Binford 1983:153; see also Stevenson 1991). Janes (1989:136) also saw a "zone of debris" radiating outward from a central hearth. If this were the case in the confined cave setting of Cave 1, this "toss zone" would need to be cleared fairly often as material would continue to pile up. F3 may therefore have fallen within this "toss zone," or it may have provided a convenient midden area to deposit refuse. As this depression filled to match the level of the rest of Area A, material may have accumulated more consistently, perhaps now from regular occupation of an expanded, more level Area A (Group E3).

Stratigraphic layers in Cave 1 were difficult to identify, varying with light conditions and irregular surfaces (Figure 17). Nevertheless, stratigraphic layers were identified during (and after) excavation, shown in Figure 8. Roughly 20 layers can be discerned in the Promontory occupation; while these may not directly relate to individual occupations, they do reflect around 20 depositional events that occurred to form these separate layers. Therefore, it is reasonable to consider around 20 episodes of artifact accumulation, either as the result of multiple occupations or of cleaning occurrences, or a combination of the two.

Figure 16 demonstrates the differences in depth between F3 and F55, and helps to demonstrate that F3 is located in an area that was once a depression. Two dates were obtained from the charcoal and fibrous layers in Steward's trench wall (F78). One is early Promontory, and one much earlier (Figure 13). The dotted line in Figure 16 connects F3 with F78 at the approximate boundary below the Promontory Culture material. Excavation ceased in F55 because in all units we came down upon a hard-packed surface. This combined with the difference in depth between F3's and F78's Promontory layers strongly indicates that F3 is located in a natural depression of the cave.


Figure 17: Photo of the top portion of F3's east profile, demonstrating the difficulty in identifying precise stratigraphic boundaries.

Livable Areas

During the 2014 field season, I took total station points around the perimeters of what we believed were the “livable areas” of Cave 1: areas where people would perform normal daily activities and therefore discard material (see Figure 4). These areas were identified using our own observations, as well as the map in Steward (1937) indicating where he found cultural material (Figure 5). These observations were based on three aspects: areas in which there was sufficient occupation space under sloping cave walls; the presence of surface artifacts; and the presence of juniper bark, which Steward thought was used as a bedding material. The large quantities of shredded juniper bark would be a natural analog to the Subarctic Dene and Algonquian practice of using spruce boughs to cover lodge floors in northern Canada (e.g., Clark and Clark 1974:34-35; Janes 1989:131). Spruces boughs were laid down to create the living surface, over which robes or mats could be laid for both daily life and sleeping pads. In the Subarctic, spruce boughs were regularly replaced with fresh ones (Clark and Clark 1974:35; Janes 1989:131). As trees like spruce were unavailable and there were not many other options around Promontory Cave 1, using stripped juniper bark as a surface was another option and could explain why the matrix is composed of such a large amount of juniper bark. As cultural material was essentially dropped on the spot, these juniper bark layers would cover up this debris. There is no evidence of cultural material or juniper bark in Area C, but in Area A and Area B livable areas defined in this way were recorded (Figure 18, Figure 19, and Figure 20). It is interesting that Area C was scarcely used. This area contains the pictographs, so that the use of this space may have been avoided because of their presence. In both Areas A and B it appears that the majority of each area was utilized, save for where the ceiling approached the floor and it became too low for habitation.

Figure 18: Area A, after backfilling, facing approximately southwest.

Figure 19: Area B, after backfilling, facing approximately northeast.

Figure 20: A portion of Area C, facing approximately northwest, showcasing one of the pictographs in Cave 1. Also, note the difference in the matrix (a yellow silt) versus that of Areas A and B (grey/brown silt with juniper bark strips).

Types of Artifacts

Our excavations found much the same types of artifacts as Steward did in 1930-31. This collection includes many artifacts made from organic materials such as hide and wood. Categories of artifacts include those that are used for hunting, clothing, and daily life. Table 2 is a list of the general categories of artifacts that were excavated from Promontory Cave 1.

Basketry*	Faunal Bone	Hide/Leather*	Stone Tool	Worked Stone
Bead*	Fire Cracked Rock	Historical Artifacts	Shell	Worked Wood*
Botanical*	Feather*	Lithics	Wood*	
Ceramics	Fecal Material*	Mineral	Worked Bone*	
Charcoal*	Fibre*	Moccasin*	Worked Botanical*	
Cordage*	Fur/Hair*	Quill*	Worked Reed*	

Table 2: Categories of artifacts found during the 2011-2014 Promontory Cave 1 excavations. Adapted from BYU's list of Artifact Categories. Asterisks denote organic, perishable material.

Out of the 26 categories listed, 17 (marked with *) are organic materials that would typically not survive in the average North American open archaeological site. Sixty-five percent of the categories are perishable materials, which would leave only 35% of the categories to be found by archaeologists in an open site: a small representation of daily life. The intermediate category here is bone, which occasionally survives in open sites but not always.

An interesting aspect of the artifact assemblage from Promontory Cave 1 is the presence of both male and female made items. Typically, what we find in the archaeological record are the manifestations of men's activities: mainly hunting in the form of projectile points and the remaining faunal bones. Women were normally responsible for hide tanning and manufacturing items from hides (Thompson 2013:4). Historically, women's participation in the past and in the archaeological record has tended to be pushed aside for investigation of the more exciting and dangerous realm of hunting. This emphasis is likely due, in part, to the fact that most archaeologists in the past were male, but also that the by-products of women's work (moccasins, clothing, etc.) do not preserve well (Sundstrom 2008:168). Yet, clothing was a vital aspect of living in cold environments, and procuring hides was an important factor in a hunt; hides were required for tipi covers, clothing, containers, and more (Brink 2008:224). Reilly (2015:39) suggests that in some cases hide procurement could have been the main motivation for a hunt. Clothing could be more than just practical: it was a physical representation of social, cultural, and spiritual values (Thompson 2013:3). It could demonstrate a man's ability to provide for this family, as well as a woman's skill in hide working (Thompson 2013:4). Typical Athapaskan clothing was beautifully decorated with quillwork and fringing (Thompson 2013:19), characteristics we see on moccasins and scraps left at Promontory Caves. Although gender roles may not have been so black and white as archaeologists like to think, the assemblage at Cave 1 does demonstrate the male and female realms in the form of projectile points and hunting paraphernalia, traditionally relating to a man's activity, and extensive hide working, traditionally a woman's activity. My analyses focus on these two categories: hunting and hide working, including artifacts associated with both men and women.

A Unique Opportunity

The above descriptions of Promontory Cave 1 demonstrate the remarkable nature of this archaeological site. The incredibly tightly modelled occupation range of only 20-40 years is not common in typical open archaeological sites, where the error ranges can be much larger or no directly dateable material exists. In those circumstances, archaeologists have to rely on relative dating techniques such as projectile point typologies to estimate dates that can span thousands of years. Another distinctive aspect of this site is that it is a bounded space. For many sites, it is difficult to determine the exact site boundaries, due to a combination of factors. Site disturbance and land ownership can affect an excavation so that the boundaries cannot be tested. As well, there may not be enough time, resources, or reasons to test an entire site in order to determine where it ends. Here, I know exactly how large this site is because it is bounded by the cave space. This, combined with the tight date range and the incredible preservation, allows me to perform calculations and make reasonable estimations about how much cultural material exists in this cave. I can then make inferences about the population that lived here.

Connections to Dene Migration

Migration of Dene people from the Canadian Subarctic to the American Southwest has been confirmed both linguistically (e.g., Rice 2012; Sapir 1936) and genetically (e.g., Achilli et al. 2013; Malhi et al. 2003; Malhi 2012; Monroe et al. 2013). Archaeologically, evidence of migrating Apachean ancestors is harder to find. The Dene language is highly resistant to borrowing from other languages (Sapir 1936), but Dene people will readily borrow material culture to adapt to new environments (Ives et al. 2010). This tendency makes it difficult to confidently identify material culture from migrating Dene populations; however, we believe that we have found solid evidence of a migrating Dene population at Promontory Caves 1 and 2. The styles of the hundreds of moccasins are indicative of a northern origin; these are specifically made in a Subarctic style (Billinger and Ives 2015; Ives 2014; Ives et al. 2014; Steward 1937), and other artifacts, such as tabular bifaces made for hide softening, are also suggestive of a northern origin (Reilly 2015). The preservation at Promontory Caves has allowed for this distinct form of identity to survive in the archaeological record.

Many researchers have suggested that the east lobe of White River Eruption was the event that spurred Dene migration southward (e.g., Ives 2003; Jensen et al. 2014; Moodie et al. 1992). Jensen et al. (2014:875) recently obtained the precise date range of 846-848 CE for the east lobe eruption. The volcanic ash would have created a toxic environment, and may have been the push that spurred migration southward. This precise timing also provides ample time for a population to have travelled to Promontory Cave 1 by 1250-1290 CE.

A further complication of finding evidence of migrating Dene groups is the debate over which route(s) they took (e.g., Wilcox 1981). Some favour a Plains route, taking people out east to the Plains then down south. Others favour a mountainous route, either an intermontane one, or one along the Rocky Mountain foothills (e.g., Perry 1980). The Promontory Caves can place a definitive spot on a map for where Apachean ancestors stopped during the migration. This site lends weight to the mountainous route theory, but does not exclude the Plains route, as the most parsimonious explanation is multiple routes (Seymour 2012a). The population at the cave exhibited some Plains traits, such as the focus on bison hunting. Northern Dene groups would already be familiar with mountain living as well as communal hunting (Ives 2003; Perry 1980).

Least cost path (LCP) analysis is also suggestive of multiple routes. Least cost path analysis is a tool used in GIS that calculates the most cost-efficient path from one point to another (Surface-Evans and White 2012). When used in archaeology, it is based on the assumption that humans will strive to decrease the cost of traversing a landscape; these costs can be both physical and social (Surface-Evans and White 2012). I used Esri's ArcGIS (specifically ArcMap) to compute least cost paths to model Dene migration (Figure 21). These routes were calculated using the slope of the landscape, determined using 100 m digital elevation models (DEM). This robust scale can eliminate subtle changes in slope, but is useful on a continental scale. This approach does not account for any other factors, physical or cultural, but can still provide valuable information about past movement (Rissetto 2012). The paths shown in Figure 21 are suggestive of multiple routes, and also support the possibility of a route starting on the Plains and then moving into the mountains.

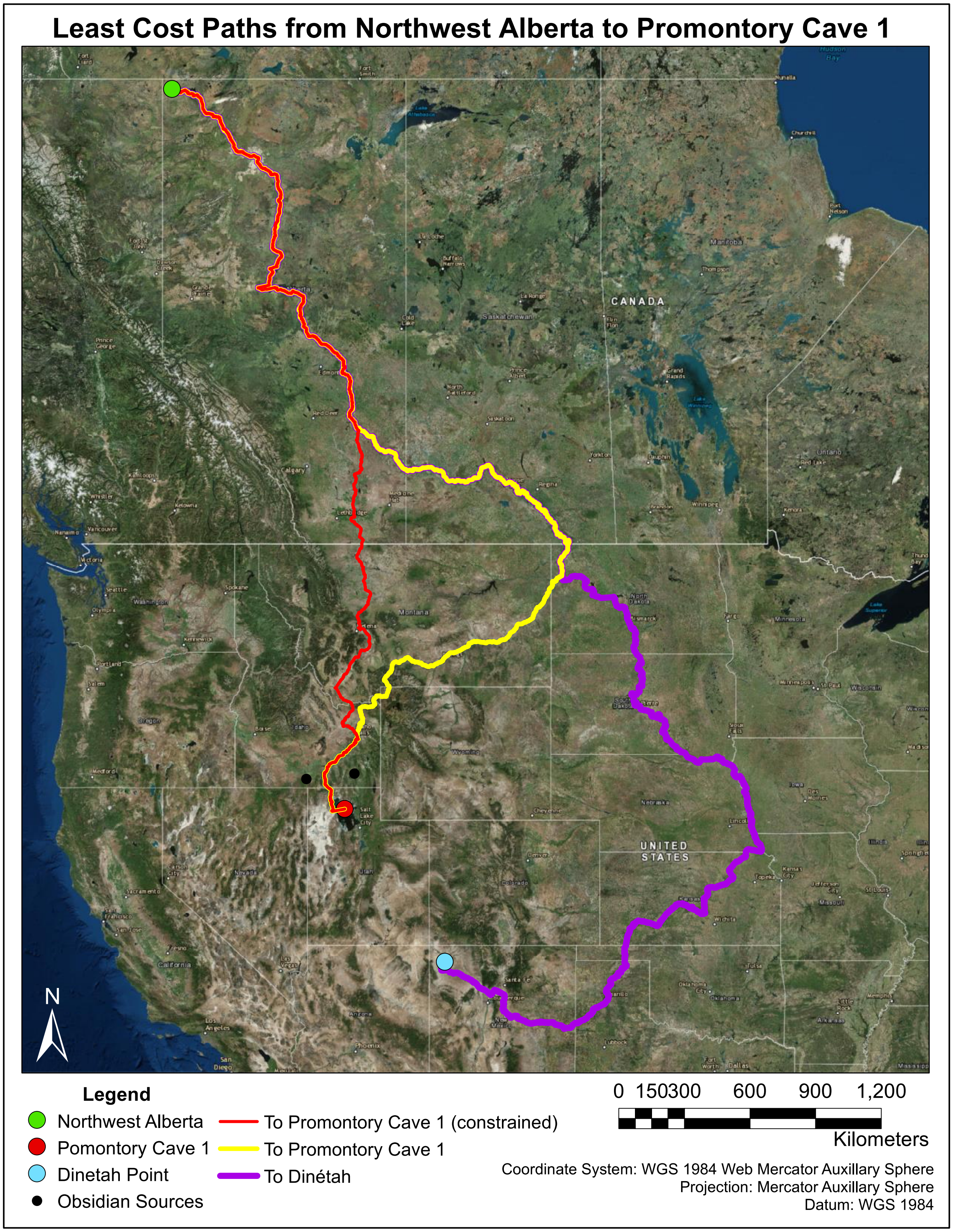

Figure 21: Least cost paths from northwest Alberta (simulating Dene migration origin) to Promontory Cave 1 and Dinétah (the Navajo homeland, simulating one Dene migration end point). The constrained path (red) was calculated using a smaller study area. When the study area was expanded, the routes expanded to the east.

Analyses of mitochondrial DNA (mtDNA) show that Dene groups exhibit high proportions of haplogroup A, and specifically haplogroup A2a (Malhi 2012; Monroe et al. 2013). Haplogroup A is exhibited at nearly 100 percent in northern Dene groups but can be as low as 50 percent in southern Dene groups, with the remaining proportion of mtDNA being made up of haplogroup B and C variants. This distribution demonstrates that gene flow took place from other groups into southern Dene groups (Malhi 2012:242). Other Native American groups in the Southwest do not exhibit high frequencies of mtDNA haplogroup A, whereas haplogroups B and C are common in the Southwest. This, along with Y-chromosome analysis, indicates that women and men were being incorporated in to migrating Dene societies, but Dene women were not leaving to join other groups. Ancient DNA (aDNA) studies of Fremont burials have shown a high proportion of haplogroup B and the absence of haplogroup A (Parr et al. 1996). Since we know that Fremont and Promontory people were in contact, it is possible that Fremont women married into migrating Dene groups such as the one at Promontory, thus contributing to the presence of haplogroup B of the southern Dene populations. This inclusion of new members was likely necessary; a small hunter-gatherer group of 25-50 members, which is what was likely at the Promontory Caves, would not be large enough to provide marriage partners, and other Apachean populations may not always have been in contact. In order to reach the American Southwest, spouses from other societies would be needed, leading to the incorporation of new members along the way (e.g., Anderson and Gillam 2000; Ives 2010; 2014; 2015; Moore and Mosely 2001:Table 1).

Population Studies

The population at Cave 1 exhibited hunter-gatherer traits, so a study of the typical population of average hunter-gatherer groups is fitting. It has previously been suggested that, based on hunter-gatherer group sizes, a microband of around 30-50 people inhabited Caves 1 and 2 (Ives and Billinger 2015:77). This value will be tested in my analysis to see if it holds true, and to see if we can further refine our understanding of group size, composition, and artifact accumulation in the caves.

A group size of 25 has been reported so often for hunter-gatherers ethnographically that a discussion in Lee and DeVore (1968:245) led to it being dubbed "magical" (see also Wobst 1974:170). Wobst (1974:170) provides the table below (Table 3) summarizing the group sizes reported in Damas (1969), and demonstrating the repetition of numbers around 25. To build on this observation and determine how viable a population size of 25 is, Wobst (1974:173) used simulations to determine that a minimum group size of 25 is adaptive to the daily economic life of hunting and gathering societies. This does not guarantee that such a local group or microband will be long lived, because demographic modelling has shown that they are too small to survive typical long-term stochastic fluctuations in birth rate and mortality (Anderson and Gillam 2000; Ives 2010; 2014; 2015; Moore and Mosely 2001:Table 1). Local groups or microbands will join together with other groups and form macrobands for a portion of the year, and this practice has been observed in Dene groups in the Subarctic (Ives 1998). During this time of aggregation, trade in artifacts and information would occur, and would provide an opportunity to find spouses.

Band Society	**Minimum Band Size**	**Source in Damas (ed.) 1969**
!Kung Bushmen	25 mean	Marshall p. 281
Hadzapi	20-60 range	Bicchieri p. 209
Birhor	25 mean	Williams p. 146
Semang	20-30 range	Gardner p. 211
Andaman Islanders	30-50 range	Gardner p. 211
Athapaskans (in general)	20-75 range	McKennan p. 104
Eastern Subarctic Hunters	25-50 range	Rogers p. 52
Iglulingmiut	35 mean	Damas p. 210
Copper Eskimos	15 mean	Damas p. 210

Table 3: Table copied from Wobst (1974:170) listing the population sizes reported in Damas (1969).

Hamilton et al. (2007) reanalyzed Binford's (2001) dataset of 339 hunter-gatherer societies plus 1189 social groups and found consistent values for the sizes of various groups. A family consisted of 4-5 people, a residential group 14-17, a social aggregation 50-60, and periodic aggregations 150-180 (Hamilton et al. 2007:Table 1; see also Kelly 2013:172). Their analysis suggested that a residential population could be smaller than 25, around 15 people; however, a size of 25 is the most consistently used value when discussing the first level of group size.

Wobst (1974:173) also calculated a maximum band size of 175-475 people; this figure relates to the other "magic number" of 500 that represents the size of a population that will overcome the impacts of stochastic birth and death processes, so that a regional population or macroband remains reproductively viable (see also Kelly 2013:167). This group size was also discussed in the volume edited by Lee and DeVore (1968), but was more of an assumption than a value that held true (Kelly 2013:167). Nevertheless, a group of 25 can only survive if it is part of a larger network of groups within which to find spouses.

Genetic studies suggest that the founding Apachean population was relatively small, and hunter-gatherer studies suggest that the migrating groups would be in the microband size range (Malhi et al. 2003; Malhi 2012; Monroe et al. 2013). During a migration of this magnitude, it would become impossible for contact to be kept between the migrating groups and the original point of departure, or between other migrating groups. As the genetic evidence shows, these migrating groups would have added members from groups they met along the way, keeping their population viable.

Jarvenpa's (2002) work on ethnographic Dene group sizes demonstrates perfectly how small groups cannot survive for long periods of time without a network of relationships with other groups. His average group sizes are listed in Table 4, but these groups needed a network of people to help when they fell on hard times (Jarvenpa 2002:168). In the case studies Jarvenpa (2002) discussed, these connections were forged by marriages and the alliances they create. A migrating Dene group would also need to form relationships with groups they met in order to ensure continuation of the population, and the ancient DNA studies previously discussed demonstrate this gene flow did indeed occur at some time during the migration.

Group(s)	**Average Group Size**	**Reference**
Southern Chipewyan (average between 6 communities)	36.9	Jarvenpa 2002
Mackenzie Drainage Dene	24.4	Jarvenpa 2002
Iglulingmiut	26.6	Jarvenpa 2002

Table 4: Group size for ethnographic populations.

Research currently underway at the University of Alberta is using average space needs per person to look at how the cave space was used (Lakevold 2017). Lakevold (2017) has obtained an average value of 4.46 m^2 needed per person, based on ethnographic sources for western North America. Using the total area of Areas A, B, and C (449 m^2), this results in a maximum population of 100 people. However, when using only the dimensions of Areas A and B, which total 348 m^2, this calculation would decrease this maximum to 78 people. She notes that this number would represent an aggregated group, and with the amount of accumulation present it is more likely that a smaller population inhabited the cave more frequently than a group periodically aggregating. Using only Athapaskan ethnographic data for space requirements (6.31 m^2), Lakevold (2017) calculated a maximum number of 55 people, or about 5-6 households.

I determined the livable areas in the cave to be 163 m^2 in Area A and 76 m^2 in Area B. As discussed above, these are the areas where juniper bark and artifacts are present, and where there is room for people to stand up. Using this smaller total of 239 m^2 and the Athapaskan space requirement of 6.32 m^2, the maximum population size that could have been living in Cave 1 decreases to 38 individuals. Other ethnographic sources Lakevold (2017) examined had space requirements larger than 6.31 m^2, so there is a possibility that the maximum population was smaller than this.

Having estimated the approximate size of the group likely to have inhabited Cave 1 (between 25 and 50 people), we can now turn to the ways in which population composition is relevant to my research as well. Research by Helm and Lurie (1961) included the composition of households for the Dogrib Northern Athabascan people during 1959. Their definition of a household was at least one family unit living together whose members "contribute and share in maintenance, provision, and distribution" (Helm and Lurie 1961:9). At the Lac La Martre village, there were total of 110 people: 20 family units in 18 households (Table 5). Households ranged from 3-10 individuals and did not result from polygamy. Children under 16 comprise a large portion of the population at 42%. Males over 16 years represent 26% of the population, and females over 16 years represent 32%.

	Living Husband/Wife		**Children and Others**		
	Father	**Mother**	**Under 16**	**Over 16 Male**	**Over 16 Female**
Count	18	20	46	11	15
Percentage	16%	18%	42%	10%	14%

Table 5: Population distribution at Lac La Martre village in 1959. Data from Helm and Lurie (1961).

During Janes' (1983) ethnoarchaeological research among the Mackenzie Basin Dene in 1975, he reported a Slavey group that consisted of 6 families, composed of 28 people ranging from one month to 78 years old (Table 6). This core group was also often visited by others throughout the year, and family members within the group came and went regularly, travelling between settlements and the bush (Janes 1983:14). Visitors came to hunt and fish as well as socialize, and were often related in some fashion to the core group. The coming and going of people likely helped to sustain this population, as Jarvenpa (2002) indicated in his research.

	Adult Male	Adult Female	Male Children	Female Children
Count	7	8	8	5
Percent	25%	29%	29%	18%

Table 6: Population in 1975 of the Willow Lakers, a Slavey group living in the Mackenzie Basin. Data from Janes (1983).

Census data of Northern Athabascans from the Mackenzie River District described by Russell (1898:160) provides information about the number of men, women, boys, and girls in Dene communities. This data set provides realistic historical information from 1858 about the ratio of children to adults (Table 7). Russell (1898:160) also noted that the population had not changed in the previous 20 years. In most cases, children slightly outnumbered the adults, but the overall average of the 11 populations he described is exactly 50% children (Table 7). Taking the totals of all these groups, the ratio works out nearly perfectly to 25% men, 25% women, 25% boys, and 25% girls.

Group	Men	Women	Boys	Girls	Total	Percent Children
Rampart House	37	39	39	49	164	54%
La Pierre's House	32	39	49	48	168	58%
McPherson	99	107	138	111	455	55%
Good Hope	162	157	97	131	547	42%
Norman	86	74	82	82	324	51%
Wrigley	36	39	58	31	164	54%
Simpson	74	76	45	39	234	36%
Liard	70	54	53	42	219	43%
Nelson	54	54	66	50	224	52%
Providence	90	90	139	117	436	59%
Rae	168	188	176	179	711	50%
Total	908	917	942	879	3646	50%
Total Percentage	25%	25%	26%	24%	100%	50%

Table 7: Population of the Mackenzie River District, adapted from Russell 1898:160.

Similarly, the 1824-1827 Hudson's Bay Company census of the Beaver (Dunne-za) people listed 192 individuals, 86 of which were children, which equates to 45% of the population (HBCA B.224/a/2-15; HBCA B.224/D/2). Census figures from Fort Vermillion in 1826-1827 indicate an average of 3.5 dependents per man (Ives 1990:143). Observations by McKennan

(1969:102-103) on Athapaskan groups also support a range of 30-50% for children. The average of McKennan's (1969) population numbers results in a population with 26% men and 27% women. These data, along with the above tables from Russell (1898), and Helm and Lurie's (1961) and Janes' (1983) data suggest a fairly even split of children to adults in these populations, and a fairly even split between men and women. This range of historical and ethnographic data from northern Dene populations is consistent with the aforementioned hunter-gatherer data in terms of group size. The data suggest that we might expect a group size of around 25 individuals, although Cave 1 could have more, with an even split between adults and children as well as between males and females. Table 8 makes an idealized breakdown of population composition based on group sizes of 25 and 50, pulling from the above studies.

Population Size	**Men**	**Women**	**Children**
25	6.25	6.25	12.5
50	12.5	12.5	25

Table 8: Population composition of two groups sizes, using the breakdown of 50% children, 25% men, and 25% women.

Social science literature indicates that the composition of a migrating population is not always the same as a (relatively) stationary one. If the Promontory Cave 1 population was a migratory one, we also need to consider the impact of migration on population size and group composition. There can be sexual asymmetries in population composition; migrants tend to be young and young males are the most likely to migrate (Anthony 1990; Lee 1966); however, when migrating into an empty landscape, females are needed for reproducing to maintain a viable population. Anthony (1990:895-896) discusses how migrating groups will rarely migrate into unknown areas. Information about new land will be gained from other groups, or scouts could be employed to move ahead and report back. Magne (2012:362) suggests that scouting would occur at the generational level for Dene migration. Given the differences exhibited today between the Northern and Southern Dene groups, it is evident that the southern groups readily adopted and invented new technologies and ways of life. Contact with other groups would have helped to increase their knowledge of the areas around them, so they were not migrating blindly. Cave 1 may have first been found and inhabited by scouts, who then brought a more typical larger population consisting of men, women, and children to the cave. Once the group was established in this area, it may have been necessary to find spouses in the surrounding populations, especially if there was a male bias in this migrating group. Here, relationships would have been founded with nearby groups, possibly Fremont people at the nearby Chournos Springs site. Due to the success of the group within the cave, the population may have grown and created an asymmetrical ratio between children and adults.

The studies above consistently use or report a population of around 25 people for hunter-gatherer groups. Research specifically on the space inside Promontory Cave 1 results in a maximum population of around 38 people. I increase this to 50 in my calculations to provide a round number and to test theories that a microband of around 30-50 inhabited Cave 1 (Billinger and Ives 2015). Another common thread is the high percentage of children, around 50% of the population. These values will factor into my calculations, as they will be used to represent a typical and idealized hunter-gatherer population. I believe this form of ethnographic analogy is valid, as similar environmental and stochastic factors would be acting on hunter-gatherer groups throughout time. It is reasonable to assume, and necessary for my research, that these population proportions can be extended into the past.

Chapter 3: How, When, and Why Artifacts Enter the Archaeological Record

As mentioned earlier, the unique opportunity that Cave 1 presents due to the bounded space, precise chronology, and preservation allows for detailed research into artifact use-lives, discard rates, and accumulation. The following is an overview of the theories linking these factors. I explore how these variables are used in various formulae, along with other variables such as population size and occupation time. The methods and formulae described will be used to infer population size, occupation frequency, artifact use-life, and discard rates.

Formation Theory

Archaeological sites are formed through cultural and natural processes, and factors that create archaeological records are called formation processes (Schiffer 1975; 1987:7). The formation processes that create the archaeological record result in a distorted view of the past: using only artifacts and the location in which they were found, archaeologists try to recreate what past life was like. Formation processes can remove artifacts and material culture traces from the archaeological record, modify the original condition of an artifact, and distort the associations between artifacts by creating false relationships (Schiffer 1987:20). For example, artifacts that are always used together may not be discarded at the same time or in the same place; on the other hand, artifacts that are unrelated in function may be discarded in the same place (e.g., a midden) (Schiffer 1987:20).

Cultural processes that affect how artifacts are discarded include occurrence and time of breakage or depletion, rates of reuse and recycling, size, manufacturing cost, popularity, wealth or poverty of the owner, frugality, curation, amount of transportation, and the heirloom effect (Adams 2003; Schiffer 1987; Shott 1989; Surovell 2009). Artifacts may also be deposited due to chance; for example, losing an arrow during a hunt. Time lag is the period between the date of manufacture of an item and the date of discard (Adams 2003). Time lag can vary greatly with different types of artifacts, as the probability that an artifact will be abandoned after use depends on many things, including tool type and activity (Ammerman and Feldman 1974). Reuse and recycling keep artifacts in use when they otherwise may have been discarded (Schiffer 1987:28). Curation and the heirloom effect also keep artifacts in use for much longer than they may have been otherwise, because of sentimental or perceived value or the expense of replacement (Adams 2003; Schiffer 1987). Absence of an artifact at a site does not necessarily mean it was not used or it was not important; the absence could simply mean that the artifact was kept to be reused or recycled, or it had sentimental value (Binford 1976). Artifacts will be kept in circulation if the culture valued reusing materials instead of throwing them away (frugality effect). If the cost of manufacturing an item is high, those items may also be kept longer and used to their fullest extent (Shott 1989). On the other end of the spectrum, tools that are expediently made with material that is easy to come by, such as flake tools, may be manufactured and discarded within the same activity period (e.g., Sillitoe 1988).

Once the artifacts are discarded, various disturbances, both cultural and natural, can affect the continued formation of the archaeological record. Cultural disturbances include cleaning up of activity areas, or digging pits or middens. Cleaning of areas can be related to the size of the artifact; typically, larger artifacts will be moved and discarded elsewhere (secondary refuse), but microdebitage may be left in place (primary refuse) (Binford 1983:153; Schiffer 1987:267; Stevenson 1991). This size sorting has been noted at many archaeological sites and can be unintentional or intentional (Stevenson 1991). Horizontal displacement can result from foot traffic, by which large objects will be kicked around in high traffic areas until they reach an area of low use (Stevenson 1991:271). Trampling by people as well as animals can also affect both the vertical and horizontal placement of artifacts and has a tendency to affect smaller artifacts more than larger ones (Schiffer 1987:126; Stevenson 1991:272). Looser sediment will result in more movement of artifacts (Schiffer 1987:126), which can obscure associations and create a different view of how the artifacts were deposited. Intentional clearing can be expedient (unplanned), or systematic (planned, intensive, and typically scheduled). Systematic refuse clearing will produce secondary deposits on the edges of heavily occupied areas (Stevenson 1991:274-275). Another aspect of cultural disturbances of primary artifact positions are the actions of children, who are more likely to pick up and play with larger items than smaller ones, therefore affecting their final depositional location (Stevenson 1991:271). Children will also be more likely to transport and dispose of artifacts in areas less frequented by adults.

Non-cultural or natural processes that affect archaeological sites and artifacts include the effects of the weather, fauna, and bacteria. Sunlight promotes weathering, and the presence of water typically accelerates deterioration such as rotting (Schiffer 1987). Bacteria and fungi that accelerate deterioration or rotting need water and will not survive in very dry conditions. Cycles of hot and cold, wet and dry, and freeze and thaw conditions also promote weathering (Schiffer 1987:186). Conditions that are favourable for soil bacteria will promote decay of organic materials, but constant freezing, water submersion, and dryness can inhibit bacterial growth (Schiffer 1975:841). Other chemical reactions can also affect artifacts; for example, acidic conditions will destroy bone and other organics (Schiffer 1975:841). Animals can affect the archaeological record through actions such as trampling, digging, and burrowing.

Promontory Cave 1 exhibits nearly perfect natural conditions for delicate artifacts such as hide and plant material to survive. The protected cave environment ensures that there is little direct sunlight and little to no moisture. This protection prevents precipitation from entering the cave, and protects the deposits from extreme temperatures—keeping the cave cooler in the summer and warmer in the winter than the surrounding air. The sediment within Promontory Cave 1 is fairly loose, however, so trampling by people and animals has affected the location of artifacts.

The creation of an archaeological record occurs from the moment artifacts or refuse are deposited. From there, multiple processes act upon these artifacts and their surrounding sediments, sometimes changing their associations, until the site is excavated and the items begin a new cycle as archaeological artifacts. It is the archaeologist's job to study these artifacts and their depositional location to breathe life into these objects and learn more about the people who used them.

Use-Lives of Artifacts

The use-lives of artifacts are difficult to know, as there are many variables that will affect when and where an artifact will be deposited. Major factors that will affect the use-life of an artifact include the material it is made of, how it is used, and how often. These factors can vary greatly depending on the person or group in question. The time of year determines what activities will occur, and therefore when certain artifacts are more likely to be used. The use-life of an individual artifact will depend on the number of artifacts of that type that are available for use. For example, if a household has a number of cooking pots, they can rotate through them, meaning that each of these pots will last longer than if a household owned and used only the same one at a time (Varian and Potter 1997).

It is important to consider that for certain artifact classes, the time lag between manufacture and discard can be quite long. Thus, differences in artifact frequencies at a site could be misinterpreted as differing activities; however, different frequencies may actually be due to differences in use-life (Shott and Sillitoe 2004). This case is true for curated artifacts such as certain hide working tools (Pokotylo and Hanks 1989; Reilly 2015). We should not expect to find these tools often, even where they were used extensively (Reilly 2015). Binford's (1976) study of the Nunamiut Eskimos demonstrated that where an artifact is discarded is not necessarily where it was used. Archaeologists often use the presence or absence of a type of artifact to suggest site use; for example, the presence of scrapers and other hide working tools would suggest that hide working occurred. However, as Binford (1976) described, broken artifacts were often brought back home to be recycled or repaired. A site where hide working occurred may show no evidence of it if all the tools were kept to be reused or recycled. He described the Nunamiut technology as being organized curatorially and characterized by recycling (Binford 1976:338). Such factors influenced the population living at Promontory, where there is evidence that the cave occupants were frugal, keeping material and tools until they were no longer usable. This is particularly evident with the moccasins, many of which (73.1%) had patches or were otherwise worn out (Billinger and Ives 2015). The leather artifacts indicate a large amount of hide manufacturing occurred here, yet only small scraps of leather were left behind.

Another difficulty in studying the use-life of various artifacts in North America is that several forms of technology disappeared quickly with European contact, too early for ethnographers to record. Some studies, such as Osgood (1970) and Sillitoe (1988), do provide details of the material culture of a group of people that use a mixture of traditional and newer technology. Osgood's and Sillitoe's studies provide use-life data for some artifacts; relevant ones are listed in Table 9. In certain cases Osgood (1970) did not provide a distinct time period for the life of an artifact; rather, he describes an artifact as lasting a short or long time. Sillitoe (1988)

	Artifact	Use-life	Notes	Reference
Stone Tools	Stone skin rubber	Long time	Possibly akin to tabular scrapers?	Osgood 1970
	Ulu/Woman's knife (stone)	3 years		Osgood 1970
	Stone skin scraper	2 years	Even with high use	Osgood 1970
	Stone softener (tsētél) / tabular scraper	Decades/ Generations	Expediently made but highly curated; a woman would own 2-3, and may pass them down to daughter	Janes 1983; Pokotylo and Hanks 1989; Reilly 2015
	Stone scraper (obsidian)	Short	Two scrapers used per cow hide; resharpened every 15-20 strokes	Clark and Kurashina 1981
	Stone scraper (chert)	Long	Thousands of strokes before resharpening	Brink 1978
	Beamer	Decades	Curated for long periods of time	Janes 1983
	Stone axe	Decades	Stone lasts a lifetime; wooden handle only 4-5 years	Sillitoe 1988
	Chert knife	Discarded after use	Made off a flake—manufacture time is quick so no need to keep many around	Sillitoe 1988
Bone Tools	Bone awl	Short to long time	Depends on element used and size, and experience of maker; may be inherited	Osgood 1970
	Bone skin scraper	0.5 years	Corners break off; but older it is the stronger it becomes	Osgood 1970
	Bone flesher	Generations	Can be handed down	Reilly 2015
	Bone knife	1.5 years		Osgood 1970
Clothing	Parka (skin)	2 years	Varies with use and material	Osgood 1970
	Boots	Variable	Depends on activity; active man needs new soles twice in winter	Osgood 1970
	Moccasins	2-3 months	2-3 months normal wear and tear; 4-5 needed per day when tracking	McClennan 1975; Helm and Lurie 1961; Russell 1898
	Mittens	Long time		Osgood 1970
	Robe/blanket	Variable		Osgood 1970
	Rabbit skin robe	3 years		Osgood 1970
	Feathers	Years	Used for decoration on clothing/wigs/etc.	Sillitoe 1988
Miscellaneous	Bows	Long time		Osgood 1970
	Arrows	By chance	Can be lost when hunting	Osgood 1970
	Grass basket	1 year		Osgood 1970
	Grass mat	2 seasons	Made to sleep and sit on	Osgood 1970
	Needles (wood)	Years		Sillitoe 1988
	Borers	Discarded after use	Made from stone, bone, or wood	Sillitoe 1988

Table 9: Use-lives of artifact categories from a variety of ethnographic and other sources.

provided typical use-lives for every artifact he described, as well as the range of ages for the ones that were owned at the time of his study.

Working with individuals who still use traditional technology in modern times can also be very useful for estimating use-life. Women who still tan hides may use a combination of traditional and modern tools (e.g., Reilly 2015), giving us an idea of how these tools were used and deposited in the past. Experimental studies can also suggest how long an artifact can be used until it breaks or becomes unusable (e.g., Brink 1978; Clark and Kurashina 1981).

Systemic Number

The systemic number is the average number of artifacts of one type in use at a given time (Schiffer 1975; 1987). This number is related to the size of the population and the use-life of an artifact. The larger the population, the larger the number of artifacts. If an artifact's use-life is short and breakage occurs often, people may keep more available on hand, increasing the systemic number. This value comes into use in my analyses.

The previous discussion on hunter-gatherer populations and the possible number of people living in Cave 1 suggests an estimated population of around 25-50 people. As discussed earlier, the hunter-gatherer populations evaluated here have an average of 50% children, 25% men, and 25% women (Table 8). The proportion of men to women is important here because some tools were typically only used by one or the other sex. As well, older children and adolescents would have been participating in activities such as hunting and hide working and would be using the same tools. For example, Gwich'in Athabascan boys would be taken into the field to learn how to hunt beginning at age 10, which would result in them discarding the same tools as adult men (O'Brien 2011:21-22). As well, there may be elderly individuals that contribute less to the more rigorous activities such as hunting.

With the previous discussion in mind, I need to obtain the number of able individuals who would be contributing to regular artifact discard for the activities I focus on. This number becomes relevant when using the calculated total number of artifacts to estimate population size. So, in a population of 25, I suggest there are eight each of males and females who are able enough to contribute to artifact discard from hunting and hide working activities: the six or so adults, plus two older children. This leaves nine children too young to participate in these activities, though they would still be discarding artifacts used in learning and play. Thinking back to Hamilton et al.'s (2007) study, a family consists of 4-5 people, so a group of 25 would be about five families. This is consistent with the 6-7 each of men and women that make up the population, assuming that each family has a mother and father, and potentially older relatives living with them. So, within these five families, nine children are too young to participate, which is a reasonable number of small children. These numbers make sense if we assume an equal proportion in each five-year age group. If I split the "children" category into ages groups of 0-5 years, 6-11 years, and 12-17 years, each group should consist of 33% of the child population, assuming consistent birth rates and survival rates for the population[2]. Thirty-three percent of 12.5 is about 4 children; so, four children are old enough to be participating in daily subsistence and manufacturing activities (resulting in about 8 males and 8 females), while those remaining are too young. The 8-9 children that are too young would also be discarding artifacts (such as toys), but not to the same degree as older individuals, and young infants would not be discarding anything. These postulations assume an "idealized" population that has consistent proportions of

[2] Female infanticide has been noted in Dene societies (Helm 1980) but the large proportion of children's moccasins as well as the lack of adult male moccasins suggests this population had average or higher birth rates and survival rates (the proportion of adult males should increase when female infanticide occurs). For the purposes of this study, I assume consistent birth rates and high survival rates.

men, women, boys, and girls. Populations fluctuate, but these values provide average numbers that I can use in my calculations. For a population of 50, these values would be doubled. To summarize, in a population of 25 people, 16 (8 male, 8 female) individuals would be expected to contribute to regular artifact discard for hunting and hide working activities.

Systemic Numbers of Artifacts

For this research, I focus on a few key artifact types on which to perform my calculations. These include the tools associated with hide working and hunting, in which case we have a greater degree of control over the variables connected with artifact use and discard. Table 10 below lists how many artifacts individuals would use, based on ethnoarchaeological and ethnographic sources. These values will later inform on what the systemic number for the Promontory Cave 1 population would be, depending on the population value I calculate.

Tool	**Number per individual**		**Reference**
	Female	**Male**	
Hide-softening tools/tabular scrapers	2-3		Janes 1983, Reilly 2015
Beamers	1-2		Janes 1983
Scrapers (metal)	2		Reilly 2015
Fleshers	1-2		Reilly 2015
Knives (metal)	3		Reilly 2015
Arrow shafts		15 (at least)	O'Brien 2011
Bows		Several	O'Brien 2011

Table 10: The number of artifacts used by individuals according to ethnoarchaeological and ethnographic sources.

Accumulations Research

Accumulations research, as a subset of formation theory, examines the relationships among artifact discard, duration of occupation, and population size (Varian and Mills 1997:141). Although the formation of the archaeological record relies heavily on human agency and sometimes unpredictable factors, many scholars have attempted to create mathematical equations to study the discard and accumulation of artifacts (e.g., Schiffer 1975; Surovell 2009; Varian and Mills 1997; Varian and Potter 1997; Varian and Ortman 2005). These models generally use variables such as the length of occupation of a site, population size, the use life of an artifact, the number of artifacts in use at a given time, and how often an artifact type is discarded. Depending on the archaeological site in question, some of these variables may be known, but sometimes they must be estimated.

Varian and Mills' (1997:144) review of the literature on computer simulations based on accumulations research found that:

> "…variation in use-life can (1) produce variation in assemblage composition that might be erroneously attributed to different activities, (2) affect seriations in nonchronological ways, and (3) cause archaeological frequencies to differ from systemic frequencies."

Therefore, use-life is an important variable when studying the accumulation of artifacts; yet, as discussed above, use-life can be highly variable. The relationships among use-life, occupation span, and population are at the centre of accumulations research. The "Clarke Effect," as Schiffer (1987:55) labeled it, is the "statistical tendency for the variety of discarded artifacts to increase directly with a settlement's occupation span." This generalisation means that the longer a site is occupied, the more artifact types will be discarded. While the variables at question here can be very different for different groups of past peoples, mathematical models have been developed to study and understand the relationships among these variables.

Accumulations: The Math

Schiffer (1975) created a formula, now commonly referred to as the "discard equation," that solves for the total discard of a single artifact type:

$$T_D = St/L \qquad \text{(Equation 3.1)}$$

T_D = total number of artifacts discarded
S = systemic number (number of artifacts of that type in use)
t = length of time over which discard takes place
L = use life of that artifact type.

This equation is the most commonly used and is the most parsimonious of others that have been developed (Surovell 2009:63; Varian and Mills 1997:142, 158). The difficulty with this equation is that the systemic number and the use-life may have to be estimated for archaeological sites. Generally, these variables are estimated by using ethnographic examples, but Varian and Mills (1997) and Varian and Ortman (2005) argue that using direct archaeological cases is more accurate. Varian and Mills (1997:159) argue that it is difficult to choose an ethnographic study that matches an ancient case, since there is considerable variation between and among societies. There are also limiting assumptions to Schiffer's discard equation: reuse does not take place, use-life and systemic numbers remain constant, artifacts are not traded in and out, all use and discard takes place within the site, and the artifact type is a functionally homogeneous class (Schiffer 1987:55). Obviously, use-life and discard rates may vary year-to-year and person-to-person. Here, we must assume an average that is consistent through time in order to use this equation to better understand a site. I use this equation to calculation population size and also use-lives for select artifacts.

Surovell (2009:68) connects discard rates to the number of site occupants and the occupation span in the following formula:

$$d = prt \qquad \text{(Equation 3.2)}$$

d = total number of discard artifacts
p = number of site occupants
r = per capita discard rate
t = occupation span

This equation assumes that the discard rate and group membership remains constant. Reworking this formula to solve for the number of site occupants applies to my present research ($p = d/rt$). I also use this equation to obtain discard rates for select artifacts. Surovell (2009:69) also describes a formula for occupied site area:

$$s_o = pa \quad \text{(Equation 3.3)}$$

s_o = occupied site area
p = number of site occupants
a = per capita space requirements

He combines the above two formulae into one that calculates artifact density (Surovell 2009:69):

$$d/s_o = prt/pa = rt/a \quad \text{(Equation 3.4)}$$

Therefore, artifact density is dependent on occupation span and discard rate divided by the per capita requirement for space (Surovell 2009:70).

It is important to make a distinction between total accumulation, which is the total amount of discarded material that survives in the archaeological record, and total discard, which is everything that was discarded in the past (Varian and Mills 1997). At sites that do not preserve organic materials, the total accumulation and total discard can be extremely different. At sites like Promontory Cave 1 that exemplify ideal preservation, these values are much more similar. The equations and methods described above aim to create models for estimating variables such as occupation time and population. A common thread is the presence of assumptions that must be met for these models to work perfectly, assumptions that are not typically met with real world archaeological examples. However, these models provide a beginning point for studying site occupation and accumulation, and Promontory Cave 1 has exceptional characteristics for accumulation studies.

Non-Perishable versus Perishable Artifacts

One of the most difficult aspects of archaeological research is the fact that the majority of the record is lost to taphonomic and other destructive processes. The archaeological record that survives for archaeologists to excavate is merely a portion of the material culture used by past peoples. The Promontory Caves defy this typical pattern. Because of the dry nature of the cave environment, organic material has survived. While at most sites only durable materials such as stone and bone remain, perishable organic materials such as leather and wood have lasted in the Promontory Caves. A key aspect to my research is to better understand the ratio between non-perishable and perishable materials. This is a unique opportunity to examine an arguably nearly complete record of material culture left behind by a group of people.

Perishable artifacts are organic artifacts made from materials such as wood and plants that typically do not survive in the archaeological record, unless they are protected from the outside environment. Non-perishable artifacts are made of durable materials such as stone that endure the archaeological record and do not break down in typical environmental conditions. Non-perishable artifacts can still be destroyed in certain circumstances; for example, stone headstones weather and break down in acid rain, and metal tools may eventually corrode and rust in the right environment (Drooker 2001:5). Perishable materials, when they survive, can provide a plethora of information. Drooker (2001:5) noted that past lives of people have been reconstructed "almost entirely on the basis of their stone tools," which leaves so much out of the equation. Perishable artifacts made of plant and animal materials were also important not only in social identity, but could also have spiritual connections as well (Hastorf 2001).

Ethnographic studies demonstrate that perishable and organic materials by far dominated the everyday material culture in hunter-gatherer societies. Osgood's (1970) account of Ingalik material culture and Sillitoe's (1988) catalogue of the artifacts of the Wola people in Papua New Guinea are prime examples of this reality. Approximately 80-85% of the artifacts Osgood (1970) described were made of material that would typically disappear in the archaeological record. A further 5-10% were made of bone or antler: material that occasionally survives, but not always. Only about 10% of the material was made of stone, metal, or fired clay—materials that will survive. Sillitoe (1988) provides similar numbers: 85% of the objects described were made from plant or animal material that would not survive; 13% were bone and shell that may survive in the right conditions, and only 3% were made of stone and would last in the archaeological record. These percentages for both Osgood (1970) and Sillitoe (1988) would hold if there is only one of each artifact type, which obviously would not be the case. Regardless, if the artifacts Osgood (1970) and Sillitoe (1988) described were abandoned to the archaeological record and excavated hundreds of year later, only a very small portion of the material culture would be left for study. This results in a pinpoint view of the past.

The permafrost of northern Canada can also provide better than average preservation for archaeological sites. The Rat Indian Creek site in Yukon yielded bark and wood along with bone, antler, and stone (LeBlanc 1984). Lithics by far dominated the assemblage (around 90%), but most of these were pieces of debitage and non-formed tools. Bone and antler artifacts made up approximately 4%, bark 5%, and wood under 1% of the total archaeological assemblage. Even with the better preservation conditions at this site, materials such as leather or hide did not preserve. These materials would compose a substantial portion of people's material culture in the form of clothing and footwear, especially in the Arctic. The thousands of pieces of lithic debitage also skew these ratios. Taking the debitage out of the calculations and using only formed tools creates a situation that is more comparable to the ethnographic studies: bone and antler 21%, bark 27%, wood <1%, and stone tools 51%.

Robbins (1973) conducted ethnographic research from an archaeological perspective (ethnoarchaeology) on the Turkana in Kenya, purposefully identifying household artifacts and their proportions. He observed that 63% of the items were perishable, but this percentage increased to 82% if objects that have both perishable and non-perishable components are included (Robbins 1973:211). This value is very similar to those mentioned above.

Hogup Cave is located in Utah, in the Great Salt Lake desert, west of Great Salt Lake (Aikens 1970:1). This cave is smaller than Promontory Cave 1, but was excavated to a greater extent and contained deeper deposits. The oldest stratum (Stratum 1) was dated to 8350 ± 160 RCYBP, and the youngest (Stratum 16) to 480 ± 80 RCYBP (Aikens 1970:28-29). Hogup Cave was used over a much longer period of time than Promontory Cave 1, and it too provided a protected environment for artifacts, resulting in similar preservation or organics such as basketry, netting, wooden artifacts, and more. Including all artifacts and debitage, the breakdown is as follows: 27% bone, 39% lithics, 3% ceramics, 26% wood and plant material, 5% hide. Removing the debitage and unworked bone results in the following changes to the proportions: 4% bone, 29% stone tools, 6% ceramics, 51% wood and plant material, and 10% hide. The non-perishable artifacts account for 61% of the material found, not including lithic debitage and unworked bone.

Ozette, on the Olympic peninsula of Washington, is likely the most famous Northwest Coast site because of its incredible preservation and the artifacts that were found there. Three houses were covered by a mudslide, creating an anaerobic environment that allowed wood and fibre artifacts to preserve. This site was occupied over a thousand years and so artifacts were numerous; most of the perishable artifacts were found from more recent occupations of the three main houses, one of which appeared to have been continuously occupied over one hundred years (Kirk 2015:29). Over 40 000 structural remains and 55 000 whole artifacts and fragments were recovered from the preserved 18th century houses (Kirk and Daugherty 2007:106). Here there were 95% perishable materials and 5% lithics (Croes 1995:80). Having all of these artifacts frozen in time and in place due to an instantaneous mudslide allows for study into activity areas and relationships between areas within and between the houses.

The Hoko River site (45CA213) also in Washington is a wet site that preserved organic materials due to submersion under water (Croes 1995). Two portions of the site were excavated, a wet site and a dry site. The dry site contained only lithic artifacts, and the wet site contained more diverse artifacts such as basketry, cordage, fishhooks, woodworking tools, and more perishable materials. Croes (1995:79) calculated that 96% of the artifacts from the wet site were perishable, leaving only 4% made of stone.

The above accounts suggest that perishable materials can comprise 60-95% of material culture, and these data are summarized in Table 11. The Northwest Coast sites have the highest percentages, around 95%. This high figure could be due to differences in how artifacts are quantified, but also because of the location of the sites. Woodworking was a large aspect of life on the Northwest Coast; people were more sedentary and built houses, boxes, and other items with wood. This situation differs from sites in other areas of western North America, where people were not as sedentary, and wood was not available in great quantities. The ethnographic accounts by Osgood (1970) and Sillitoe (1988) have the next highest percentages, all of which

Site/Group	**Non-perishable**	**Occasionally**	**Perishable**	**Reference**
Ingalik, Alaska	10%	5-10%	80-85%	Osgood (1970)
Rat Indian Creek, Yukon	51%	21%	28%	LeBlanc (1984)
Hogup Cave, Utah	35%	4%	61%	Aikens (1970)
Hoko River, Washington	4%	*	96%	Croes (1995)
Ozette, Washington	5%	*	95%	Croes (1995)
Wola, Papua New Guinea	3%	13%	85%	Sillitoe (1988)
Turkana, Kenya	18%	*	82%	Robbins (1973)

Table 11: Percent of perishable and non-perishable artifacts from sources described above (with lithic debitage, ceramics, and unworked faunal bone removed if applicable). *Sites where bone was included in the non-perishable category and not calculated independently.

fall between 80 and 85%. Osgood's (1970) and Sillitoe's (1988) data is also different from the others in that they are percentages based on one of each item being present as these authors did not record proportions of artifacts. Regardless, it is evident that the normal case is to have a large percentage of perishable materials in use.

When archaeological sites exhibit excellent preservation, many more studies can be completed; for example, at Ozette, archaeologists can better understand technology and "material culture, economic orientation, and relationships between social and economic forces acting in this village" (Samuels and Daugherty 1991:24). Being able to study the complete range of technologies used at a site opens up so many more avenues for research. Many artifacts that are used in daily life, such as basketry, projectile shafts, and other tools, are made of wood and plant material. Studying these where they do preserve, such as in very wet and very dry sites, can provide information on how people procured food, how they stored it, and whom they traded with (Croes 2001).

We cannot assume that just because an artifact is made of something sturdy and lasting that it will therefore be used longer. The Wola people would discard stone flake knives after one use because they were easy to make and not worth keeping; yet artifacts made of wood and plant material could last decades with proper care (Sillitoe 1988). Sillitoe's (1988) study showcases that it is the type of artifact, not just the material, which determines the use-life of an artifact and therefore how often items will enter the archaeological record.

What an artifact is made of and where it is deposited will determine how long it survives in the archaeological record. However, the type of artifact will affect its use-life, sometimes to a greater extent than the material it is made of. This relationship is variable between groups and leads to difficulties when estimating use-life and other variables for the equations described above. As mentioned previously, the mathematical models developed for accumulations research are a good starting point to study these variables, but it is important to acknowledge that past populations were variable and different from the ethnographic present

Chapter 4: Methodology

The following chapter describes the various methods used to determine the density of artifacts excavated from Cave 1, and the calculations in which these values were used. I also describe how I calculate the ratio of non-perishable to perishable artifacts; how I use statistical analysis to compare the livable areas; and the accumulation equations used to estimate population, discard rates, and use-lives.

Counts of Artifacts

Obtaining the counts for various artifact classes is straightforward in some cases but difficult in others. One of the challenges is the large amount of material that was recovered. Artifacts that we rarely see are preserved in this cave environment, and some unusual artifacts were collected for which we are uncertain as to their purpose. Another issue is the presence of fragments. The cave occupants appear to have been quite frugal; much of what was left behind was broken, worn out, or unusable. In many cases we are left with fragments of artifacts, such as portions of moccasins, broken arrow shafts, and mat fragments. Fragments were typically counted as representing one artifact. Billinger and Ives (2015) examined the moccasins from Cave 1 and were not able to identify possible pairs. Having personally examined the artifacts, in most cases I do not believe there are many unidentified refits of the larger artifacts such as stone tools, mat fragments, or bone tools within the assemblage. Refits likely exist for the lithic debitage and ceramic sherds, but these are unlikely to affect the total numbers to a great degree.

While I have made calculations for all the artifacts found in Cave 1, I have chosen to focus on certain tools used in hunting and hide working. These artifacts were chosen because of their potential to inform us about population size and demographics, as well as their suitability for accumulations research. Other categories such as pieces of hide/leather and fur/hair, are not countable. Some artifacts have unknown purposes, such as certain pieces of worked wood and plant material; these I have grouped together in categories such as “worked botanicals.” These categories are more applicable in my analysis of non-perishable versus perishable artifacts.

The majority of this raw count data was collected personally in May and June of 2014, with supplemental data collected in May 2015. This task was executed by going through all the boxes and bags of artifacts collected during all recent excavation seasons, and keeping a record and count of what was found. Data collected by others are noted where applicable. Small discrepancies may arise because some of the recent material had not been catalogued at the time I counted, or occasionally artifacts would be found in the wrong category (e.g., faunal bone being found within a lithics bag). These minor discrepancies aside, my counts should reflect very closely the final counts for all material recovered by the modern excavations to date.

Volume of Excavated Material

The volume in cubic metres was calculated for every unit excavated. F3 presented a challenge for calculating volume because this unit’s walls sloped inwards drastically, producing an irregular shape. This was remedied by using the rendering program AutoCAD. Three-point proveniences were taken down the corners of F3, and these were entered into AutoCAD. By connecting these points and creating a 3D solid that replicated the shape of F3 within this program, AutoCAD was then able to calculate the volume of this shape.

The volume of F28 was calculated by hand because its walls were very straight and the profile provided accurate measurements. The unit was broken into two sections, one a rectangular prism, and the other a triangular prism. The volume was calculated by using the geometric formulae for these two shapes:

$$V_{F28} = (\text{length x width x height})_{\text{rectangle}} + \frac{(\text{length})(\text{width})(\text{height})_{\text{triangle}}}{2} \qquad \text{(Equation 4.1)}$$

F15 is the small test trench north of F3. Excavation here was loosely controlled, and began as a 0.40 m x 0.60 m unit. The walls sloped inwards and the bottom was 0.25 m x 0.30 m. This unit was excavated to only 0.50 m below surface then abandoned. To calculate the volume, I used the formula for a truncated rectangular pyramid (a pyramid without a tip):

$$V_{F15} = (1/6)(\text{height})[\,(a \times b) + (a+c) \times (b+d) + (c \times d)\,] \qquad \text{(Equation 4.2)}$$

a/b = top edges
c/d = bottom edges

The volume for F55 was calculated using ArcGIS. After completing excavation of F55, total station points (with northing, easting, and depth) were taken along the edges and throughout the bottom surface of this trench. A TIN (triangular irregular network) was made using these total station points within ArcScene. A TIN is a vector-based representation of a surface and is created by triangulating a set of three-dimensional points to create a surface. The TIN generated using the total station points is a 3D representation that closely resembles the excavated trench. A TIN was also produced using only the top points of F55 that were taken around the outline of the units; this created a plane over F55 that roughly represents the pre-excavation surface. ArcGIS's "Surface Difference" tool was then used to calculate the volume. The Surface Difference tool calculates the displacement between two surfaces, in this case the two TIN surfaces. This tool allows for an accurate calculation of the volume of this trench.

Volume of Deposits

Calculating the depth of deposits makes for somewhat of a conundrum. Steward (1937) consistently described about 24 inches (0.6 m) of Promontory material throughout his excavations in Areas A and B; in F3, however, Promontory Culture deposits extend 1.9 m in depth. As discussed previously, it appears that F3 was originally a depression that may have seen subsequent use as a midden, in which material was brushed aside or thrown to clean the central hearth area. This usage could be a factor in what is seen in Area A, and I made a volume calculation that takes this depth into account.

The volume of deposits was calculated for both Area A and B. Multiple volumes were calculated to cover a range of scenarios for the depth of deposits. Volume was calculated using ArcScene. Total station points were taken over the two living areas within the cave during the 2014 field season to obtain slope. These livable areas were determined using observations in the cave, as well as Steward's map of cultural deposits (Figure 5; Steward 1937: Figure 1). Steward's excavation areas are generally visible when these points are plotted in ArcScene. To obtain a more accurate representation of the pre-excavation surface, the points within Steward's basins were lifted to match the surrounding points, in both Areas A and B. This created a flatter surface that would better reflect the pre-excavation (i.e., pre-1930) surface. A TIN was then created using these points, and this became the "top" surface. The depths of the points were then edited to portray various maximum depths and a TIN created based on these points; this became the "bottom" surface. ArcScene's "Surface Difference" tool calculated the volume between these two surfaces (described in more detail above; see Figure 23 and Figure 24).

In Area B, I first lifted Steward's Trench B to match the surrounding area. Then two volumes were calculated. First, a uniform depth of 0.6 m was used over the entire area, to match Steward's observations. Second, a more basin-shaped volume was calculated. The middle points were dropped 0.6 m, the intermediate points 0.35 m, and the edge points 0.1 m. This procedure gives two potential volumes that likely encompass the true volume.

Area A is less uniform and more difficult to calculate. Steward observed 24 inches of Promontory material, yet in F3 the Promontory material extends to 1.9 m. Looking at the radiocarbon dates plotted against the F3 profile, it is evident that a section of dates is not in chronological order (Group E2). I propose a scenario in which the front area of the cave, where F3 was placed, was once a structural depression in the cave floor. At some time, or times, material was cleared into the F3 area, filling it with artifacts of different ages. Therefore, I calculated one volume using F3's depths for the front portion of Area A and Steward's observations for the remainder. The data points at the front around F3 were dropped by 1.9 m, the edge points were dropped 0.2 m, and the remainder were dropped 0.6 m. A few points around F3 were dropped 1.25 m so there was more of a gradual change from the deep F3 area to the rest of Area A. A volume was also calculated using a uniform depth of 0.6 m for comparison.

Density Calculations

Artifact densities were calculated using the total number collected, divided by the volume of excavated material:

Density = number of artifacts excavated / volume of excavated material (Equation 4.3)

Densities were calculated several ways using the various units. Densities were calculated per individual unit in order to compare the different units and livable areas. A density was also calculated using all the units together to obtain the density of the cave as a whole. Densities are presented as N artifacts per cubic metre.

Proportional Calculations

The densities were used to estimate the potential total number of artifacts present in Cave 1. This calculation was executed by multiplying the density of an artifact type by the total volume of deposits.

Total artifacts present = density(volume of deposits) (Equation 4.4)

Here I did multiple variations of this calculation. I calculated the total number of artifacts using the overall density for the whole cave, but also made calculations by specific area. The densities for each of the main intact units, F3, F15, and F28, were used to calculate the total number of artifacts in each area separately. Provided that F3 may represent a midden area and is inconsistent with the shallower depth of cultural deposits Steward (1937) encountered, I also did a calculation using F28 to represent the whole cave, leaving aside the densities from F3. By doing a variety of calculations I can examine these results and use Steward's (1937) and our own observations and collections to determine which result is most likely. Not knowing exactly how much Steward excavated adds difficulty to this comparison. The artifact collection from his expedition is quite large, but the exact volume of material he excavated is unknown.

Ratio of Non-perishable versus Perishable Material

Using the results from the counts of artifacts and the proportional calculations, I compare the number of perishable artifacts to the number of non-perishable artifacts. These results provide a comparison for other archaeological sites where organic material is not preserved. I will also compare Promontory Cave 1 to other sites with excellent preservation and to ethnographic accounts that provide the numbers and types of artifacts people used. These results will highlight the vast amount of material that is usually missing from the majority of archaeological sites, and provide a point of comparison for more typical archaeological sites from which we can estimate what else may have been present when a site was abandoned.

For this ratio, I did three calculations, each time removing certain artifacts that overpowered the rest or did not qualify as a formed artifact. I first removed the unworked faunal bone category, as the over 30 000 pieces of bone completely obscures all other artifacts. I then removed categories like fur and hair and unworked scraps of hide that do not qualify as formed or worked tools, and are not easily quantified. Lithic debitage was also removed because it is a form of waste and not a tool. The quantity of debitage can also vary greatly depending on the activity. Flintknapping a tool from an unworked core to a formed tool will produce more debitage than retipping a projectile point. I felt that the number of pieces of debitage does not adequately contribute to the ratio of non-perishable to perishable materials because of this large degree of variation; as well, I believe it is more accurate to compare ratios of formed tools as opposed to by-products. Ceramics were also not included in the last calculation because these represent pieces of a larger artifact. One pot can be broken into hundreds of pieces, skewing the ratio much like lithic debitage would. The artifact categories that were used in the calculation of the ratio were those that represented formed or worked individual tools.

Statistical Comparison

In order to identify possible differences among the areas of Cave 1, I compared F3 and F28 by calculating Shannon-Wiener and Simpson's diversity indices along with Chi-squared tests to determine if there is a statistical difference in the artifacts deposited in each area. This will indicate whether different artifacts were being deposited in each of the areas, and therefore whether the areas were being used differently. Johansson (2013) previously used diversity indices to compare the faunal remains from Promontory sites.

The chi-squared statistic is used to compare counts of different samples. It measures how far the observed values deviate from the expected values (Drennan 1996:187-188). Essentially, this statistic determines whether the variation in the samples represents the real variation in the populations, or variation due to sampling. The equation is as follows:

$$X^2 = \Sigma\frac{(O-E)^2}{E} \qquad \text{(Equation 4.5)}$$

O = the observed value
E = the expected value

This equation results in a number that must then be compared to a chi-squared distribution table to find the probability that the samples are different due to chance sampling (Drennan 1996:189). To use this equation, there cannot be any cell values under five. I combined some categories and eliminated categories with few artifacts to ensure that each value has a sufficient enough quantity to perform this test.

Diversity indices are a way to statistically measure the richness (number of categories) and evenness (diversity of samples based on how each category is represented) of a sample. A sample in which the categories are evenly distributed is more diverse than a sample in which a few categories are well represented and some are poorly represented (Baxter 2003:237). The value for a diversity index increases when the number of categories increases, or when evenness increases.

The Shannon-Wiener diversity index quantifies the uncertainty of predicting what artifact type could be chosen at random (Rindos 1989); i.e., when there is only one type, it equals zero and there is no uncertainty. The more categories there are, the more uncertainty there is in predicting what artifact would be chosen. The higher the value of the Shannon-Wiener index, the more diverse a sample is. The equation is as follows:

$$H' = -\Sigma p_i \ln(p_i) \quad \text{(Equation 4.6)}$$

H' = Shannon-Wiener index
p_i = proportion of artifacts in the i^{th} category.

Simpson's diversity index is an index of concentration; concentration refers to the likelihood that two randomly chosen artifacts are from the same category. The formula is:

$$D = 1-\Sigma p_i^2 \quad \text{(Equation 4.7)}$$

D = Simpson's diversity index
p_i = proportion of artifacts in the i^{th} category.

This equation produces a number between 0 and 1, in which the higher the value, the higher the diversity in the sample.

Criticisms for these diversity indices include their dependence on the most abundant category (Baxter 2003:237). As well, sample size is always an issue for statistical analysis. The more someone excavates a site, the more artifacts they are likely to find. As well, since archaeologists excavate only a portion of the site, how much is enough to represent the entire site? Despite such limitations, these indices remain valuable tools to examine samples in archaeology.

Accumulation Rates

To study the accumulation rates of the various types of artifacts present in Cave 1, I use multiple methods. First, I simply divided the total projected numbers of artifacts by the occupation span of 20 or 40 years in order to provide a crude initial look at artifact discard. Then I used finer methods that include Schiffer's (1975) formula and Surovell's (2009) equation. These equations are explained in the previous chapter. These equations will be solved in various ways with the variables I have available (e.g., occupation span), as well as with estimates for the variables I do not know (e.g., systemic number). Estimations for use-life and systemic numbers will be derived from ethnographic and experimental sources (see Table 9 and Table 10). Ethnographic analogy is used here to obtain information about artifact usage. I argue that this is an acceptable form of ethnographic analogy because hide working artifacts, such as scrapers and fleshers, along with hunting artifacts, such as arrowheads, were likely used much the same way in the past as they were and are in the ethnographic present. There are only so many ways to manufacture a stone scraper or a bone flesher, and these artifacts would therefore be worn down and discarded in similar fashions past and present. Using the above formulae will allow a comparison among them to better understand the accumulation rates of artifacts within Cave 1, as well as provide insights into population and discard rates.

Chapter 5: Results

Volume of Excavated Material

Using the various methods described previously, the volume of excavated material was calculated for each unit. These results are shown in Table 12. Figure 22 shows the two TINs made to calculate the volume of F55. This method was possible for this unit and not the others because total station points with x, y, and z data were taken throughout the unit after excavation was complete. These TINs therefore resemble fairly accurately what the unit looked like.

Unit	Volume (m^3)
F3	1.66
F28	0.29
F15	0.075
F55	1.69
Total	**3.76**

Table 12: Volume of excavated material from Promontory Cave 1.

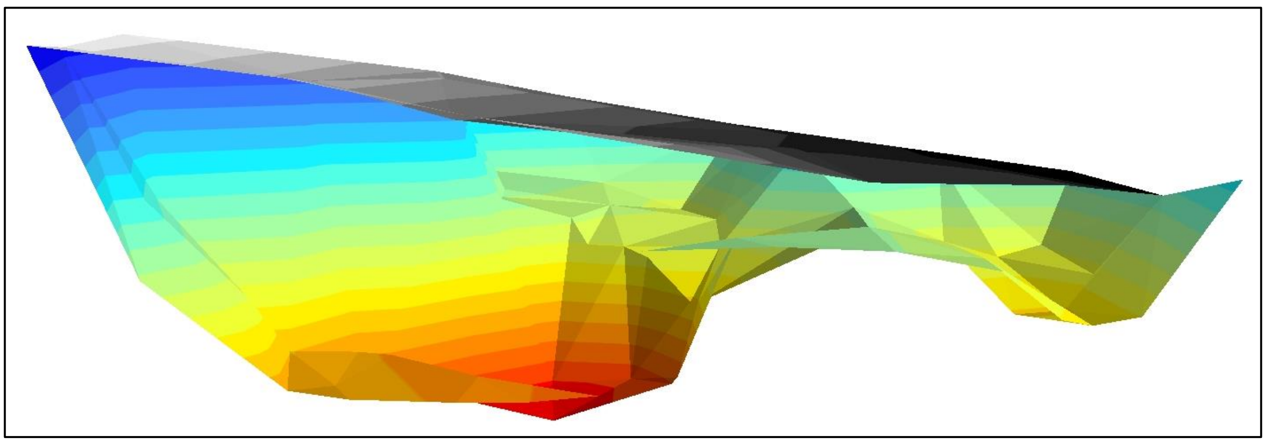

Figure 22: Top and bottom TINs for F55. The top TIN is shown in grey gradient, the bottom in rainbow (red is deeper). View is looking approximately southwest. The deep red portion is Steward's Trench A.

Volume of Cave Deposits

Determining how to calculate the volume of the cave deposits was difficult, as it is unknown how the cave bedrock is shaped, and how much looting and previous excavations affected the current surface. Any calculation will be an estimate; I used all the information available to make educated and reasonable estimates for how deep cave deposits are, including

Steward's (1937) observations, my personal observations, and the observations and notes taken by other members of the excavation team. The estimated ranges calculated are listed in Table 13. By using two volume values for each area, I can be more certain that the true volume lies somewhere within my range of results. The basin calculations are both smaller than the uniform depth because the depths near the edges were decreased to represent more of a bowl-shaped deposit. Figure 23 and Figure 24 show the different calculations used; Figure 23 shows the uniform 0.6 m depth in Area B, and Figure 24 shows the basin shape used in Area A.

Area	Livable Area (m^2)	Volume 1: uniform depth of 0.6 m (m^3)	Volume 2: basin (m^3)
A	163	106.63	99.97
B	76	47.51	24.80
Total	239	154.14	124.77

Table 13: The multiple volumes calculated for the excavated material of Promontory Cave 1.

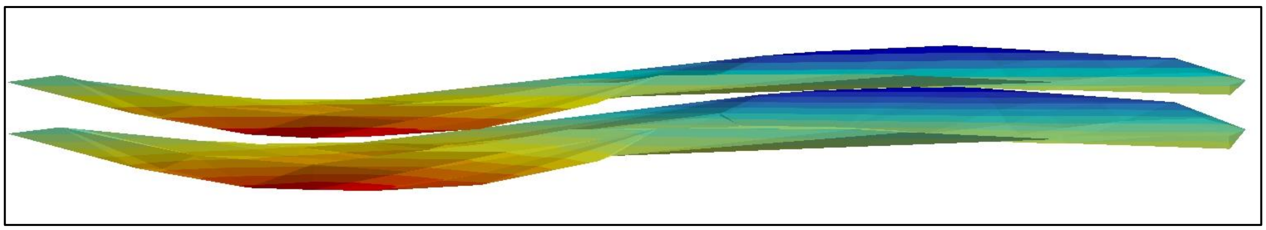

Figure 23: The top and bottom TINs for Area B, looking west. Here the bottom TIN was dropped 0.6 m. ArcGIS's "Surface Difference" tool calculated the difference (volume) between these two surfaces.

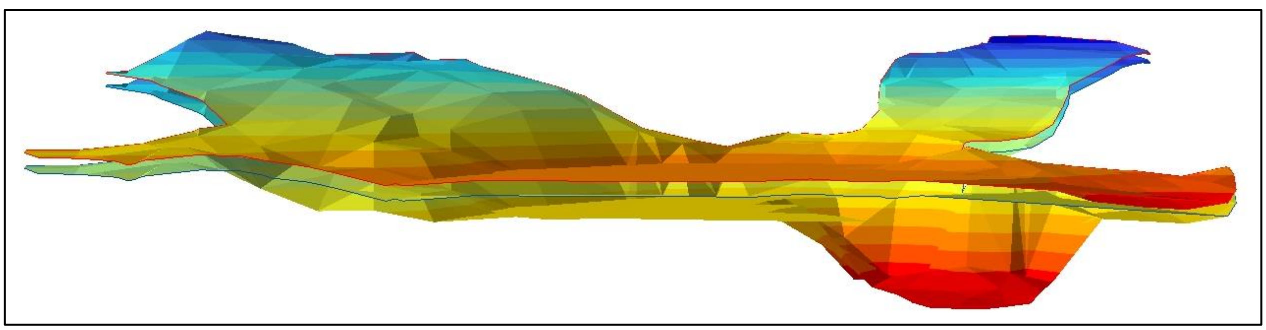

Figure 24: Top and bottom TINs for Area A for the basin calculation, looking approximately northeast. Here the area around F3 was dropped 1.9 m. Red represents deeper areas.

The volume of material we have excavated equates to a very small percentage of the total cave fill. We excavated a total of 2.03 m^3 of intact material, not including F55. This amount equates to an estimated 1.3% and 1.6% of the cave deposits. While this is a small sample from the site, it is important to recall that these excavations resulted in the recovery of tens of thousands of artifacts, and that Steward collected similar types of artifacts from within his larger excavation areas. It is not common that archaeologists know the exact boundaries of a site, so the ability to calculate with reasonable certainty the percentage excavated is a huge asset to my research.

Counts and Densities of Artifacts

The counts of all artifact classes recovered during the recent excavations from Promontory Cave 1 are listed below in Table 14. These are organized by broad category and then listed alphabetically. F3 contained most of the artifacts, as would be expected for the largest intact excavation unit. The excavated volume of F55 is slightly larger than F3; however, these were loose deposits that were not in situ. Though these loose deposits were artifact-rich, we recovered fewer artifacts. By far the most abundant artifact collected in terms of frequency is faunal bone. Other organic materials, such as scraps of leather and hide as well as artifacts made of plant material, are also common. A simple overview of Table 14 demonstrates the incredible quantity of perishable materials. Many of the artifact categories listed would never be found in a typical open-air archaeological site. At many sites, only the first category, lithics, would remain after the taphonomic processes occurred, representing a remarkably small portion of the assemblage. Densities cannot be calculated for some of the artifact classes listed in Table 14 because they were found only on the surface. Many of the artifact classes cannot be used for the proportional calculations because they were again found only on the surface or in F55. I calculated densities for F55 as a comparison for the other units, but I feel that using it for proportional calculations would not be accurate as the artifacts were not in situ and the deposits were much looser than the intact units.

Category	Artifact	Count					
		F3	F28	F55	F15	F5	Total
Lithics	Bifaces	20	0	5	0	0	25
	Cores	3	0	0	0	0	3
	Debitage	1406	28	392	20	2	1848
	Drills/Gravers	0	0	1	0	1	2
	FCR	0	1	0	0	0	1
	Utilised Flakes	132	3	34	2	1	172
	Hammerstones	1	0	1	0	0	2
	Incised Stone	0	0	1	0	1	2
	Projectile points	41	1	16	2	3	63
	Scrapers	5	0	2	1	0	8
	Slate knives	2	0	3	0	0	5
	Tabular bifaces	2	0	0	0	0	2
	Unifaces	0	0	0	0	1	1
Bone tools	Awls	2	0	1	0	0	3
	Beamers	2	0	0	0	0	2
	Fleshers	5	0	2	0	0	7
	Polished bone[3]	9	0	4	0	0	13
Gaming	Bone pieces	3	0	0	0	0	3
	Cane dice	86	6	59	1	1	153
	Wood pieces	1	0	0	0	2	3
Clothing	Moccasins	35	2	15	1	2	55
Decoration	Beads	18	0	6	0	1	25
	Quills	48	6	5	0	0	59
Hunting	Arrow shafts	28	3	13	0	2	46
	Feather shafts	1	0	10	0	0	11
Textiles	Basketry	1	1	0	0	0	2
	Cordage	111	7	21	5	0	144
	Mat fragments	8	0	1	0	0	9
Miscellaneous	Ceramic sherds[4]	431	24	156	2	21	634
	Pieces of hide/leather	850+	85	316+	3	6	1260+
	Worked botanicals[5]	189	3	441	0	2	635
	Faunal bone[6]	24597	1386	4227	102	4	30330+
	Fur/hair (bags of)	91	12	8	2	0	113

Table 14: Counts of artifacts from the excavation units (F3, F28, F55, and F15) and the surface (F5) in Promontory Cave 1. Plus symbols indicate categories in which artifacts were difficult to quantify, or counts had not been finalised at time of writing.

[3] This category is for bone artifacts that cannot be identified as distinct tools such as fleshers or beamers, but are polished and likely used for hide working.
[4] Ceramic data courtesy of Gabriel Yanicki.
[5] This category included worked wood, bark, and reed/cane that has been worked in some way but is not identifiable as a distinct artifact type.
[6] 12 pieces had no provenience data.

The densities per cubic metre of all these artifact classes are listed in Table 15. I rounded the densities to the nearest whole number, though I used the non-rounded result for the proportional calculations. It is evident that F28 contained fewer artifact types and is much less dense than F3. F15 is located very close to F3 and should therefore exhibit similar densities. This is the case for some artifact classes such as projectile points and cordage. There were fewer artifact classes found in F15, likely because of the small sample size of excavated material, and the fact that material was not all screened. F55 is in between F3 and F28 in its densities. F55 is high in densities of small artifacts that Steward and his team could have easily missed because they were not screening, but it also includes artifacts such as moccasins that he would not have left behind. The fill of F55 may represent some backfill, but more likely material that fell into the trench.

To get as accurate a number as possible, I combined F3 and F15 to provide a density that represents Area A (Table 16). F28 is the only modern unit excavated in Area B, so it represents the density in that area. Examining these densities, it is obvious that the two areas are different. Many of the artifact classes that were found in F3 were not found in F28. This difference could be due to the smaller amount excavated, but also due to differences in area use.

Category	Artifact	Density (per m³)			
		F3	F28	F55	F15
Lithics	Bifaces	12	0	3	0
	Cores	2	0	0	0
	Debitage	847	96	232	267
	Drills/Gravers	0	0	1	0
	FCR	0	3	0	0
	Utilised Flakes	80	10	20	27
	Hammerstones	1	0	1	0
	Incised Stone	0	0	1	0
	Projectile points	25	3	9	27
	Scrapers	3	0	1	13
	Slate knives	1	0	2	0
	Tabular bifaces	1	0	0	0
	Unifaces	0	0	0	0
Bone tools	Awls	1	0	1	0
	Beamers	1	0	0	0
	Fleshers	3	0	1	0
	Polished bone	5	0	2	0
Gaming	Bone pieces	2	0	0	0
	Cane dice	52	21	35	13
	Wood pieces	1	0	0	0
Clothing	Moccasins	21	7	9	13
Decoration	Beads	11	0	4	0
	Quills	29	21	3	0
Hunting	Arrow shafts	17	10	8	0
	Feather shafts	1	0	6	0
Textiles	Basketry	1	3	0	0
	Cordage	67	24	12	67
	Mat fragments	5	0	1	0
Miscellaneous	Ceramic sherds	260	82	92	27
	Worked botanicals	114	10	261	0
	Faunal Bone	14817	4738	2504	1360

Table 15: Densities per cubic metre of artifacts excavated from Promontory Cave 1, rounded to the nearest whole number.

Category	Artifact	Density (per m³)		
		Area A	Area B	Entire Cave
Lithics	Bifaces	12	0	7
	Cores	2	0	1
	Debitage	822	96	497
	Drills/Gravers	0	3	1
	FCR	0	3	0
	Utilised Flakes	77	10	46
	Hammerstones	1	0	1
	Incised Stone	0	0	1
	Projectile points	25	3	17
	Scrapers	3	0	2
	Slate knives	1	0	1
	Tabular bifaces	1	0	1
	Unifaces	0	0	0
Bone tools	Awls	1	0	1
	Beamers	1	0	1
	Fleshers	3	0	2
	Polished bone	5	0	3
Gaming	Bone pieces	2	0	1
	Cane dice	50	20	41
	Wood pieces	1	0	1
Clothing	Moccasins	21	3	15
Decoration	Beads	10	0	7
	Quills	28	21	16
Hunting	Arrow shafts	16	10	12
	Feather shafts	1	0	3
Textiles	Basketry	1	3	1
	Cordage	67	24	39
	Mat fragments	5	0	2
Miscellaneous	Ceramic sherds	250	82	171
	Worked botanicals	109	10	171
	Faunal Bone	14236	4738	12866

Table 16: Densities for each area of Cave 1. These densities are used for the proportional calculations. The Area A density uses the results from F3 and F15 and the Area B density uses F28. The Entire Cave density uses the totals from F3, F15, and F28.

Proportional Calculations

Using two depths and shapes for the deposits within Promontory Cave 1 provides a range for calculating possible total numbers of artifacts. These values were obtained by multiplying the area densities (Table 16) by the volume of deposits for each area (Table 12), and are depicted in Table 17.

Category	Artifact	0.6 Depth			Basin		
		Area A	Area B	Total	Area A	Area B	Total
Lithics	Bifaces	1229	0	1229	1152	0	1152
	Cores	184	0	184	173	0	173
	Debitage	87 640	4548	92 188	82 162	2374	84 536
	Drills/Gravers	0	162	162	0	85	85
	FCR	0	162	162	0	85	85
	Utilised Flakes	8235	487	8723	7721	254	7975
	Hammerstones	61	0	61	58	0	58
	Incised Stone	0	0	0	0	0	0
	Projectile points	2643	162	2805	2478	85	2562
	Scrapers	369	0	369	346	0	346
	Slate knives	123	0	123	115	0	115
	Tabular bifaces	123	0	123	115	0	115
	Unifaces	0	0	0	0	0	0
Bone tools	Awls	123	0	123	115	0	115
	Beamers	123	0	123	115	0	115
	Fleshers	307	0	307	288	0	288
	Polished bone	553	0	553	519	0	519
Gaming	Bone pieces	184	0	184	173	0	173
	Cane dice	5347	975	6321	5013	509	5521
	Wood pieces	61	0	61	58	0	58
Clothing	Moccasins	2213	325	2537	2074	170	2244
Decoration	Beads	1106	0	1106	1037	0	1037
	Quills	2950	975	3925	2766	509	3274
Hunting	Arrow shafts	1721	487	2208	1613	254	1868
	Feather shafts	61	0	61	58	0	58
Textiles	Basketry	61	162	224	58	85	142
	Cordage	7129	1137	8266	6684	594	7277
	Mat fragments	492	0	492	461	0	461
Miscellaneous	Ceramic sherds	26 612	3898	30 510	24 948	2035	26 983
	Worked botanicals	11 616	487	12 103	10 890	254	11 144
	Faunal Bone	1 517 965	225 113	1 743 078	1 423 089	117 521	1 540 610

Table 17: Projected total number of artifacts for Promontory Cave 1 using Area A and B densities. Results are rounded to the nearest whole number.

Alternatively, I also did a calculation using only the density from F28 to project estimated figures for the entire cave (Table 18). Using F28 to represent the entire cave results in quite different numbers, and does not show the many artifact classes that are not present in F28. For the classes that are present in both areas, using only F28 presents noticeably smaller, though still substantial, numbers.

Category	Artifact	0.6 Depth Total	Basin Depth Total
Lithics	Bifaces	0	0
	Cores	0	0
	Debitage	14 755	11 944
	Drills/Gravers	527	427
	FCR	527	427
	Utilised Flakes	1581	1280
	Hammerstones	0	0
	Incised Stone	0	0
	Projectile points	527	427
	Scrapers	0	0
	Slate knives	0	0
	Tabular bifaces	0	0
	Unifaces	0	0
Bone tools	Awls	0	0
	Beamers	0	0
	Fleshers	0	0
	Polished bone	0	0
Gaming	Bone pieces	0	0
	Cane dice	3162	2559
	Wood pieces	0	0
Clothing	Moccasins	1054	853
Decoration	Beads	0	0
	Quills	3162	2559
Hunting	Arrow shafts	1581	1280
	Feather shafts	0	0
Textiles	Basketry	527	427
	Cordage	3689	2986
	Mat fragments	0	0
Miscellaneous	Ceramic sherds	12 647	10 237
	Worked botanicals	1581	1280
	Faunal Bone	730 378	591 206

Table 18: Projections for artifacts for Promontory Cave 1 using densities only from F28.

Finally, projections were made using the estimated densities for the entire cave as a whole (Table 19). This calculation results in the largest estimate for total number of artifacts because the F3 densities are more dominant.

Category	Artifact	0.6 Entire Cave	Basin Entire Cave
Lithics	Bifaces	1520	1231
	Cores	228	185
	Debitage	110 539	89 476
	Drills/Gravers	0	0
	FCR	76	62
	Utilised Flakes	10 415	8431
	Hammerstones	76	62
	Incised Stone	0	0
	Projectile points	3345	2708
	Scrapers	456	369
	Slate knives	152	123
	Tabular bifaces	152	123
	Unifaces	0	0
Bone tools	Awls	152	123
	Beamers	152	123
	Fleshers	380	308
	Polished bone	684	554
Gaming	Bone pieces	228	185
	Cane dice	7070	5723
	Wood pieces	76	62
Clothing	Moccasins	2889	2338
Decoration	Beads	1368	1108
	Quills	4105	3323
Hunting	Arrow shafts	2357	1908
	Feather shafts	76	62
Textiles	Basketry	152	123
	Cordage	9351	7569
	Mat fragments	608	492
Miscellaneous	Ceramic sherds	34 743	28 123
	Worked botanicals	14 597	11 815
	Faunal Bone	1 983 080	1 605 208

Table 19: Proportional calculation totals using the densities for the entire cave, disregarding separate units.

My projections show that there is the potential for a massive amount of material culture to have originally been present in Cave 1. Some of this material has been excavated by Steward and our more recent project, but the majority still remains in the cave. The different ways that the total possible numbers of artifacts were calculated occasionally resulted in drastically different values. For example, the predicted number of moccasins ranges from 853 (using F28's density and basin shaped deposits) to 2889 (using the entire cave density and a uniform depth of 0.6 m). The calculations using the entire cave density likely overestimate the values, as it is unlikely the artifact distribution in the entire cave was as dense as F3. The values for F28 likely underestimate the values because F3 and Area A were larger areas that were likely more desirable living areas, compared to Area B, which appears to not have been intensively occupied. F28 also does not contain many of the artifact classes present in F3. It is likely that the true values lie closer to the estimates made using the separate area densities, in the middle of the ranges provided.

Statistical Comparison

I calculated several versions of the Shannon-Wiener and Simpson's diversity indices to compare the different areas of the cave (Table 20 and Table 21). Because these equations rely heavily on the most abundant artifact categories, I did a calculation in which I removed the faunal bone category, which contained over 30 000 pieces and overshadowed the remaining artifact categories. I also made a calculation without the debitage or hide and leather fragment categories, because these were also especially abundant. Each calculation demonstrates that Area A is more diverse than Area B, a result which is expected, as fewer artifact categories were found within F28. Removing the faunal bone and other categories made a noticeable difference:

removing these categories helps to show a more realistic diversity value for both areas, and affirms that Area A yields consistently higher values than Area B.

Shannon-Wiener Index	**Area A (F3)**	**Area B (F28)**
All categories	0.59	0.52
No faunal bone	1.80	1.64
No faunal bone, debitage, or hide	2.10	1.89

Table 20: Results of the Shannon-Weiner diversity index test completed on the counts of artifacts from F3 and F28, rounded to the nearest hundredth.

Simpson's Index	**Area A (F3)**	**Area B (F28)**
All categories	0.23	0.20
No faunal bone	0.75	0.70
No faunal bone, debitage, or hide	0.81	0.78

Table 21: Results of the Simpson's diversity index test completed on the counts of artifacts from F3 and F28, rounded to the nearest hundredth.

A Chi-squared test was performed to compare figures from F3 and F28. Artifacts were grouped into larger categories because many categories had less than 5 artifacts in F28 (Table 22). In this test, the chance that the difference between the two units was due to sampling error was less than 0.1% ($p < 0.01$, $X^2 = 40.01$, df = 4); therefore, I can be over 99.9% confident that there is a real difference in the proportions of artifact categories between F3 and F28. All three statistical tests confirm that F3 and F28 are significantly different. This result likely reflects differences in use and activities occurring in the different areas, an interpretation which I discuss below.

Artifact Type	**F3 Observed**	**F28 Observed**	**F3 Expected**	**F28 Expected**
Lithics	1612	33	1561	84
Clothing, decoration, textiles	221	16	225	12
Ceramics	431	24	432	23
Faunal Bones	24597	1386	24650	1333
Misc. (hunting, worked botanicals, bone tools)	236	6	230	12

Table 22: Observed and expected values for the categories of artifacts from Promontory Cave 1.

Accumulation Rates

The accumulation rates of artifacts deposited in Promontory Cave 1 were calculated to study how artifacts were discarded and how many people inhabited the cave. To start, the accumulation rates for the artifacts excavated from Promontory Cave 1 were calculated over

Category	Artifact	Over 40 years		Over 20 years	
		0.6 Depth	Basin	0.6 Depth	Basin Total
Lithics	Bifaces	31	29	61	58
	Cores	5	4	9	9
	Debitage	2305	2113	4609	4227
	Drills/Gravers	0	0	0	0
	FCR	4	2	8	4
	Flake tools	218	199	436	399
	Hammerstones	2	1	3	3
	Incised Stone	0	0	0	0
	Projectile points	70	64	140	128
	Scrapers	9	9	18	17
	Slate knives	3	3	6	6
	Tabular bifaces	3	3	6	6
	Unifaces	0	0	0	0
Bone tools	Awls	3	3	6	6
	Beamers	3	3	6	6
	Fleshers	8	7	15	14
	Worked bone	14	13	28	26
Gaming	Bone pieces	5	4	9	9
	Cane dice	158	138	316	276
	Wood pieces	2	1	3	3
Clothing	Moccasins	63	56	127	112
Decoration	Beads	28	26	55	52
	Quills	98	82	196	164
Hunting	Arrow shafts	55	47	110	93
	Feather shafts	2	1	3	3
Textiles	Basketry	6	4	11	7
	Cordage	207	182	413	364
	Mat fragments	12	12	25	23
Miscellaneous	Ceramics	763	675	1525	1349
	Worked Botanicals	303	279	605	557

Table 23: Accumulation rates per year of artifacts from Promontory Cave 1 using the total projected numbers from Table 8. This assumes consistent occupation over the time period.

periods of 20 and 40 years, bracketing the Bayesian modelling results for the duration of the Promontory Culture occupation (see discussion on radiocarbon results in Chapter 2). The values in Table 23 were calculated using the projected totals from Table 17. These values are the accumulation rate per year for each artifact type, assuming consistent occupation over the 20 or 40 year time period and consistent use and discard of the artifact in question. These assumptions reflect idealized circumstances that may or may not be accurate, but do provide a basic starting point to examine how artifacts were being discarded.

Schiffer's Equation

Recall that Schiffer's (1975) equation is $T_D = St/L$ (Equation 3.1). This equation was first used with moccasins because various ethnographic sources provide values for most of the variables (e.g., McClennan 1975; Helm and Lurie 1961; Russell 1898). Other artifacts have less certain use-lives so it is more difficult to use this equation. Using this equation with moccasins results in the values for "S" (number of artifacts in systemic context) shown in Table 24. With moccasins, it is necessary to divide by two to get the number of pairs in systemic context. This calculation assumes consistent and unchanging variables over the occupation period, a circumstance not typical in human populations. Values for occupancy time (t) are 20 and 40 years, bracketing the radiocarbon results from Cave 1. Since it is likely that the cave was not being inhabited all year, I also included a total occupancy time of 10 years, which would be equal to groups spending only a portion of the year in the cave, as is suggested by the seasonal indicators discussed previously. This would equal 120 total months of occupation, which could have been spread out over the 20 years (six months of occupation per year) to 40 years (three months of occupation per year), or a frequency in between. The 20-year category could also be thought of as 240 total months spread out over 40 years (six months of occupation per year).

Total artifacts discarded (T_D)	Systemic Number (S)		
	10 years	20 years	40 years
2244 moccasins	45 (22)	22 (11)	11 (5)
2537 moccasins	51 (25)	25 (12)	13 (6)

Table 24: Calculated values for "S" in the equation $T_D = S*t/L$; where T_D is the projected total for moccasins, t is occupation span, and L is the use-life, such that we can solve for $S = (T_D*L)/t$. Rounded to the nearest whole number. In brackets, this number is divided by two to represent the number of pairs in systemic context.

As discussed previously, there are indications that the cave was not lived in full time but instead it was likely part of a seasonal round that included sites in Idaho as well (Arkush 2014). The presence of animal dung throughout the deposits also designates time when humans were not present. As well, the stratigraphic layers are hinting towards around 20 episodes of accumulation (Figure 8). These observations make the equations using 10 and 20 years more likely than 40 years, as these months and years would have been spread out over this time period. The implications of these results for the population number will be discussed in further sections.

Schiffer's equation can be rearranged to solve for any of the variables, depending on what variables are known. For other artifact classes in Cave 1, I used this equation to estimate artifact use-life. This analysis required first estimating how many of each artifact type would be in systemic context. For these calculations, I assumed a population of 25, as previous calculations have so far suggested a smaller population making use of Cave 1, and as discussed above, this is a reasonable group size for a hunter-gatherer group. In a population of 25, I previously estimated that there would be eight each of males and females contributing to artifact discard. From here I estimated how many of each artifact type each individual would have. Many of these artifact types were typically used by men (e.g., hunting paraphernalia) or women (e.g., hide working tools). The values in Table 10 were used to estimate systemic numbers for this population. For example, women might typically own around two tabular scrapers, so two per woman for eight women equals 16 in systemic context. For artifacts for which I do not have ethnographic sources, such as awls, I estimated that a woman would likely need a couple of each, as the numbers for other hide working tools range from one to three of each artifact type (see Table 10) and there are some differences in sizes of the awls we and Steward excavated. I therefore suggest that women may own two awls, perhaps one larger and one smaller. Using these systemic numbers, Schiffer's equation was used to calculate use-lives. Table 25 displays these results. These results are assuming consistent occupation of the site throughout each year, a frequency which was not necessarily the case. Again, I added a total occupancy time of 10 years to provide a realistic alternative scenario. Doing this calculation results in a range of possible use-lives, depending on how long the cave was occupied. A discussion of which use-lives are most likely will follow in the next chapter.

Artifact	**Systemic Number (S), assuming population = 25**	**Total Discarded (T_D)**	**Use-life (L) (years)**		
			10 years	**20 years**	**40 years**
Scrapers	16	346	0.46	0.92	1.85
		369	0.43	0.87	1.73
Awls	16	115	1.39	2.78	5.57
		123	1.30	2.60	5.20
Tabular Scrapers	16	115	1.39	2.78	5.57
		123	1.30	2.60	5.20
Fleshers	16	288	0.56	1.11	2.22
		307	0.52	1.04	2.08
Projectile points	120	2562	0.47	0.94	1.87
		2805	0.43	0.86	1.71
Arrow Shafts	120	1868	0.64	1.28	2.57
		2208	0.54	1.09	2.17

Table 25: Results of Schiffer's (1975) equation $T_D = St/L$, solving for use-life (L) in years, which is highlighted in grey.

Surovell 2009

Recall Surovell's (2009) equation for calculating the total number of artifacts discarded is $d = prt$ (Equation 3.2). Rearranging this equation to solve for the number of site occupants results in the equation $p = d/rt$. I performed this equation on moccasins, as we have a good grasp on the values for d and r for this artifact type (Table 26). This equation provides a direct way to obtain the population based on the total number of artifacts discarded.

Total number discarded (d)	Number of Site Occupants (p)		
	10 years	20 years	40 years
2244 moccasins	22	11	6
2537 moccasins	25	13	6

Table 26: Calculated values for number of site occupants (p) using equation p = d/rt; where d and t are the number of moccasins and the occupation span, respectively, and r is always 10 moccasins per person (i.e., 5 pairs) per year. Values are rounded to the nearest whole number.

The discard rates for the majority of the other artifacts types found in the cave are not so easily found ethnographically. Therefore, I will estimate discard rate using what the other results have indicated for population size. The projected values and Schiffer's equation for moccasins and other artifact types suggest that the population size was on the smaller end. I will use a population size of 25 to estimate the discard rate for a variety of artifacts. As with Schiffer's equation, this equation assumes consistent rates of occupation of the site, so again I add a total occupancy time of 10 years to account for the cave not being inhabited yearlong. These results are shown in Table 27 and will be discussed further in the next chapter in terms of what they

Artifact	Total Discarded (d)	Discard Rate (r) (artifacts per year)		
		10 years	20 years	40 years
Scrapers	346	1.38	0.69	0.35
	369	1.48	0.74	0.37
Awls	115	0.46	0.23	0.12
	123	0.49	0.25	0.12
Tabular Scrapers	115	0.46	0.23	0.12
	123	0.49	0.25	0.12
Fleshers	288	1.15	0.58	0.29
	307	1.23	0.61	0.31
Projectile points	2562	10.25	5.12	2.56
	2805	11.22	5.61	2.81
Arrow Shafts	1868	7.47	3.74	1.87
	2208	8.83	4.42	2.21

Table 27: Results for Surovell's (2009) equation r = d/pt, and assuming a population (p) of 25 individuals.

mean for artifact use and discard. These results also inform on how people treated artifacts and whether they were being curated or not, as well as whether the population needed to be frugal.

Ratio of Non-perishable to Perishable Artifacts

The ratio of non-perishable to perishable artifacts was first completed using every artifact class listed in Table 28. This does not truly demonstrate a good ratio because the amount of faunal bone, over 30 000 pieces, completely dominates the assemblage (Table 29). As with the statistical calculations, I eliminated this category from a second calculation. In a third calculation I additionally eliminated lithic debitage, fur/hair, hide/leather, and ceramics categories that do not represent a complete or formed tool or artifact. This also resulted in different percentages. The ratios described previously from ethnographic sources and other archaeological sites also tend not to include unworked faunal bone and debitage, as these values dominate the assemblage and eradicate the ability to look at a clear ratio of non-perishable to perishable tools.

Non-perishable	**Occasionally**	**Perishable**
Bifaces	Awls	Cane dice
Cores	Beamers	Wood gaming pieces
Debitage	Fleshers	Moccasins
Drills/Gravers	Polished bone tools	Beads
FCR	Bone gaming pieces	Quills
Utilised Flakes	Faunal bone	Arrow shafts
Hammerstones		Feather shafts
Incised Stone		Basketry
Projectile points		Cordage
Scrapers		Mat fragments
Slate knives		Pieces of hide/leather
Tabular bifaces		Worked botanicals
Unifaces		Fur/hair (bags of)
Ceramic sherds		

Table 28: Artifact classes divided into categories depending on how well they survive the archaeological record in typical open settings.

	Non-perishable	Occasionally	Perishable
All categories	8%	85%	7%
No faunal bone	52%	0.5%	47%
No faunal bone, debitage, fur, hide, or ceramics	20%	2%	78%

Table 29: Percentage of the total artifact assemblage for each category, rounded to the nearest whole percent.

To obtain a simple ratio, I used the last calculation that did not include classes that were not representative of individual artifacts. Because the category of artifacts that occasionally survives is so small, I combined this category with the non-perishable category and obtained a non-perishable to perishable ratio of 1:3.5. These calculations demonstrate that the proportion of the material record we are missing in typical open archaeological sites is an incredibly large portion of past life. This loss and its implications are discussed in further sections.

Conclusion

The above results indicate that it is reasonable to assume a population of around 25 people inhabited the cave for a portion of the year. The moccasins are the most supportive artifacts for this conclusion due to the good ethnographic data about them. The calculations suggest that the population was not sedentary; instead the group likely returned for a portion of the year each year. These results and the interpretation of them will be discussed in depth in the next chapter. These results have consequences for the estimates of population size and occupation length, as well as information about artifact use-lives and discard rates.

Chapter 6: Discussion

In this chapter, I review the results from the previous chapter in roughly the order they were presented. I examine the total projected numbers I calculated and use these to explore aspects of the Promontory Cave 1 site such as population size and duration of occupation. I also examine what else these artifacts can tell us about the activities of this population. The statistical comparisons between the two living areas are discussed in terms of how these two areas may have differed and why. The results from the accumulation equations are then discussed to determine population size and occupation length using different methods than above. These equations were also used to obtain artifact use-lives and discard rates, which will be evaluated. Finally, the ratio of non-perishable to perishable artifacts is examined and compared to other sites and to ethnographic sources. Before my review, however, I first evaluate the accuracy of the projections I have made and compare these to the information we have on Steward's excavations.

Comments on the Accuracy of Projections

Judging from the amount of cultural material excavated, Promontory Cave 1 was a densely occupied site. Having done multiple calculations for the projected total numbers of artifacts, I can now surmise which calculation is most likely to estimate the true number of artifacts. Considering that F3 may be within a midden area and therefore denser than the rest of the cave, F28's densities could be more reliable to represent the remainder of Area A. However, many artifact classes found in Area A were not found in Area B, suggesting that Area B was used more lightly and may have been used for a different purpose than Area A. Steward (1930; 1937) also mentions finding the majority of the artifacts he collected in Area A, further suggesting that Area A as a whole was more dense and diverse in terms of numbers and types of artifacts. Lakevold's (2017) space syntax research also suggests that Area B was less desirable and more likely a secondary occupation area. The calculation using the entire cave is likely an overestimation, as the F3 densities overpower the rest (Table 19). The different artifact densities in each area suggest differences in activities, so using each unit to represent their respective areas seems to be most likely to reflect the true state.

I believe that the true values for the total number of artifacts lie in the ranges given in Table 17, using the Area A and B densities separately. I believe that the basin volume is the most accurate for Area A, and the uniform 0.6 m volume is the most accurate for Area B. These volumes account for the area around F3, which is obviously much deeper than the rest of the area; and in Area B my observations suggest that a uniform depth of 0.6 m is more accurate than having the deposits thin out at the edges. Area B is small already, and having the livable area thin out towards the edges cuts out a fair amount of material. I believe the deposits thin out closer to the edges of the cave, where the roof slopes down too much to allow for regular human occupation and therefore little cultural material would build up. Steward excavated two small trenches along the edges of Area B and did not note that there was cultural material here (Figure 5). However, using the densities from F3 for all of Area A still may overestimate the number of artifacts. If Steward's records had noted provenience, then I could approximate his densities to compare to ours. He did take location and depth data, but this information has been lost along with his other field notes as he chose not to include this data in his publication due to the homogeneity of the deposits (Steward 1937:10). In Table 30 below, I have attempted to calculate the volume he excavated, using his maps of the cave along with his statement that there were only two feet (0.6 m) of artifact-rich material (Steward 1930; 1937). This calculation does not include the trenches he excavated in Area C, as he did not mention finding artifacts in these trenches and it is assumed they are virtually sterile, a conclusion corroborated by our observations as well. The Area A volume is problematic, as I had to approximate the surface area of the wider area he claimed to have excavated.

	Area A		Area B	Total
	Trench	Basin		
Area Excavated (m^2)	11.3	90.7	3.3	105.3
Volume (m^3)	6.7	54.4	2.0	63.2

Table 30: Estimated areas and volumes for Steward's excavations in Promontory Cave 1.

As stated before, Steward's map has its inaccuracies. It is evident that since F3 and F15 were excavated into intact deposits, his outline of the excavated area in Area A is overstated (Figure 4). However, as Table 31 shows, his densities and projected values are much lower than the calculations based on the modern excavations. I believe this difference is due to two main factors. First, the area he indicated as "excavated" in Area A in his more impressionistic mapping is larger than what was really excavated. A smaller excavation area would result in higher densities. However, if I decrease the volume he excavated by one quarter or one third, my adjustment still results in small densities. For example, decreasing the volume by a third results in 42.12 m^3 excavated, and with a total of 248 moccasins, the density is 6 moccasins/m^3; nowhere near the 21 moccasins/m^3 in F3, but closer to the 7 moccasins/m^3 in F28. Also, in his 1930 report, Steward reports that he found 150 moccasins in Trench A. This number would indicate a density of about 22 moccasins/m^3—nearly identical to the density in F3. The deposits are likely not completely uniform across the entire livable areas, but without other modern units to test this possibility, I believe that using the F3 densities to represent the entirety of Area is valid. Second, because he and his team did not screen the material, they would have missed artifacts that were not large enough to be seen or noticed among the abundant juniper bark. Artifacts made of wood would have been easily missed, as they would camouflage with the

Category	Artifact	Totals		Densities		Projected Values	
		Steward	U of A	Steward	F3	Steward 0.6	Steward Basin
Lithics	Bifaces	9	25	0.14	12	22	18
	Cores	0	3	0.00	2	0	0
	Debitage	0	1848	0.00	847	0	0
	Drills/Gravers	2	2	0.03	0	5	4
	FCR	0	1	0.00	0	0	0
	Flake tools	13+	172	0.21	80	32	26
	Hammerstones	2	2	0.03	1	5	4
	Incised Stone	5	2	0.08	0	12	10
	Projectile points	10	63	0.16	25	24	20
	Scrapers	5	8	0.08	3	12	10
	Slate knives	8	5	0.13	1	20	16
	Tabular bifaces	0	2	0.00	1	0	0
	Unifaces	0	1	0.00	0	0	0
Bone tools	Awls	6	3	0.09	1	15	12
	Beamers	0	2	0.00	1	0	0
	Fleshers	0	7	0.00	3	0	0
	Worked bone	32	13	0.51	5	78	63
Gaming	Bone pieces	8	3	0.13	2	20	16
	Cane dice	24	153	0.38	52	59	47
	Wood pieces	0	3	0.00	1	0	0
Clothing	Moccasins	248	55	3.93	21	605	490
Decoration	Beads	0	25	0.00	11	0	0
	Quills	0	59	0.00	29	0	0
Hunting	Arrow shafts	83	46	1.31	17	202	164
	Feather shafts	0	11	0.00	1	0	0
Textiles	Basketry	9	2	0.14	1	22	18
	Cordage	117	144	1.85	67	285	231
	Mat fragments	38	9	0.60	5	93	75
Misc.	Ceramics	649	634	10.27	260	1583	1282
	Worked botanicals	94	635	1.49	114	229	186
	Pieces of hide/leather	91	1260+	1.44	512	222	180
	Faunal bone	N/A	30330+	N/A	14817	N/A	N/A
	Pipes	1	N/A	0.02	N/A	2	2
	Mullers (for seed grinding)	2	N/A	0.03	N/A	5	4

	Arrow smoothers	3	N/A	0.05	N/A	7	6
	Mittens	2	N/A	0.03	N/A	5	4
	Bows	4	N/A	0.06	N/A	10	8

Table 31: Steward totals (from Steward 1937), estimated densities (per cubic metre), and projected values. Our totals and the densities from F3 are listed for comparison.

juniper bark, along with small artifacts like cane dice and debitage, both of which he found in very small amounts (Table 31).

Another possible cause of error is that *Ancient Caves* may not include every artifact excavated by Steward and his team. For instance, two toothed fleshers are present in the Natural History Museum of Utah's collection, but not described in *Ancient Caves*. Lithic debitage is also not discussed in *Ancient Caves*. This absence seems unlikely, leading me to believe he either found lithic debitage but chose not to include it in the publication; or, all the lithic debitage was missed because they did not screen material. It was very rare to see small flakes while excavating, and all lithic debitage was found in the screens during our excavations.

This comparison suggests that F3 and Steward's Trench A were similar in densities and the remainder of the cave exhibits much smaller densities. Steward dug a much larger volume of material than we did (nearly twenty times as much), but seemingly found proportionally less material, at least from what is reported in *Ancient Caves*. As mentioned in Chapter 2, the maps he provided may be more impressionistic than exact, but the volume I estimate is likely not too far from what he did excavate. As demonstrated above, even reducing his volume by a third still results in lower densities than what we recovered in Area A. Steward's observations, as well as our own, suggest that Area A was heavily used, and likely has a density of artifacts closer to that of F3 than F28, as suggested by the nearly identical density of artifacts within our F3 and his Trench A. The ranges using the Area A and B units independently, shown in Table 17, are therefore the most likely, and these are the ones I carry forward.

Assumptions

The above calculations required that I make a number of assumptions for the equations to work. I essentially had to assume that Cave 1 exists in a bubble, and that everything within this bubble is consistent. Both Schiffer's (1975; 1978) and Surovell's (2009) equations require that certain variables, such as discard rates, use-lives, group membership, and systemic numbers, remain constant throughout occupation. These variables, however, will vary due to raw material, size, and a multitude of other factors described in more detail in Chapter 3. In assuming that the population was not sedentary but occupation was regular, including a 10-year occupation span provided a further likely value for representative calculations.

Further assumptions were made, based on ethnographic analogy, for the systemic number of artifacts and what a typical and ideal hunter-gatherer population would look like. I used various sources from around the world, but included more Dene sources because we have good reason to believe the Promontory Culture occupation were Apachean ancestors. For the most part, these sources were consistent in the various variables I took from them, further justifying my usage of ethnographic analogy. Assumptions based on the above variables are required for this research, but I believe the results produced are as accurate as archaeology can be when studying the past.

Applications of Proportional Calculations

The following sections will in turn look at the results of the projected calculations, and examine how these numbers inform us about the Promontory Culture population that lived in the cave. Moccasins are discussed first, as there is good ethnographic information about how many were used per year, and this can be used to help determine occupation span and population. Next, hide working tools are looked at together as they are closely related. Projectile points and arrow shafts are examined next to inform on the male realm of hunting.

Moccasins

The total number of moccasins projected for Cave 1 ranges from 853 to 2889. Steward (1937) found 248 moccasins in Cave 1, and we have found a further 55 moccasins and fragments (Figure 25). It is also possible that more fragments exist that have not been identified as such. Looting and other collecting took away a great number of moccasins as well; there are at least 50 known instances in other collections (John Ives, personal communication 2016), and more may exist in unknown collections. Given this total of over 355 moccasins from excavations and looting, the prediction of 853 moccasins seems too low for the total deposits. As discussed above, the range given by the results of the calculations using separate area densities is more likely: 2244-2537 (Table 17). I use these numbers of moccasins in several ways to estimate population and occupation time.

A variety of ethnographic sources indicate an average of five pairs of moccasins used per adult per year. McClennan (1975:307) stated that with normal wear and tear, a pair will last two months, so 6 pairs would be needed per year. Helm and Lurie (1961:96) reported a woman needed 3-4 pairs per year, and a man needed at least 4, although Clayton-Gouthro (1994) reported that 3-4 pairs would only last an average man through the winter. On the extreme end, Russell (1898:172) writes that 4-5 pairs would be needed per day when tracking. Other sources also state that multiple pairs were taken when going off to war (Grinnell 1966:63), and extra moccasins were taken when going on hunts (Wilson 1924). Averaging these reports, five moccasin pairs per adult per year seems an adequate estimation of what would be needed at a residential site like Promontory Cave 1. Though most of the moccasins left at the cave were

Figure 25: Example of a complete moccasin found in Promontory Cave 1 (42BO1.173.1).

from children and adolescents (Billinger and Ives 2015), for ease of calculation I will use five pairs per year for each individual. Older adolescents likely had similar discard rates as adults as they were performing many of the same tasks. Children may have used more moccasins because they were growing and active; however, they may also have used less because they may have been more confined to the cave space than older individuals, and may also have been less likely to always keep their footwear on. Chiracahua children would receive their first moccasins by the age of two, and prior to that be carried using a cradleboard (Opler 1941:11-15), and so would not contribute to moccasin discard. The ethnographic sources suggest a short use-life, so moccasins would not be handed down between children. With no ethnographic information on the discard rates for children, I assume they use similar numbers to adults.

For certain equations using the number of moccasins, I am assuming that a person has only one pair of moccasins in their possession at a time. As in the cases above that report multiple pairs taken on hunts and other long-distance activities, if moccasins were worn out during this time they were likely discarded outside the cave (as is suggested by Billinger and Ives [2015] to account for the lack of adult male moccasins). The majority of the moccasins excavated have patches or are completely worn out (Billinger and Ives 2015), and we have not found any moccasins that appear to be unused. These two facts suggest that unused moccasins were not being stockpiled in the cave, and that the tendency was to repair moccasins rather than always make new ones. McClennan's (1975) and Helm and Lurie's (1961) accounts above suggest that one pair was in systemic context at a time, though manufacturing new moccasins likely occurred as current ones wore out. This is another assumption that I make for ease of calculation that is supported by the ethnographic sources above.

Looking at the total numbers simply as yearly deposits, if the cave was occupied consistently over a span of 40 years, this equates to 56-63 moccasins discarded per year. Divided by ten moccasins per person, these numbers can support only 5-6 people[7]. Over 20 years, 112-127 moccasins are discarded, supporting only 11-13 people. This calculation suggests that people were: 1) discarding moccasins outside the cave; 2) were not inhabiting the cave all year every year; 3) a population smaller than 30-50 people inhabited the cave; or some combination of all three alternatives.

Applying the ethnographic information noted above, a population of 50 people would be expected to discard 250 moccasins pairs per year, or 500 single moccasins. A population of 25 people would discard 250 single moccasins per year. Over 20 or 40 years, this figure quickly escalates to huge numbers of moccasins unlikely for Cave 1; multiplying 250 by 20 and 40 years

[7] Sample calculation: 2244 total moccasins / 40 years = 56-63 moccasins per year
56-63 / 10 per person per year = 5-6 people per year
This calculation follows Surovell's (2009) equation $d = prt$, rearranged to solve $p = d/rt$.

results in 5000 to 10 000 moccasins. These are enormous numbers that further support usage of the cave during only a portion of the year.

There are several reasons why moccasins would have been discarded outside the cave. Normally, men would be more likely to discard moccasins outside the cave on hunts, scouting, or other trips, involving both greater distances and duration. The Hidatsa woman Buffalo Bird Woman described a pedestrian bison hunt in which six men and six women took part, and were gone from their residential camp around 20-23 days before they returned (Brink 2004; Wilson 1924:231). This group brought extra moccasins with them on the trek so it is likely that these individuals were discarding moccasins outside their main residential camp area, unless they were being brought back to be repaired and used again. Buffalo Bird Woman brought three pairs for herself, and five pairs were brought for her husband (Wilson 1924:232). Individuals leaving for hunts and other trips would contribute less to the accumulation of all artifacts within the cave boundaries. Moccasins may also have been discarded outside the cave for cleanliness and space requirements (moccasins will take up more room in a midden than lithic debitage, for example). Moccasins being frequently repaired may also result in fewer than expected being discarded.

Billinger and Ives (2015) studied the moccasins found in the Promontory Caves in terms of foot length, stature, and age, and determined that the population was dominated by children and subadults. Of the 170 individuals represented by their sample, 82% of these were children or adolescents. I believe these numbers demonstrate skewing in moccasin discard. It seems unlikely that if the population size was around 50 people, 41 would be adolescents. Scaling the population down to 25, this figure would equate to 21 children. Neither of these scenarios seems plausible. While the Promontory Culture may have had a relatively high proportion of children, it seems more likely that adults were preferentially discarding moccasins outside of the cave. To account for this discrepancy, next I scale up the adult population using Billinger and Ives's (2015) proportion of children as a baseline and then project totals for adults more in line with the ethnographic and fur trade data on group compositions discussed earlier, in which children comprised closer to half of these populations.

If children and sub-adults left behind 82% of the moccasins in Cave 1 (Billinger and Ives 2015), then they left behind between 1840 and 2080 total moccasins (82% of the projected totals 2244 and 2537). And, if children actually represented closer to fifty percent of the population as indicated by the described ethnographic accounts, then doubling these values should result in a better estimate of the true number of discarded moccasins inside and outside of the cave. The new projected values then become 3680 and 4160. Over 20 to 40 years, this number results in a range of nine to 20 individuals, using the same methods as above. These population estimates are still somewhat low, suggesting that a shorter combined occupation span should be more realistic. Using the 10-year span, these estimates increase to between 36 and 42 individuals.

While the number of projected moccasins initially appears to be large, it is in reality not that large when the estimated population size, occupation span, and preservation are taken into account. Other well-preserved residential cave sites in the area, such as Hogup Cave, also show a high proportion of perishables, but do not contain the high numbers of footwear that is seen at Promontory Cave 1. The footwear that is found in Hogup Cave comes in styles characteristic of the Great Basin (Aikens 1970). This difference further identifies Promontory Cave 1 as a unique site, resulting from high fidelity preservation conditions coupled with an intrusive population committed to using soft-soled moccasins on a regular basis, unlike their Fremont neighbours, who wore sandals.

The above discussion suggests that it was a small population that inhabited the cave, and that they did not inhabit the cave year round. One realistic scenario would be that the cave was inhabited for a season or two, and then was left and returned to each year over a 20-40 year period. For example, if the population was in the cave only part of the year, say around 4-5 months, each individual would discard two pairs or four moccasins. Recalling the projected range of 2244-2537 moccasins, this would equate to 14-16 people over a 40-year period, or 28-32 over a 20-year period[8]. Therefore, the number of moccasins in the cave is indicative of a smaller population of around 25-30 people using the cave for a couple of seasons each year; this group travelled elsewhere for the remainder of the time (for example, to Idaho and site 10OA275 [Arkush 2014]). Table 1 suggests that occupation may have been any time of the year, but most of the overlap in seasonal indicators is in the winter and summer. Future, more detailed analysis of the faunal remains may refine this picture. The cave could certainly hold more people, but to match up with the projected values, this increased number of people would decrease the total number of months and years the cave was inhabited.

Using these results another way, the number of projected moccasins can be used to estimate occupation time. If five pairs of moccasins are used per year, and assuming regular wear, then one pair of moccasins has a use-life of around 2.4 months. Halving the projected totals to get the number of pairs and multiplying this result by 2.4 equals 2692.8 and 3044.4 total person-months represented by the number of moccasins present. Dividing this figure by the population gives us the number of months that the cave was inhabited (Table 32). Over 20 to 40 years, the occupation ranges from 1.3 months (50 people over 40 years) to 6.1 months (25 people

[8] Example calculation: 2244 total moccasins / 40 years = 56.1
56.1 / 4 moccasins per person per year = 14 people per year
As before, this follows Surovell's (2009) equation to solve for p=d/rt.

over 20 years) each year, using only the projected number of moccasins (Table 33). A yearly occupation of only one month seems too short, but an occupation time of around four to six months seems reasonable for a population that is mobile, but staying in this area for a few generations and depositing considerable cultural debris in the caves.

These calculations were also done with the total moccasin numbers calculated by scaling up the adult population based on the percentage of children present (Table 32). Dividing these results by the number of years results in a span of 2.2 (50 people over 40 years) to 10 (25 people over 20 years) months (Table 33). These results increase the possibilities for longer occupation time per year. Recall also that the stratigraphy suggests at least 20 episodes of deposition, perhaps indicating 20 instances of occupation that could have been spread out over the 20 to 40 years that the cave was inhabited.

Number of Pairs	**Use-life (months)**	**Total Occupation Time (person-months)**	
		/25 people	**/50 people**
1 pair	2.4	-	-
1122 pairs	2692.8	107.7	53.9
1268.5 pairs	3044.4	121.8	60.9
1840 pairs	4416	176.7	88.3
2080 pairs	4992	199.7	99.8

Table 32: Analysis of occupation span based on the use-life of moccasins for both the projected total number of moccasins (2244-2537), as well as the estimated total based on the number of children (3680-4160).

Population	**Total Occupation Time (months)**	**Occupation Time per Year /20 years (months)**	**Occupation Time per Year /40 years (months)**
50	53.9	2.7	1.3
50	60.9	3.0	1.5
50	88.3	4.4	2.2
50	99.8	5.0	2.5
25	107.7	5.4	2.7
25	121.8	6.1	3.0
25	176.7	8.8	4.4
25	199.7	10.0	5.0

Table 33: Occupation time per year based on the use-life of moccasins form Promontory Cave 1.

These interpretations assume that people were returning to the cave annually, when this cycle may not have been the case. There are a great number of scenarios that could have occurred to eventually equal the number of person-months calculated. The cave could have been occupied all year long for some years, then not used at all in following years; or, occupied during the winter one year and in the summer the next. The seasonal estimations based on faunal remains suggest occupations during many months of the year, including fall to early spring (Table 1). Recall as well that hunting and other trips could take individuals away from the cave for days or weeks, events which would skew these numbers as fewer people would be inhabiting the cave at certain times. The cave may not have always been occupied in a consistent pattern.

Eiselt's (2012) research documented yearly overwintering of Apachean people near northern Rio Grande Puebloan settlements. Plains Apache people would overwinter "under the eaves" of Pueblos for protection from harsh winter weather and would participate in trade, with the Pueblos gaining bison products and the Apache receiving agricultural produce and other goods (Eiselt 2012:68). The Apache groups would return annually to the same places and renew relationships with the same people. An ancestral Apachean group at Promontory Cave 1 may have maintained similar relationships with Fremont neighbours. Once the cave was discovered and the potential for habitation realized, people could stay at this site for more extended periods of time, developing relationships with surrounding groups, and returning annually for trade and relationship renewal. It is known that migrating Dene groups were incorporating other individuals with different genetic signatures (Malhi 2012), and the artifacts within Cave 1 indicate some contact with other non-Dene groups, such as Fremont. Coming to the cave for a few months at a time fits well with what the number of artifacts suggest. As well, the stratigraphy suggests perhaps around 20 instances of occupation (Figure 8), which could indicate some regularity in the frequency of occupation.

I believe this analysis of the moccasin numbers suggests that a small population was living in the cave for a total of around four to six months per year. If a larger population of 50 people had inhabited the cave, they would have done so infrequently (or we would have found more moccasins), and this seems unlikely once the cave and its surroundings had been discovered. I would expect that once the caves were discovered, with the protection they afforded and the presence of bison and other large game in the area, it would be desirable to make more frequent use of the cave. As well, my analysis is only for Cave 1; the total population between the two largest caves (Cave 1 and 2) may have been more. Within Cave 1 itself, however, the discarded moccasins suggest a small population.

Hide Working

Moccasins are an artifact type that lends itself well to accumulation and population calculations because good ethnographic sources provide values for use-lives. The tools used to manufacture moccasins and other hide products can also provide insight into the population inhabiting the cave, albeit in a less direct way than the number of moccasins. A number of the tools found in Cave 1 are tools used for hide working (Table 14). Hide working was obviously a significant aspect of the life in the cave, as the moccasins and leather scraps indicate (Figure 26; see also Reilly 2015). Not only was hide working important, but it was occurring at a high skill level from the beginning of occupation (Billinger and Ives 2015). Intricate quillwork decorates some of the moccasins, indicating skilled sewing. No needles were found by either Steward or us, so this fine work was performed with the awls we excavated. The following discussion examines the projected numbers for each hide working tool type.

Figure 26: An example of the hide scraps found in Promontory Cave 1. Photo by Michaela Stang.

Scrapers: My calculations resulted in a range between 346 and 369 stone scrapers. Reilly (2015) used the number of scrapers to estimate the number of hides that were processed, and here I will do the same. Clark and Kurashina (1981) performed an ethnoarchaeological study on cowhides and found that two obsidian scrapers were needed per hide. This usage would equate to between 173 and 184.5 hides for the number of scrapers discarded in Cave 1. One moose hide can produce 10-12 pairs of moccasins (Helm and Lurie 1961:96; Theriault 2006). Using moose as a proxy for bison, and using the larger value of 12 pairs, this range of hides could produce 2076 to 2214 moccasins. These values are a few hundred away from the projected moccasin numbers, and do not take into account other needs for hides such as other articles of clothing. Bison are the largest land mammal in North America (Brink 2004:27), and so would have a larger hide than a moose. This difference would still result in too few hides and moccasins to clothe the estimated population. Before intensive looting took place, there were bison hide robes on the surface of Cave 1 (George Chournos, personal communication 2014), which would have been vital in the winter months. In this case, one hide is needed for just one garment, greatly increasing the number of hides needed for all the uses of the population.

Using the yearly accumulation rates from Table 23, over 40 years, nine scrapers would be discarded per year, a number which equates to an estimated 4-5 hides per year. Over 20 years, this number increases to nine hides per year, which could make around 108 pairs of moccasins. A population of 25 inhabiting the cave year-round would need 125 pairs, so 108 pairs almost matches the requirement. However, the numbers of total moccasins suggest a shorter yearly occupation. A population of 25 discarding two pairs of moccasins each during their occupation would need only 50 pairs per year, a number covered by the calculated 108 pairs. This amount also leaves extra hides for the many other hide products that are necessary. A population of 50 would need 100 pairs, which is covered by 108 but does not leave enough extra hides for clothing and other uses. However, this study was based on obsidian scrapers, which are more fragile than those made of other materials such as chert. Brink (1978:111) found that chert scrapers were good for thousands of strokes before needing to be re-sharpened, so theoretically they could last for multiple hides. The scrapers we found in Cave 1 were mostly chert, and there was only one obsidian specimen. Steward (1937:70) also only found one obsidian scraper. Osgood (1970:79-81) describes a “stone skin scraper” made of a slate-like material that will last two years even with high use. The scrapers found in Cave 1 are all small and exhausted and seem unlikely to have lasted years. Nonetheless, Clark and Kurashina’s (1981) study provides a way to quantify the number of hides that could have been produced, and these results agree with the moccasin-based calculations: a smaller population inhabiting the cave for short periods of time.

Fleshers: The total projected numbers for bone fleshers range from 288 to 307. Fleshers can be highly curated and handed down through generations; a woman may only own 2-3 during her lifetime (Reilly 2015). The number of fleshers excavated from Cave 1 and my subsequent calculations suggest that the fleshers here were not so heavily curated. These fleshers were all expediently made on opportunistic elements, such as tibiae. Steward, however, found two toothed fleshers that may represent those that are more highly curated (Figure 27). It appears that ones like Steward found were made with more care, and therefore may have been curated for longer periods of time. Other supplemental tools for fleshing were expediently made and just as expediently discarded.

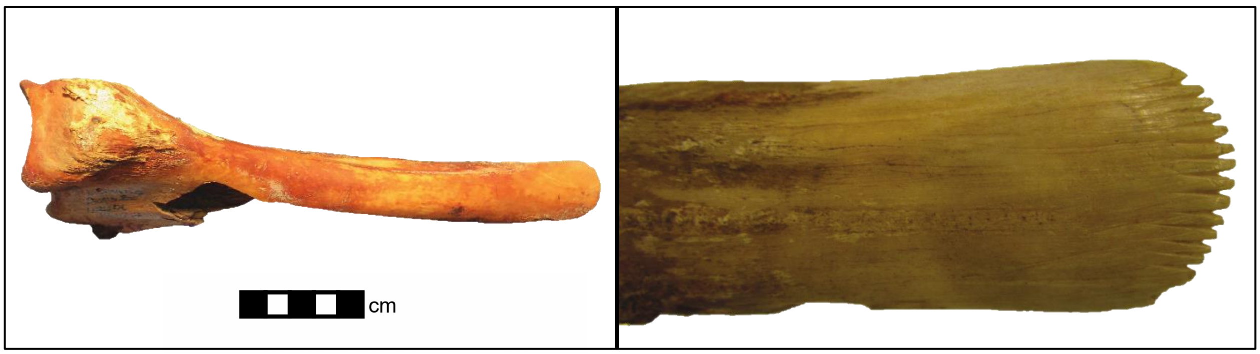

Figure 27: Left: flesher excavated during modern excavations in Cave 1 (42BO1.1324). Right: toothed flesher found by Steward (42BO1.10306), photographed courtesy the Natural History Museum of Utah.

Osgood (1970) mentions a “bone skin scraper” and notes that these tools may not last very long: only half a year before they needed to be replaced. This tool has a wood handle, with the bone portion of the tool hafted to this handle. However, as mentioned, Reilly’s (2015) work with Kaska elders reinforced the idea that some hide working tools were curated and could last for generations, even those made of bone, in contrast to some of the tools Osgood (1970) reported. The wood portion of the tool Osgood (1970) described may have weakened the overall durability of the tool.

Reilly’s (2015) research also suggests that women would carry their tools with them across landscapes. She indicated that the presence of a flesher does not necessarily indicate that hide working occurred, as such tools could be present at a variety of sites without being discarded. Also, favoured tools of this type were not simply discarded, but would be left "in a good place" once women were done with them (Reilly 2015:40). The opposite is also indicated; when tools are highly curated, their absence does not mean that the activity was not taking place. At Promontory Cave 1, hide working was very evidently occurring, so fleshers and other tools would have been used near the cave. The immense quantity of faunal bone present would also have provided ample raw material for making these bone tools. The projected values and accumulation rates calculated from these for hide working tools do not suggest that these tools were heavily curated. The use-life reported in Osgood (1970) may be more accurate here. As discussed in previous chapters, a population of 25 would have an estimated eight females participating in hide working. The yearly accumulation rate suggests each woman discarded a flesher or two each year (Table 23), coinciding with Osgood's (1970) observation that a bone skin scraper would last a season or two.

The differences between Osgood's (1970) and Reilly's (2015) observations suggest differences in how various groups and individuals viewed certain artifacts. The degree of curation was likely different for different groups, and individuals could attach sentimental value to some artifacts over others. The large number of moccasins and other pieces of hide in the cave indicate that hide working was a large part of life. The high demand for these tools may explain why they are so expediently and, in some cases, crudely made.

<u>Tabular bifaces:</u> Also known as *chi-thos*, these tools are D-shaped stone tools used in the latter stages of hide working for softening hides (Reilly 2015; XYZ). These, like fleshers, can be highly curated and passed down through generations (Albright 1984; Pokotylo and Hanks 1989; Reilly 2015). Albright (1984:56) observed one that was over 100 years old. These tools were long lasting likely partly due to their durability; they could be used on two to three hides before

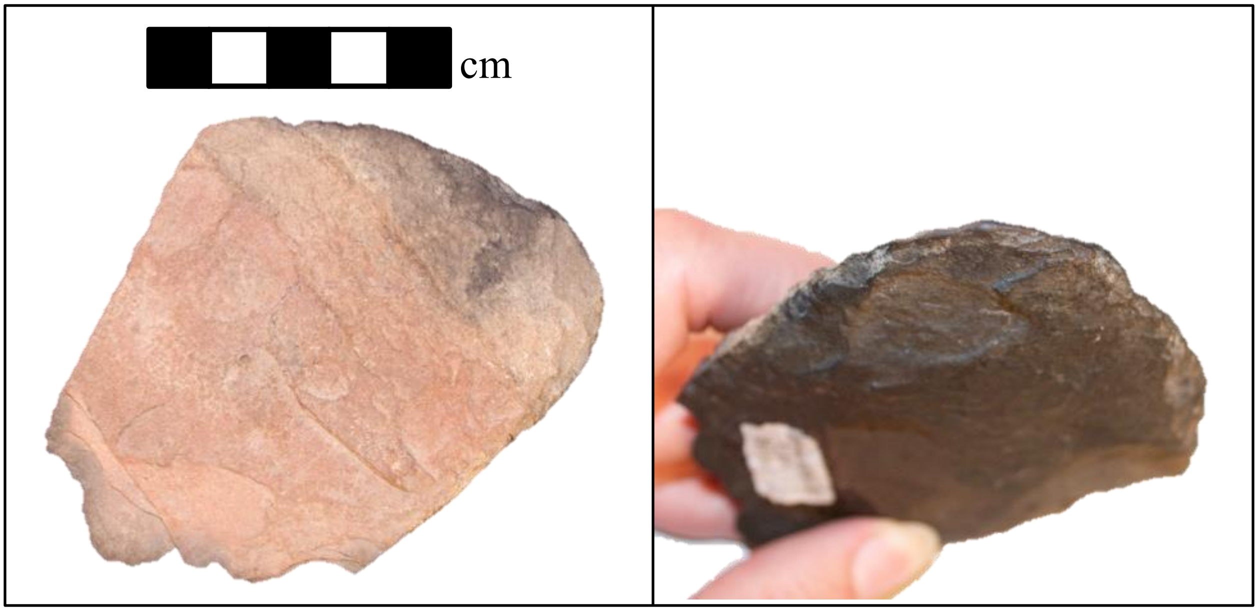

Figure 28: Tabular scraper from Promontory Cave 1 (42BO1.126.1). Right: plan view. Left: close-up of perpendicular wear indicative of scraping hides.

needing to be sharpened again (Albright 1964:56). Their use as hide softening tools required less abrasive work than removing hair or flesh, a factor also contributing to longer use-lives. A total of two tabular bifaces recovered in our excavations results in a projected range of 115-123 in Cave 1. If this artifact had a high curation rate as demonstrated by some ethnographic accounts, it is possible that this projection is an overestimation. However, some sites contain a number of these types of tools (e.g., the Rat Indian Creek site [LeBlanc 1984]) so curation may not have occurred with some groups or individuals. As well, the tabular bifaces we found were thin and may not have been ideal for continued use. One, 42BO1.791.1, has wear that is more suggestive of being used for cutting rather than hide softening, a factor which would halve the projected total. These tools would be reused many times throughout their life. In some Northern Dene communities, if these artifacts were to be discarded, they would either be buried with the owner, or put in a "safe place" (Reilly 2015). It may be that our finding of two tabular bifaces is coincidental and is not representative of the total number present in the cave, especially since Steward also found only a couple as well. On the other hand, these studies that describe the curation of tabular scrapers are concentrated in the north, and the same thinking may not apply to the population at Promontory Caves. Or, the pattern we see with the fleshers, in which some tools are expediently made and some are curated, may also apply to these tools as well.

Bone Awls: With the obvious large amount of hide working occurring in Cave 1, it is surprising that our excavations found only three awls. Steward found six, also fewer than would be expected. The projected totals of these artifacts, 115-123, do not equate to a great number being used per year (three to six). Osgood (1970) reported that bone awls could last a short or a long time depending, on the element used and its size. The awls we found were small and thin, but the ones found by Steward are generally larger and made from long bones. These could last a fairly long time. It also seems likely that a woman would need to own only one or two at a time, so they may not be discarded often. Shaping a bone into an awl that works for the precise sewing skills exhibited at this site may also take time; once an awl is made its user may want to keep it for long periods of time if it works well.

Figure 29: Bone awl (42BO1.1397.6) from Promontory Cave 1.

Other Bone Tools: The bone tools excavated from Cave 1 tend to be expediently and opportunistically made on various elements. They tend to be made of long bones or ribs broken in a way such that the ends could be shaped and used for hide working (see Figure 27, left image for example). Many of them are long bones with spiral fractures where the tip is worn with polish. The polish or wear is smooth and is suggestive of hide working. These are tools that cannot be placed in a category such as flesher, awl, beamer, etc., but this category contains the largest projected values for hide working tools (519-553). Expedient bone tools seem to have been the main tools used in Cave 1. Given the large amount of hide working that was occurring, one might expect better made tools that were used for longer periods of time, a practice which would be easier than making new tools often. However, faunal bone for making tools was readily available and perhaps it was easier to make tools as needed rather than carrying around a large toolkit. Or, nicer made tools were more highly coveted and were taken with women when they left the site.

Hide Requirements: A large number of hides are required to clothe a family. Doing research with native groups in the Subarctic, Helm and Lurie (1961:102) reported that adults would need two to three caribou hides each for their clothing, and children would need one or two hides. These figures do not include the hides needed for shelter and other uses. As previously discussed, hunting was performed not only for food, but for hides as well (Brink 2008:224; Grinnell 1966:19; Reilly 2015:39). A Tahltan woman would produce 20-30 hides per year to fulfill the needs of her family (Albright 1984:55); five families would require upwards of 100 hides per year, whereas ten families would need upwards of 200. Hide was a necessity in life and women were usually the ones performing the hide working. This was not simply routine work: hide working and associated sewing can be closely linked to cultural identity, and this kind of work provided women with the chance to demonstrate high skill levels.

Using Steward's (1937) numbers and information known about private collections, there are over 355 moccasins and fragments known in all of the collections from Cave 1. Reilly

(2015:99) calculated that these moccasins represent 78.53 m^3 of hide[9]. Reilly (2014:103) then calculated that, depending on the size of the bison, 24.5-58.3 bison hides would be needed to manufacture this number of moccasins. The projected values of 2244-2537 moccasins would require between 161.7 and 435 bison hides. Buffalo Bird Woman's account of a pedestrian bison hunt by twelve people (six men, six women), along with dogs and travois, resulted in a total of 17 bison during a one-week period (Brink 2004; Wilson 1924). If between 15 and 20 bison are attainable for a small pedestrian hunting group as demonstrated in Buffalo Bird Woman's account, then it seems plausible that the number of bison hides needed by the population at Promontory Cave 1 was reasonable and attainable. If all the hunting was done by pedestrian hunts as described by Buffalo Bird Woman, then one hundred hides might need only 5-6 hunting episodes. The highest end of the range needed for the moccasins, 435 hides, would require between 20 and 30 hunts, a reasonable number when spaced out over 20 to 40 years. This calculation assumes hunting occurred similarly to how Buffalo Bird Woman's hunt took place, but this may not have always been the case. Northern Dene groups were familiar with communal hunting, and would have been able to adapt to communal bison hunting while moving south (Ives 2003; Perry 1980), a method which would allow for greater number of animals to be taken at once, providing more hides at one time. As well, much of the hunting likely occurred nearby. Low utility elements were brought back to the cave, including articulated pieces. Hunting was likely occurring in and around the nearby saddle area, and so bison and their hides may have been relatively easily acquired; long distance hunting trips may not have always been required. Hunting may also have been occurring during different times of the seasonal round, with completed hides and by-products being brought into the cave.

[9] Her calculations used a total of 340 moccasins; the number excavated during modern excavations has increased since her research as new fragments were identified.

The hide requirements needed for the moccasins provide a minimum number for the number of animals that would have been required to sustain the needs of this population. Unfortunately, other articles of clothing were not left in Cave 1, so I cannot speculate on how many more animals were needed purely for hide. Regardless, the overwhelming amount of faunal remains demonstrates that this population contained skilled hunters, and would have been able to provide the number of hides required by the population through pedestrian or communal hunting. I now turn to the tools used for this activity.

Hunting

Hunting was a crucial activity to provide both sustenance and raw material for tool making and hide working. The immense amount of faunal bone within the cave signifies that these people had no hardship in obtaining animals; the projected totals range from an astonishing 1.54 to 1.74 *million* faunal bone fragments. The main weapon during this time period was the bow and arrow (Figure 30). Components for this weapon include the arrow shaft, made of wood and/or cane, and the projectile point, made of stone. Included in my counts of "arrow shafts" are fragments made of both wood and cane, ranging from just the nocked end or foreshafts, to longer pieces in between these two. We did not find a bow in Cave 1, but Steward (1937:17) did find four bows or possible bow fragments. Men would typically own only one or two bows (O'Brien 2011), and these are less likely to break or be lost on a hunt than arrows. Bows were likely taken

Figure 30: Hafted arrow foreshaft from Cave 1 (42BO1.1224.1).

with the men when they left the cave. The following discussion focuses on projectile points and arrow shafts, two closely related artifacts.

Projectile Points[10]: The majority of the projectile points found were arrowhead types such as Desert Side-Notched, Cottonwood Triangular, and other side-notched points. These are found in the surrounding area and do not identify this population as distinct; though, these types of points are more commonly associated with Promontory sites (Forsyth 1986; Janetski 1994). The use of projectile point types that are common in the area indicates that this population was in contact with other groups from whom they either learned to make these points, or these points were acquired from them. It is also possible they were recycling points that they found. Dene groups often adopt material culture of other groups quite willingly (Ives et al. 2010). Secondary lithic recycling takes place when discarded artifacts are scavenged from the archaeological record. This practice has been documented ethnographically and archaeologically and can save time and energy when searching for raw materials (Amick 2007). Navajo and other Dene populations have been known to acquire projectile points through other groups and from scavenging abandoned pueblos (e.g., Keur 1941:71; Kearns 1996:126, 132; Morice 1894:54). The obsidian sources of the tools from Cave 1 would have taken days-long trips to acquire the raw material. If obsidian could instead be scavenged and recycled, this is much more efficient. Some of the larger points seen in Figure 31 are types from the Archaic period; they are much earlier than the Promontory population was inhabiting Cave 1, yet they come from well-dated Promontory deposits. These types include Elko, Gypsum, and other dart point types that would date much earlier than the Promontory occupation (Holmer 1965; Joel Janetski, personal communication 2015). These specimens must have been scavenged from the surrounding landscape.

[10] Lithic analysis based on my own observations along with analysis performed by Dr. Joel Janetski.

Many of the points are small and broken (Figure 31), features that are reason for discard, and these tools would need replacing. Many of them exhibit snap fractures at the tip, likely from impact while hunting; these arrows must have been retrieved and brought back to the cave for re-tipping. The projected number of projectile points (2562-2805) equates to a high number relative to the short occupation of this site. To hunt enough bison and other animals to not only sustain the food requirements but also the large hide requirements would mean that a number of projectile points would be used, re-sharpened, and reused again until loss or discard.

Figure 31: A sample of the projectile points found in Promontory Cave 1, demonstrating the high number that exhibit breakage and the variability in form despite the narrow temporal range of the Promontory Culture in Cave 1.

Seventy percent (44/63) of the projectile points are made of obsidian, 22% chert (14/63), 5% (3/63) chalcedony, and one each of basalt and quartzite. A majority of 58% of the total lithic assemblage is obsidian. Obsidian sourcing of 30 artifacts from Cave 1 using energy dispersive x-ray fluorescence (XRF) and trace element analysis was completed, and showed the origins to be the Malad (about 125 km northeast in a straight line) and Brown's Bench (about 165 km northwest) sources (Hughes 2011; 2012). Both lie to the north of Cave 1, in Idaho. The results of the sourcing demonstrated that the majority (22/30) of the tested artifacts came from the Malad source (Hughes 2011; 2012). This heavy use of obsidian would have required numerous trips to obsidian sources over the 20-40 years that the cave was occupied if this material was always acquired directly from the source. Speculating on why obsidian was favoured, it may be noted that many of the artifacts were small and there were many flake tools. Obsidian is a high quality raw material that allows for precise, controlled flintknapping, and has extremely sharp edges (Andrefsky 2006:24), so that it was likely favoured for small projectile points and flake tools that required sharp edges. It is also possible that this obsidian was gained through trade; ceramics recovered from the cave suggest contact with Fremont people who were in the area, and Malad was one of the main obsidian sources they used (Janetski 2002:354). Trade with or knowledge gained from other groups may explain the reliance on the Malad source, along with the fact that the path there was shorter than the one to the Brown's Bench area. Both sources lie to the north (seen in Figure 21), so this population may also have passed these sources and knew of them previously, before arriving at Cave 1. The previously mentioned site 10OA275 in Idaho was likely part of the Promontory population's seasonal round, and this travel would have provided an opportunity to access these sources as well (Arkush 2014). And as mentioned above, these obsidian artifacts may have been scavenged and recycled as well, benefiting from trips made by others to these obsidian sources.

O'Brien (2011), in his study on Gwich'in Athabascan implements, stated that at any one time a hunter generally had several bows in good order, as well as at least 15 arrows. Bows and arrows were made according to the user's height and strength, so each hunter would need his own set (O'Brien 2011). I calculated the use-life for projectile points at around five months (Table 25), and the occupation span was previously estimated at around four to six months per year. This calculation would suggest that each man would need to replace or re-tip his arrows at least once during their stay in the cave. It is unlikely that all of the 15 arrows would need to be re-tipped at once, but let us assume that for a moment. Using the projected numbers of projectile points as a proxy for the arrows, and dividing these by 15 arrows in a set, there would be 171-187 sets of arrows represented. Dividing this figure by twenty episodes of occupation, this calculation would equate to between eight and nine sets per year. Assuming one set per adult male, this would indicate a population of around 25. Recall earlier discussions about population in which I estimated that eight individuals out of a population of 25 would be prime-age males contributing to artifact discard, so this fits perfectly with that assumption. Performing this calculation with 40 episodes of occupation decreases the result to between four and five sets per year; this value is too low for a reasonable population size.

Complicating this conclusion slightly is the possibility of toy projectile points. Boys as young as 5 would be given small bows and arrows to start learning how to handle them properly, and they would continue to learn until they were old enough to hunt with adult-sized bows (e.g., O'Brien 2011). Some of the projectile points found were incredibly small, and may have been used by young boys (see Figure 31). The moccasin sizes prove that children were a large portion of the population, as does ethnographic information. Young boys learning to use and make arrows may have been more likely to discard small points within the cave. Toy arrowheads are more often found near campsites versus kill sites, as the camp is where these boys would be playing with them (Dawe 1997). An examination of the Promontory Cave 1 artifacts for evidence of children's toys and tools would be an interesting path for future research. On the whole, however, there is an excellent fit amongst projectile point use-life data, estimated length of occupation, and projected group size and composition.

Arrow Shafts: The projected number of arrow shafts, 1868-2208, is not too far from the number of projectile points. The number of shafts versus projectile points indicates that there is not a one to one ratio between the two. If the projectile point is damaged when hitting prey, then the shaft can be recovered and reused with another point. The projected numbers suggest a ratio of arrow shafts to projectile points of 3:4. This is a useful ratio, as it further quantifies how much perishable material is lost to typical taphonomic processes. Like the projectile points, the arrow shafts from the cave were typically broken and therefore at the end of their lives. An arrow shaft made of cane versus wood may also not last as long as it is not as sturdy, and is inclined to split on impact. We found nocked fragments made of both cane and wood, and a shaft may have components of both. Here I have lumped all arrow shaft fragments together in one category. The projected totals for arrow shafts and projectile points and the ratio between the two indicate that arrows shafts last longer than points, but not too much longer. These are organic artifacts that do not preserve well; archaeologists find the projectile points, but in our analyses of these tools we too often forget that they are only a part of the whole.

Summary of Projection Applications

The projected numbers of artifacts were used in a variety of ways to infer information about the population. Though the projected total numbers of artifacts seem at first large, in reality the picture appears this way only because of the extraordinary degree of preservation. Rather, the number of artifacts, especially the moccasins, actually indicates a smaller population using the cave for only a portion of each year. Both traditionally male (hunting) and female (hide working) tools are in great abundance, suggesting a population that was thriving. This population frequently hunted to provide not only sustenance, but also to obtain hides to make moccasins, clothing, and other leather goods.

Comparison of Areas Within Cave 1

The diversity indices used to compare the livable areas within Cave 1 demonstrate that F3 (Area A) is more diverse (Table 20 and Table 21). The following section explores why this difference exists, and whether it indicates if there were different activities occurring in each area. Area A is the larger of the two areas and has more available light, so it is not necessarily surprising that more activities would be performed here. An overview of Table 14 and Table 15 demonstrates the much lower densities that were excavated from Area B. Almost no debitage or stone tools were found in F28, indicating that flintknapping and re-tooling was primarily occurring in Area A. No bone tools and a much lower quantity of hide scraps were found in F28, an observation which again suggests that most hide working and manufacturing of clothing and moccasins was occurring in Area A. There were also fewer gaming pieces excavated from F28, indicating that more gaming activities were occurring in Area A than Area B. Other options for the differences between the areas could be gendered activities or other activities that only included a portion of the population. This area provided privacy both visually and with suppression of sound from other areas, so it may have been used for activities for which these qualities were desired. The lack of sound travelling is evident when large groups are in the cave, and has also been quantified through soundscape analysis (Lakevold 2017).

The statistical analyses provide support for the idea that F3 is within a depression used as a midden. A midden will collect an abundance of different types of artifacts, resulting in a high diversity of artifact types. A midden area will also collect material from all parts of the area, rather than what is just dropped in place. It still appears that Area A was used for more types of activities than Area B. I believe that these statistical analyses suggest that Area B was more likely sleeping area, and Area A was more of an activity area. The lower density and diversity of artifacts in Area B indicate that fewer activities were occurring here. The difference between the densities of F3 and F28 can be very large, such as with ceramics (Table 15). The incredibly small number of tools in F28 is also in contrast to F3, and further suggests that little manufacturing or work was occurring in Area B. Light was poor in this area; excavators regularly wore headlamps and used lanterns to provide light. Detailed sewing work and tool manufacture would be more easily done (and seen) in Area A. Steward (1937:9) believed that the layers of striped juniper bark was laid over the ground surface for bedding, akin to the use of spruce boughs for the same reason in the Subarctic (Clark and Clark 1974:34-35; Janes 1989:131). Bison hide robes were also present prior to excavations, and these could have been laid down on the surface for sleeping. All in all, Area B appears to have been the more desirable area for sleeping, as less material was in this area than Area A, and juniper bark and bison hide robes were laid over the material to provide comfort. These assertions could be better supported if Steward's publications had included provenience information, as he excavated much larger areas than we. This information would provide a larger sample size to study the differences between the two areas.

Further supporting the notion of F3 as a midden area are the concepts of "toss zones" and "zones of debris" (Binford 1983; Janes 1989). If the area were simply an extension of the living space and not a midden, then these theories would suggest that larger artifacts would be found around the edge of the area, with smaller ones found nearer the central hearth. However, F3 contains large artifacts, such as moccasins, as well as small artifacts, such as debitage. This occurrence may be indicative of an area-wide cleaning in which material was pushed into a natural depression, at least during the initial occupations when the depression was still noticeable. The radiocarbon dates suggest some mixing between the early and middle the occupation periods (E1 and E2 in Figure 8), but deposition becomes more regular as time goes on (E3 in Figure 8). A smaller initial population may have used the F3 area as a midden area, and then once it became level with the surrounding area and the population grew, it was used more often as an extension of the living area.

Another possible scenario is that material in Area B was cleaned up and also dumped in the F3 area; however, this possibility seems unlikely for numerous reasons. First, the path from the front of the cave to the back is narrow and requires steps up or down with the help of handholds. Carrying material from Area B to Area A this way would not be easy. The simpler practice would be to have a midden in Area B as well, but if this exists it has not been excavated. As well, Cave 2 contains contemporary Promontory material, and people from the same or related groups likely used this cave at the same time as Cave 1 was being inhabited. Area A in Cave 1 may have been a communal activity space for those living in Cave 1 and Cave 2, as Cave 2 is much smaller than Cave 1 and would not provide much room for activities. Using Area B as a sleeping area would provide privacy from this more communal activity area. Comparing the density of material excavated from Cave 2 to that of Cave 1 would be a worthwhile goal in future research.

Area A is the largest area within the cave so it is logical that the majority of activities occurred here. What is peculiar is the apparent lack of use of Area C. Steward noted that this area was sterile, and our explorations attest to this as well. Area C is a large area that covers the back third of the cave (Figure 4), and could have provided much more storage and activity space. This area is rocky but not so much that its use should be hindered, and more light reaches this area than Area B. This area is flanked on either side by rock art, which may have impacted how this area was used (see Figure 20). It could be that the presence of rock art there led to avoidance of this area. For example, Copeland and Rogers (1996:226) noted that Navajo people regarded Puebloan rock art sites as locations already charged with power. Things relating to Puebloan life were generally avoided and even considered dangerous by the Navajo, but there are many cases of Navajo rock art overlaying Puebloan art, along with evidence of using these sites for ceremony and ritual (Copeland and Rogers 1996:226). If Area C was generally avoided, and used only for ceremonial or ritual activities, relatively few traces might be left. Obviously, something was different about this area of the cave, deterring people from discarding artifacts there. This pattern of avoidance was consistent throughout the entire Promontory occupation.

Ultimately, Area A was the main activity area in the cave, with the majority of tool and clothing manufacturing and maintenance occurring here. In terms of activities that leave cultural debris, Area B was used to lesser degree. Area B may have been a sleeping area that was separate from the main hearth and manufacture area. With the evidence provided, I conclude that Area A was used as the main communal activity area, likely because it was a larger area with more light available.

Accumulation Equations

Schiffer's (1975) and Surovell's (2009) equations use some of the same variables, such as occupancy time and total number of artifacts discarded, and their equations resulted in similar values in terms of population. Schiffer's (1975) equation was used to obtain the use-lives of selected artifacts, and Surovell's (2009) was used to calculate discard rates. These variables are connected, as typically an artifact will be discarded once its use-life has ended. After discussing the results from each formula, I will discuss how these equations are related and make conclusions as to how many people were inhabiting the cave, as well as the relationship between an artifact, its use-life, and the rate at which it was discarded.

Population and Occupation Span

Schiffer's (1975) equation (Equation 3.1) was first used to obtain the systemic number of moccasins, using the total projected range of moccasins and various yearly occupation times (Table 24). These results suggest a shorter occupation span, with a smaller population. The calculated number of pairs in systemic context over 10 years ranged from 22 to 25. Assuming one pair per person, this figure would indicate a population of around 20-25 people. This fits well with the previous results from the projected numbers of artifacts discussed in the previous section, an analysis which also suggested a smaller population over a shorter period of time. More specifically, the analysis based on the use-life of moccasins (Table 32) produced an estimated total occupation span of around 120 months, or about 10 years. I previously suggested that a smaller population inhabited the cave for 4-6 months a year over the dated occupation span of 20 to 40 years. The results from Schiffer's equation corroborate this conclusion. If the cave was used for 40 years, then this averages to three months per year (the total 120 months divided by 40 years). Over 20 years, this averages to six months per year.

However, as mentioned previously, I calculated a new total for moccasins based on the proportion of children's moccasins collected from Cave 1. If 82% of the moccasins were from children, but children actually comprised around 50% of the population, then some moccasins are missing because of adult discard bias. Using this inflated number of moccasins (3680-4160) based on the proportion of children's moccasins in the cave results in a yearly occupation of 4 to 10 months for 25 people, and 2 to 5 months for 50 people (dividing the total months in Table 32 by 20 and 40 years) (Table 33). The stratigraphy suggests around 20 episodes of accumulation; if each episode represented a period of occupation, then the calculations using 20 years would be more accurate (assuming one occupation per year). A population of 25 would have to occupy the cave for between nine and 10 months, and a population of 50 would have to occupy the cave between four and five months, for each of the 20 episodes of occupation (Table 33). This would suggest a larger population closer to 50 people, as I do not believe it is likely that people inhabited the cave for 10 months at a time. However, all other analyses have consistently suggested a smaller population closer to 25. I believe these 20 episodes therefore do not represent individual occupation events. Perhaps some of these stratigraphic units represent cleaning events that did not occur during every occupation; cleaning events would also explain the mix up of radiocarbon dates discussed in Chapter 2. These large stratigraphic levels were difficult to identify during and after excavation, so more precise individual occupation layers that may have existed would have been impossible to see in the conditions in which we excavated. These values could also be inflated if the 82% figure for children's moccasins is an overestimate that results in a total number of moccasins that is too large. The occupation times above using the original numbers of moccasins do appear to result in more reasonable values for occupation time based on a population of 25.

This discrepancy in estimates of population size may also arise because I am assuming a consistent population size. It is quite possible that initially scouts or a small group first inhabited the cave, and then the size of the group grew, in part owing to successful large mammal hunting. At times the population size was likely near 25 individuals, but at other times could have been more or less. The cave was abandoned after only a few generations, for no obvious reason we can immediately discern. Perhaps a growing population outgrew the cave, and with declining bison populations were forced to move on. This would be an interesting direction to explore in future modeling, but is beyond the scope of the current research.

Surovell's (2009) equation uses similar variables to Schiffer (1975), but can directly solve for the number of site occupants. The number of site occupants was calculated based on the number of moccasins (Table 26). As with Schiffer's equation, the most likely scenario is a population of around 25 for a combined time of 10 years, a figure obtained using the higher end of the total estimated number of moccasins. A population less than this (such as 6-13 individuals as the other results would suggest when projected over 20 and 40 years) would not be demographically sustainable, and is not consistent with the high volume of cultural materials and debris present in the Promontory Culture occupation that obviously occurred within Cave 1. A projected group size of around 25 is also consistent with the typical group size of hunter-gatherer groups, as discussed in Chapter 2. What makes these results more valid is that the value of 25 was obtained using methods independent of simple ethnographic analogy. The projected totals of artifacts within the cave and the accumulation equations have all independently resulted in a population size of around 25 people. The results from the equations are consistently indicating a smaller population size and shorter combined occupation period. This value of 25 was used for further analyses, using Schiffer's (1975) and Surovell's (2009) equations to estimate use-lives and discard rates, respectively.

Use-Lives of Artifacts

Assuming a population of 25 individuals, the use-lives of selected artifacts were calculated using Schiffer's (1975) equation (Table 25). These artifacts encompass the activities of hide working (scrapers, fleshers, awls, and tabular scrapers) and hunting (projectile points and arrow shafts). Using the range of projected numbers of artifacts and the various estimated occupation spans, several possible use-lives were calculated (Table 25). Previous analysis has suggested a combined total occupancy time of around 10 years, spread out over the 20 to 40 years of cave occupation. The calculated use-lives will be discussed in terms of the shorter combined occupation spans of 10 to 20 years, which represent 120 months and 240 months, respectively, spread out over the 20 to 40 years range. The 40-year occupation time (or 480 months) is not used, as I have shown that the population was not sedentary.

With the high amount of hide working occurring in or near the cave, a large number of stone scrapers would have been used and exhausted. Clark and Kurashina's (1981) research indicated two obsidian scrapers used per hide, meaning the use-life could be as short as a day. However, Brink's (1978) research indicated that chert endscrapers can be used for a long time, and Osgood (1970:79-81) described a "stone skin scraper" that lasted two years even with heavy use. The drawing that he provided is comparable to a hafted endscraper. The results from my calculations indicate a use-life of around four months to just under a year (Table 25). Given that the scrapers excavated from Promontory Cave 1 were made of materials like chert, and not obsidian, a use-life of a little less than half a year seems reasonable. A factor influencing these numbers is the discard location of scrapers. Some aspects of hide working (such as defleshing) were likely occurring outside the cave area, as these can be smelly and messy processes. Hunting and hide working could also have taken place during other parts of the seasonal round, as the site 10OA275 in Idaho would suggest; this would mean that fully or partially processed dry hides may have been transported to the cave (Arkush 2014; Reilly 2015). When scrapers were exhausted and no longer usable, they would be discarded where this work was taking place, as there would be no need to bring them back to the cave. If there were actually more scrapers maintained by the group than is represented within the cave, then the use-life would be shorter. As well, if my estimation of 16 scrapers in use at a time is incorrect, this error again alters the calculated use-life. If a woman had more than two in her toolkit, then the calculated use-life would decrease. Different values for the number of scrapers would also alter the estimated number of hides, discussed previously. A decreased use-life would mean that more scrapers were required per hide, and that these tools were not as durable as one may think even though they are made of stone.

As few awls were excavated, the equation resulted in a longer use-life for these artifacts (Table 25). The calculations resulted in a range of about 16 months to just under three years, using total occupation spans of 10 to 20 years. Osgood (1970) notes that awls can last a short or long time, depending on the type of awl and what it is used for. He (1970:73-75) described a "sewing awl" that lasted a long time with experienced users, and notes that novices broke them easily. These awls can also be inherited, though not always for use, but for for sentimental value (Osgood 1970:75). So, a longer use life of 16 months or more is reasonable for the awls here, assuming the awls that we excavated were being used for hide working (as we found no needles, they likely were).

The use-life range calculated for fleshers is between approximately six months to a year (Table 25). Osgood (1970:78-79) writes that a "bone skin scraper" lasts half a year, but Reilly (2015) reports that fleshers can be handed down through generations. As previously discussed, it appears likely that expediently-made fleshers made opportunistically on available elements were discarded more regularly than the fine, toothed examples such as those that Steward excavated (see Figure 27). A use-life of six months, assuming a combined 10-year occupation, matches well with Osgood's (1970) observations that similar bone tools lasted the same amount of time. Steward found two toothed bone fleshers of the type that I am suggesting may have been more curated. Projecting these two fleshers into the total cave deposits results in a total of between four and five. Substituting this lower value for the total number of fleshers discarded (T_D) into Schiffer's (1975) equation (Equation 3.1) for comparison, the calculation results in results in a use-life of 32 to 40 years, more akin to being curated and handed down through generations.

Tabular scrapers are another tool that is reported to be curated for long periods of time (Table 9; Janes 1983; Pokotylo and Hanks 1989; Reilly 2015). The values reported in Table 25 are about 16 months to just under three years. As this tool is made of stone, and it is used towards the end of the hide working process to soften already de-fleshed and de-haired hides, a long use-life is not unreasonable. As discussed previously, the degree to which these and other artifacts are curated can vary between individuals and groups. At least some of these tools may not have been curated in this population; or, the few we did find were by chance and the projected values are not an accurate representation of how many, or few, are in the cave. Ignoring the curation factor for a moment, a use-life of 16 months to a few years is a reasonable result for a stone artifact that is used to soften hides. Osgood (1970:81) describes a "stone skin rubber" that was used to rub a dry hide; this artifact may be the closest tool to a tabular scraper described by him. This tool was not modified; it was a river stone that was deemed the right size but was not flaked (Osgood 1970:81). Its use is similar to that of a tabular scraper, which is also used to scrape the hide in later stages and is not heavily worked. This tool is said to last a "long time." (Osgood 1970:81). It is unclear whether Osgood's (1970) "long time" could mean years or decades; regardless, if these tools are not being curated, then 16 months to a few years remains a valid estimated use-life for these stone artifacts.

The use-life range for projectile points is just under half a year to just under a year (Table 25). A short use-life is expected because projectile points can be lost, not only due to breakage, but due to chance as well. Firing an arrow while hunting can result in the point and arrow being lost. Osgood (1970:207) reported that the length of life for an arrow varied considerably, with much due to chance. Projectile points also undergo more impact forces than other tools and so will break more frequently. A use-life of around five months makes sense for a population that hunted a great deal. The use-life for arrow shafts is similar to that of projectile points, lasting a few months longer (Table 25). This use-life is logical because arrowheads will break, but the shaft may still be usable and can be re-tipped with another point. Short use-lives are to be expected for artifacts that have a high chance for breakage and a high chance of loss, as is the case for projectile points and shafts.

These use-lives are for a population of 25 individuals inhabiting Cave 1. If I plug in values for a population size of 50 instead, these use-lives double in length. For some artifacts this simply does not make logical sense. For example, the use-life for projectile points would double to between about one or two years. A use-life this long for a type of artifact that experienced heavy use and a high chance of breakage simply is not reasonable. This further supports a population size of around 25 individuals within Cave 1.

As the Chapter 3 discussion indicated on the question of how artifacts enter the archaeological record, many factors play into these use-lives, such as how often the artifacts were being used, a frequency that may vary between groups, between individuals, and over time. These values will differ also depending on the material used, especially for projectile points, as different raw materials have different strength values. Artifacts like projectile points and scrapers have the shortest use-lives, but are frequently used tools that have a higher chance for breakage. Tools like awls and tabular scrapers, which are used often as well, have longer use-lives because of the way they are used and the circumstances in which they are used. These tools are used on hides that have had all the meat and hair stripped from them; the abrasion is less for soft leather than a hide with meat and hair still to be removed. As well, raw material for the described bone tools was readily available and so this population did not need to be frugal with these tools. The use-lives above are those that I believe are reasonable, provided the results of all the calculations and the comparisons made to ethnographic and ethnoarchaeological accounts are valid.

Artifact Discard Rates

Per capita discard rates among hunter-gatherer groups are not easily known, as they are not typically reported on in ethnographic works. Ethnographic sources may mention how many artifacts of a specific type a person owns, but not how often they are discarded (e.g., Sillitoe 1988). Some authors mention, with varying levels of detail, how long the use-life of an artifact would be, from which a discard rate could be roughly surmised (e.g., Osgood 1970). This calculation also depends on how many of each artifact would be in use at a given time. As mentioned at the beginning of this section, a population size of 25 was used to solve for the discard rates using Surovell's (2009) equation (Equation 3.2).

The discard rates calculated are per capita rates; therefore, these results are for the population as a whole, although not every member of the population will be using these artifacts. Using scrapers as an example, these are most often used in hide working and so they are typically used by women. Using a 10-year total occupancy time and the low end of the total number of artifacts discarded resulted in a discard rate of 1.384 scrapers per person per year (Table 27). But if only women are using this tool, then I need to adjust this value. I am assuming that there were eight females old enough to perform hide working in this population of 25; these females therefore represent 0.32 of the total population. Dividing the per capita discard rate by 0.32 results in 4.33 scrapers discarded per woman per year. The use-life calculated for scrapers was a little under half a year, assuming that a woman would have two scrapers in her toolkit. If women have two scrapers in a toolkit, and if they last about half a year, then discarding between four and five per year works out neatly.

The discard rates in Table 34 are adjusted for the assumed number of individuals who would be utilizing these artifacts. In each case, either men or women (and older adolescents) would be using these artifacts, not the entire population. So for each of the values of Table 27, the per capita discard rate was divided by 0.32 to obtain the value for number discarded per male or female per year (Table 34). These discard rates at first appear high for some artifacts, such as projectile points. However, recall that the use-life for projectile points is only around five months, and with a full quiver of arrows that are being used often, this use-life would result in many being discarded per year. Also recall that the Promontory Culture faunal remains from Cave 1 are abundant and it is clear that the occupants of the cave were highly proficient large game hunters.

Artifact	Discard Rate (r) (per year)	
	10 years	20 years
Scrapers	4.33	2.16
	4.61	2.31
Awls	1.44	0.72
	1.54	0.77
Tabular Scrapers	1.44	0.72
	1.54	0.77
Fleshers	3.60	1.80
	3.84	1.92
Projectile points	32.03	16.01
	35.06	17.53
Arrow shafts	23.35	11.68
	27.60	13.80

Table 34: Discard rate results per year from Table 27, adjusted to represent the portion of the population using the selected artifacts.

The discard rates above are related to the previous results for estimates of use-lives as the same variables are used to calculate them. This interpretation only makes sense, for if an artifact's use-life is one year, then its discard rate will be one per year. This rate changes if more than one artifact is used at a time, which is why the systemic number is used for these calculations. As discussed above, artifacts such as projectile points and arrow shafts have a short use-life and there are many in systemic context, and so these artifacts have a high discard rate as well. The frequency of use is high for these artifacts. Artifacts that are used for more gentle work, such as tabular scrapers for hide softening, have a longer use-life and so a low discard rate.

For this equation, I used a population size of 25 because that is what previous analyses have indicated, largely based on the moccasins. The discard rate for moccasins (10 per year) was based on averaging values from ethnographic accounts. If I alter this discard rate to increase the number of moccasins discarded per year then the population size becomes too low to be sustainable. If, for instance, a person discards 16 per year (or eight pairs), then the population decreases between 14 and 16 individuals over a total 10-year occupation time; this population size decreases even further over 20 years. The results further support that a discard rate of 10 moccasins per year per person is a good estimate, further validating the calculations I made based on this value.

The values in Table 34 differ from those in Table 23 because they are per capita rates, whereas the values in Table 23 are just the average number discarded per year for the whole population. Examining these values reinforces the idea that while at first it seems that an enormous number of artifacts were discarded in Promontory Cave 1, the discard rates per year are reasonable. The cave only appears so unusual because of the exemplary preservation, a fact that has been reiterated in all of my calculations.

Summary of Accumulation Equations

An artifact's use-life and discard rate depends on many factors. What an artifact is made of, how it is used, and how many are needed to complete a task all contribute to how long artifacts will last. Social factors such as curation and frugality also play a part in how long an artifact will be used before it is discarded. These factors and more were discussed at length in Chapter 3. The results of the equations above suggest a population that did not need to be very frugal, at least with the artifacts I chose to examine. If raw materials for these artifacts were difficult to attain, I would expect longer use-lives and low discard rates. Instead, we see what I believe are reasonable values for these two variables. The material for bone tools would have been easily attained given the large quantity of faunal bone in the cave. The large quantity of wooden artifacts suggests that wood was not difficult to find, either. The obsidian sources, Malad and Brown's Bench (Hughes 2011; 2012), are both to the north and so may have become known to this population during migration southward. These materials may also have been obtained within a seasonal round. It is unknown where the other chert and chalcedony materials were obtained, but evidently they were not impossible to obtain. So, I would conclude that given the above calculations, the population at Promontory Cave 1 was in good condition with regard to availability of materials to make tools, and was not experiencing a shortage of these materials.

The use-lives and discard rates above provide a value for comparison for other archaeological sites and artifacts. The formulae used can be rearranged to solve for any of the variables, depending on which ones are available. Now that my values for use-life and discard rates are available, archaeologists can use them to calculate population size if they have the other variables such as total artifacts and occupancy span, or any combination thereof. These values may not apply to every group at every site, but can provide a beginning point for discussion and can act as a comparison for other sites.

Ratio of Non-perishable to Perishable Artifacts

Recall that the ratio of non-perishable to perishable (formed) artifacts calculated was 1:3.5; 78% of the artifacts excavated from Cave 1 were made of perishable materials. The quantity of non-perishable materials is quite substantial, and this part of past life is so rarely seen. This value serves as a way to estimate the perishable component of archaeological sites without the same level of preservation. While this unusual site is only one example and every site cannot be expected to imitate this one, the ratio provides at least a comparison to visualise the amount of perishable material that is normally missing. While there may be some unique aspects to the Promontory Culture occupation in Cave 1, it is important to note that this ratio is similar to other ethnographic accounts and archaeological sites. It is not unreasonable to generalize that more typical archaeological sites are missing a large proportion of the material culture that initially enters the archaeological record. Below I compare this ratio to some of the other sites and cases discussed earlier.

Hogup Cave is the most similar site to Promontory Cave 1 that I have described in terms of the type of site and preservation environment, as it is a dry cave that preserved organic materials. Hogup Cave was determined to have been occupied seasonally, to varying degrees over the thousands of years it was used, as part of an annual round (Aikens 2009:294; Aikens 1970:195), much like the case of Promontory Cave 1. Following the same methods described previously, deleting categories of non-formed artifacts such as debitage and unworked faunal bone, a ratio of 2:3 is obtained for non-perishable to perishable material, using the quantities published in Aikens (1970). Perishable material still dominates, but not to the same extent as at Promontory Cave 1. The Hogup cave record is over thousands of years, however, rather than just 20 to 40.

The sites on the Northwest Coast, Ozette and Hoko River, are the two archaeological examples that have a higher percentage of perishable materials than Cave 1. The ratio of non-perishable to perishable artifacts for these two sites is 1:19 (Croes 1995). I believe this is likely due to the focus of woodworking in this cultural area, as well as the inclusion of structural remains in the perishable materials category. These sites do represent the possibility of an even higher amount of perishable materials to exist in the archaeological record, and also demonstrates the differences that exist within different culture areas.

Both Osgood's (1970) and Sillitoe's (1988) ethnographic accounts list only the types of artifacts described, so that we do not have a true ratio of how many artifacts of each type were used at a given time. However, the general ratio for both accounts is about 1:4 for non-perishable to perishable artifacts. Again, a significant portion would be lost to typical taphonomic processes. This 1:4 ratio parallels Robbins' (1973) research as well, which was specifically looking at this ratio. Robbins' (1973) ethnoarchaeological research concluded that an extremely small amount of material would be found within a year of abandonment of the settlement because there was such a high percentage of perishable materials.

Promontory Cave 1 can be added to the list of ethnographic studies (e.g., Osgood 1970; Robbins 1973; Sillitoe 1988) and other well-preserved archaeological sites (e.g., Aikens 1970; Croes 1995; Kirk and Daugherty 2007; LeBlanc 1984) where a large percentage of perishable material culture is the norm. As archaeologists, we know that there would have been more than the stone and bone artifacts we generally find, but so often forget that artifacts made of wood and plant materials were abundant and played a large part in daily life.

Figure 32: A hafted scraper from Steward's excavations (42BO1.11583), likely discarded because the stone portion was too worn down to be usable. Photographed courtesy the Natural History Museum of Utah.

Figure 32 provides a good example of an entire tool that represents archaeologists' tendency to forget the perishable portions of material culture. This figure shows a hafted scraper in Steward's collection. Typically, we will find only the stone portion of this multi-component artifact, and often forget that it represents just a portion of the complete tool. To make this tool, people would have had to obtain the stone, work it into a scraper, obtain the bone, work it into a handle, obtain animals for the leather and sinew to haft it, and then put these all together. The lithic portion of this technology would very likely take the least amount of time to prepare. Much credence is often given to stone artifacts in identifying people when these can be the least distinctive artifacts. Researchers use artifacts like projectile points to attempt to connect archaeological artifacts to specific populations, but this analogy does not always work very well. Projectile points are often similar across a wide area and so may represent many populations and not just a single group or culture. Robbins' (1973) ethnographic study found that the distinctive artifacts used to identify Turkana groups made up only 4% of the artifact inventory.

Perishable materials such as clothing are not only a huge practical part of daily life, they are also a huge part of identity. Articles of clothing like moccasins can identify a person to a specific group, and the distinctive styles are a way for individuals to express themselves; for example, the beadwork and decoration on moccasins differs between groups and thus acts as an identifier (Lycett 2014). Decorative work is also a symbol of women's skill; in historical Plains societies women's status and wealth could be dependent on this skill (Lycett 2015). Hide working was a way that a woman could demonstrate her ability to clothe and support her family (Thompson 2013). These articles of identification are lost when the artifacts disintegrate in the outside environment. The design and method of manufacture of the moccasins show that the Promontory Culture occupants of Cave 1 had a completely different sewing tradition than the surrounding Great Basin groups, quite likely that of ancestral Dene people. Without the moccasins here, it would be more difficult to identify the population. This is the problem with most of the archaeological sites found in North America, and one of the biggest issues in identifying the route that Apachean ancestors travelled to get to the Southwest. The perishables in Promontory Cave 1 indicate that it was occupied by an intrusive population with Subarctic and Plains ties, likely of Dene origin. Human traces on these perishables can also be used for research such as ancient DNA analysis to genetically confirm the genetic make-up and identity of this population.

To conclude, perishable artifacts made up an enormous portion of past daily life. Stone artifacts are usually all archaeologists are left with to attempt to discern identity, but these tools may not be as closely tied to identity as items such as clothing, which often explicitly signal cultural origins. Archaeologists normally lose *so* much to taphonomic processes that degrade and disintegrate organic artifacts. Without these perishables, my analyses would not have been possible, and I would argue that our interpretation of this site would be very different and more limited. This research has served to quantify just how much is missing, and provides a ratio to compare to sites without this level of preservation.

Chapter 7: Conclusion

Promontory Cave 1 is an incredible archaeological site with the potential for a multitude of studies on essentially every aspect of past material culture. This research is an example of this. Here I summarize the above research, and how it can inform us about Dene migration and the broader archaeological record. I also return to my research questions, providing summary answers to these, and provide suggestions for future directions in which this research could proceed.

Review of Methods and Results

The methods I used and subsequent results that I obtained within this research are those that are often not feasible for many archaeological sites. Archaeological sites are diverse, and values for the variables needed for the methods I used are not always easy to come by. For example, something as seemingly simple as site size or boundaries can be difficult to attain with the time and resources available, not to mention the potential for destruction of sites by modern activity and industry. The time frame bracketing the occupation of Cave 1 was also short and precise, precision that is not possible with sites that contain no datable material. Promontory Cave 1, therefore, provided the perfect opportunity to use the methods I employed to study artifact accumulation, discard, and use-life.

The calculations and projections worked best for artifact types that were more frequent, leading to projected values that are likely close to the actual number. When we found only a few artifacts in one category, then the probability of discovery by chance increases. For example, we found only two tabular bifaces. Projecting these numbers results in potentially hundreds within the entire cave. The projected numbers may be an over-estimation of the true value if tools like these were found by chance, and the densities are actually much lower. The modern excavations also represent a small sample of the whole site, increasing the chance that we missed some artifact types; for example, we found no bow fragments even though Steward did. Performing more intensive statistics on this sample in the future may shed light on how much excavation is enough to represent the entire site. However, the examination of the use-lives and discard rates for these artifacts resulted in realistic values based on the numbers that were excavated, so the calculated densities are reasonable.

I believe my calculated projections of artifacts are quite accurate for more common artifacts such as moccasins, projectile points, and other hide working tools. These are more common everyday artifacts that are discarded when no longer usable, and therefore enter the archaeological record at a more regular rate. The best way to test my calculations would be to continue to compare them to collections from other well-preserved sites with good information. Using the accumulation equations on these sites and comparing them to my results would hopefully reveal similarities and patterns in how past peoples lived their lives.

Return to Research Questions

In Chapter 1, I listed four research questions that I aimed to answer with the various methods and calculations I performed on the artifacts from the cave. My analyses and discussions have answered these questions, and I summarize them here:

1. *What is the density of individual artifact classes within the excavated portions of Promontory Cave 1, and how many artifacts of each class can be projected to exist in the entire cave? How do these values contribute to the study of who and how many people lived in this cave?*

These variables were calculated using GIS and mathematical methods. Ranges were used to ensure accuracy and the two living areas were treated separately due to differing counts and densities within the excavations. Once the values were calculated, the projected totals were first independently compared to ethnographic and other sources that discussed systemic number and the totals were used to infer a population size of around 25 people. I also used these totals to examine other variables such as hide requirements. Second, the projected totals were substituted into accumulation equations to obtain values for population size, artifact use-life, discard rate, and other variables. This analysis helped to identify how people treat artifacts and obtain reasonable use-lives that can be compared to other sites.

The independent calculations consistently resulted in estimates of a population size of around 25 individuals. This value was repeated no matter the artifact type used in analysis and was also repeated in results of the accumulation equations. Arguably the most useful artifact for determining population size was the moccasins (2244-2537 total) because of the multiple ethnographic sources that contained information on use-life (2.4 months per pair) (e.g., McClennan 1975; Helm and Lurie 1961; Russell 1898). The projected number of projectile points (2562-2805) also provided a good indicator of the size of the male population. Using this total, along with O'Brien (2011), I was able to estimate a male population of around eight individuals; this value is identical to the estimated proportion of males that would be hunting in a population of 25 (see Table 8 and systemic number discussion in Chapter 3). The possible population size does increase when the total number of moccasins is inflated to account for the discard bias of adults based on Billinger and Ives's (2015) age estimations based on the length of the moccasins. However, another reason that there could be such a high percentage of children and adolescent moccasins within the cave is simply a higher proportion of children, rather than discard bias. If children represented more than 50% of the population, the population size could still have been around 25 people but with different proportions than are presented in Table 8. It is also quite possible that the first habitation in Cave 1 was by scouts, who were likely male, and who then brought a larger residential group to the site. This initial population may have been small and then increased in size during the period Cave 1 was used, with the proportion of children growing as well. The inflated numbers of moccasins present the possibility of a population closer to 50 individuals, but not more. Regardless, based purely on the artifacts within Cave 1 and not those that may have been discarded elsewhere, the population size is consistently calculated at around 25 individuals.

Once it was clear that this estimated population size of 25 was consistent, this value was used in further equations examining occupation span, use-lives, and discard rates. These results show that the occupation of Promontory Cave 1 was dynamic. Previous thoughts based on the immense amount of material present, along with the imprecise seasonal indicators, suggested the possibility of a relatively sedentary population. My results show this is not exactly the case. The stratigraphy suggests perhaps 20 episodes of accumulation, though I have mentioned previously that I do not believe these episodes can be directly identified as distinct occupations. These episodes do indicate pulses of discard and clearing activity, however. Table 32 best shows the total occupation time based on both the original total for moccasins as well as the inflated value. Dividing the number of months by either 20 or 40 years provides the number of months occupied per year, and produces a large range from one to 10 months (Table 33). The most likely range is a couple months to half a year, spread out over the 20 to 40 year period. Seasonal indicators such as the faunal and botanical remains indicate that occupations could have occurred essentially any time of year (Table 1). This may become clearer with more faunal age at death analysis, but as of now it appears that the occupations of Cave 1 may not have always been regular as to their seasonal timing. Multiple occupations within the same year could also have occurred. Some occupations may have lasted longer than others, and occupations may not have always occurred during the same season. Factors influencing length of stay include: the resources available (i.e., whether bison and other animals were in the area); relationships (good or bad) with surrounding groups or within the population; or even the weather. During a particularly bad winter, living in a cave sounds much more pleasant than living in the open. Humans are creatures of habit but also have agency to change their routines when presented with different circumstances.

2. *What is the accumulation rate of artifacts, and what patterns exist in these rates for various artifact classes?*

Accumulation rates were calculated in several ways. Simply dividing the projected totals of artifacts by the overall length of occupation provided a crude look at how many artifacts accumulated per year. A more accurate value for discard rate was obtained for select artifact classes using equations from Surovell (2009). The discard rates were discussed for each artifact type in turn, and compared to any known ethnographic accounts of similar artifacts. Before this analysis, however, the results from Equation 3.2 had to be adjusted to represent the discard rate based on the number of individuals using these tools, rather than the per capita rate for the entire population. Ethnographic sources indicated that use of the tools I selected was gendered, and so the proportion of males and females in the group had to be estimated. These proportions were calculated based on ethnographic records of hunter-gatherer group size and composition, as well as assuming consistent birth and survival rates and assuming that older "children" would be using tools like adults. The calculated discard rates tended to match what had been reported in sources such as O'Brien (2011) and Osgood (1970). Not surprisingly, artifacts that are used often on rough substrates, such as scrapers, have shorter use-lives than artifacts that are used less often and on softer substrates, such as awls. However, artifacts that have previously been identified to be highly curated, such as fleshers and tabular scrapers, were shown to not always be treated this way. The fleshers from our excavations in Cave 1 were expediently made and not ornate, but two that Steward found were well made, and these may represent ones that were more highly treasured.

Examining accumulation rates by calculating use-lives and discard rates demonstrated that while the total projected number of artifacts within Cave 1 initially appears to be immense, in reality the yearly accumulation is very reasonable for a population of 25 individuals. The values for hide working and hunting tools do indicate these were prominent activities, but not so much that they suggest lengthy occupation times or a much larger population. It is true that a number of my calculations required the use of ethnographic or historic data; yet, different manipulations of the accumulation equations yielded results that are highly consistent, an outcome we would not expect if different initial assumptions were seriously in error.

3. *How do different areas within Cave 1 compare in the types and amounts of artifacts present?*

The two living areas within the cave were compared by examining the counts and the densities of artifacts as well as applying statistical methods. Diversity indices were employed to compare the two areas, and this analysis identified that Area A had greater artifact diversity. This result affirms that Area A was the more desirable area for activities, and it is clear that the majority of manufacturing and other daily activities took place here. Area B had detectably lower densities and was missing many artifact classes that were present in Area A, signifying a more limited range of activities. It seems more likely that Area B was used as a sleeping area where less work was being performed, likely due to the limited light as well as the privacy that the cave structure provided. Area C had virtually no evidence of use, a factor that may be attributed to the presence of rock art that borders this area, which may have been avoided save for ceremonial occasions.

4. *What is the ratio of non-perishable to perishable artifacts, and how can this ratio help us to interpret sites that do not preserve organic material (the normal case for archaeological sites)?*

The ratio for non-perishable to perishable materials is 1:3.5; or, perishable artifacts comprised 78% of the Cave 1 tool assemblage. Perishable artifacts by far dominated past material culture, though my ratio does not include unworked faunal bone, debitage, or non-quantifiable items such as fur and hide. This is not a new declaration, but one that is often forgotten when analysing archaeological sites based only on the stone or bone artifacts left behind. So much authority is given to different types of stone artifacts in determining culture and ethnicity, but in reality many groups would have used similar types of stone tools. Perishable artifacts such as clothing, however, provide much more information about identity. This ratio can be use as a reference for understanding other archaeological sites with poor preservation, and can also be compared to other well-preserved sites to assess different lifeways. Additional implications of this ratio are discussed in a further section.

Synthesis

The above research questions resulted in the determination that a population of around 25 individuals inhabited the cave. This population may have started out smaller and then grown while using the cave, but the number of artifacts discarded within the cave consistently indicates a population size of 25 people. This population occupied the cave for a few months at a time (likely around two to four months per year) over the 20 to 40 year period. Using this information, and manipulating the accumulation equations, resulted in reasonable values for use-lives and discard rates for hunting and hide working artifacts. My results remain valid no matter the identity of the population using Cave 1, and these results have provided new information about this archaeological site and its occupants.

New Connections to Dene Migration

While I use more examples from Dene ethnographic sources, the previous conclusions make no assumption about the identity of the Promontory Cave 1 occupants, providing unusual insights into this population regardless of their cultural identity. Although the identity of the population in Cave 1 has not yet been conclusively determined, Steward's suspicion that they were a migrating Dene population remains reasonable for the evidence he recovered and for our more recent studies of the caves. For the purposes of the following section, let us assume this is the case. The following paragraphs examine how my research and results add to the current knowledge of Dene migration.

Finding evidence of Apachean ancestors on the landscape has been a difficult and contentious task. Archaeological evidence of Dene migration has proved to be quite elusive, a situation which fuels the interest and debate surrounding this topic. Questions about the exact timing and route location have hindered searches for sites in the area between the Subarctic and the Southwest, not to mention the fact that archaeologists do not know exactly what they are looking for in terms of migrating Apachean ancestor material culture, as it will be transitional between that of the origin and destination (Seymour 2012b). Dene groups also readily adopt material culture from other groups (Ives et al. 2010), further obscuring them in the archaeological record. The possible identification of the population living in Cave 1 as Apachean ancestors places a precise spot on the map between the origin and destination locations for this migration, and now I have quantified this population to around 25 individuals. This interpretation further informs the muddied story of Dene migration. While genetic and linguistic evidence suggest that the founding Apachean population was small, it was more likely in the range of a regional marriage isolate in size, and thus would have consisted of at least a few hundred people. A population of around 25, plus potentially a smaller group of people living in Cave 2, would therefore not constitute the total migrating population, for it would have faced the stochastic demographic challenges mentioned in Chapter 2. Therefore, we must fully expect multiple groups to have been involved in the migration. Whether or not they began as one group and split during the migration, or separate groups decided to migrate, they did not all stay together for the full migration distance. Instances of Promontory moccasins elsewhere, such as in Franktown Cave, Colorado (Gilmore 2005) and Ross Rockshelter, Wyoming (Garling 1964), support the concept of multiple related groups as well. This interpretation is also supported by Navajo oral traditions, which tell of multiple clans eventually meeting in the Southwest (Zolbrod 1984).

Thinking in economic terms, smaller group sizes make more sense for survival in the migration process. It is easier to feed 25 people than 125 people, and the population at Promontory Cave 1 was thriving. Food was abundant, and so were resources for making tools and other items. This group may have, at times, met up with other migrating Dene groups, but it would also be necessary to interact with and make alliances with the peoples on the surrounding landscape (i.e., the resident Fremont groups). These other groups would provide information about an unknown territory, an avenue for trade, and a new genetic pool of mates. Meeting with these groups could have been part of a seasonal round, similar to the historic Apachean groups who would overwinter near Puebloan settlements, keeping up consistent relationships (Eiselt 2012).

My research also suggests that not all Dene groups curated artifacts in the same way. Reilly (2015) and Pokotylo and Hanks (1989) both discuss generational curation of hide working tools like tabular scrapers and fleshers. My research suggests that these were not always curated in this fashion, and if the Cave 1 occupants were a Dene population, then my analysis shows differences over time and space regarding this treatment of artifacts. I suggest that some individual artifacts of the same type are more curated than others; for example, the toothed fleshers and those like it were more likely to be curated than those made quickly on readily available faunal elements. This interpretation reinforces the concept that identity and beliefs can differ between related groups and what might be so for one group is not for another.

If in the future the population at Cave 1 is determined to be a group other than a migrating Dene population, the above inferences are still valuable. Even if this population is not Dene, it is still different from the local Fremont and other cultures and sites in the Great Basin, and would represent some other intrusive population. A group of around 25 people would still represent a portion of a larger related population that occupied the cave during a seasonal round. The treatment of artifacts and how they were discarded also remains the same no matter the identity of the population. Some tools were curated more than others, and even different types of one tool (fleshers) were discarded differently.

Broader Connections to the Archaeological Record

When first looking at the projected totals of artifacts within Cave 1, it is easy to think that these are large, unique numbers. However, this picture only appears so because we are not accustomed to seeing these kinds of artifacts at all, not to mention in these quantities. As well, because this is a cave site, artifacts are contained within its boundaries, rather than being displaced and spread out as might happen in open sites. The path to the cave is not easy to traverse, and it was likely sometimes easier to leave material in the cave rather than transport it in and out. In contrast, only a fraction of open sites may be excavated, with the site boundaries unknown. Thousands of projectile points, for example, seems like a large number, but when the number of people and length of occupation is taken into account, along with patterns of discard, these large numbers are actually quite reasonable.

An occupation span of 20 to 40 years is a very short time period in the history of North America. Imagine a site with hundreds of years of occupancy and re-occupancy: sites exist like this in North America. For example, some sites on the Northwest Coast were occupied fairly continuously for hundreds or thousands of years. Sites such as Head-Smashed-In Buffalo Jump were used again and again at intervals over thousands of years. If the preservation conditions were like those in Cave 1, these sites would contain an immense amount of material (nearly three to four times more than has been excavated). Think of the landfills that exist for today's versions of debitage.

The methods I have used here can be applied to other archaeological sites with the right conditions. The important criteria that must be met are the following: total site size and volume, amount of excavated material, and the total number of excavated artifacts. With these values, densities can be calculated, and with the total site size/volume, total projected numbers of artifacts can easily be calculated. For the sites that meet these criteria, it will more often than not be only the durable artifacts that can be calculated, which still leaves out a large portion of the archaeological record and a large portion of people's lives. However, archaeologists can get a better idea of the site if they know the potential total numbers of the artifacts that existed.

For a specific example, let us compare Cave 1 with an archaeological site from the Canadian Plains, one that is typical of sites found in the area. Ahai Mneh (FiPp-33) was a campsite located west of Edmonton (Rawluk et al. 2011; Schenk and Yanicki 2011). This site was rich in terms of lithics, and certain areas were dense with debitage. Occupation occurred many times over 10 000 years, beginning in the Early Prehistoric and continuing until the Late Prehistoric. Rough calculations result in densities of four projectile points per cubic metre and two scrapers per cubic metre[11]. Compared to Cave 1, this value for projectile points is much lower; the density for the entire cave was 17 projectile points per cubic metre. On the other hand, the density of scrapers at Ahai Mneh is exactly the density in Cave 1, using the entire cave value (Table 16). Projecting the values for Ahai Mneh into the known extent of the site (around 10 000 square metres) results in 16 634 projectile points and 8182 scrapers.

When analysing Ahai Mneh, we leaned towards thinking of it as a densely occupied site that was returned to many times over the history of Alberta. However, the numbers above, when compared to Cave 1, suggest that this site was not as intensely occupied as may initially appear. Obviously, these two sites have major differences, such as the age and size, but hunter-gather groups using the same types of tools and performing similar tasks occupied them both. Comparing the extrapolated total number of artifacts at Ahai Mneh to those at Cave 1, the numbers for Ahai Mneh are lower than would be expected, given that there were many occupations over the more than 10 000 years the site was used, versus the only 20 to 40 years at Cave 1. This observation would lead me to believe that Ahai Mneh was not as densely or as frequently occupied as the large numbers of lithics would lead us to believe, and that the abundant lithics are really the result of millennia of episodic occupation rather than occupational

[11] These values are based on excavations completed by the Institute of Prairie Archaeology/University of Alberta field schools. These excavations consisted of 22 1 m by 1 m units that contained artifacts from 0 to 40 cm below surface.

intensity. This comparison is just one example of how the calculations made using the Promontory Cave 1 artifacts can serve as a yardstick by which to evaluate other sites.

The ratio of non-perishable to perishable artifacts that I calculated based on the Promontory Cave 1 deposits, along with others I calculated from similar sites, can be applied to other sites. I calculated that 78% of the material record in Cave 1 was perishable materials. Other sites I described earlier had percentages of around 60-95% perishable materials. I propose that archaeologists working at sites with poor preservation keep these values in mind when analysing and writing up reports on these sites. Archaeologists need to be aware that there could have been three to four times as much cultural material as what was excavated from open sites. If we really start to think about the Alberta campsite described above, for example, there would be an enormous amount of perishable material left behind that would have accumulated over the 10 000 years of episodic occupation. The following quote from Hastorf (2001:28-29) is particularly fitting here:

> "To be more accurate, we should remember the cloth, the reed baskets, the tuber feasts, the animal hides, and the wooden vessels that most people lived among and that we archaeologists often do not include in our inventories of assemblages, real or imagined."

Future Research

The research completed here has potential for many more future questions to be asked and answered about the inhabitants of the Promontory Caves. For this research, I concentrated on a few key artifacts for discussion, but more can be done with the remaining artifacts. Now that the calculations have been made, researchers may refer to my results to examine the other artifacts excavated from Cave 1. As well, the methods used here can, and should, be applied to Cave 2. Including Cave 2's artifacts could indicate a larger overall population, depending on the types of artifacts found there and how many would be projected. Only a couple of moccasins were found in Cave 2, so this location could be a site used for a different purpose. Perhaps, like Area B, it was used for sleeping and less for daily activity; Area A may have been the main activity area for people living in both Caves 1 and 2.

Another fruitful avenue of research would be to compare the densities within the stratigraphic groups of F3 to see how densities changed over time. This analysis could improve our understanding of how the Promontory Culture population using Cave 1 may have changed over time. The issue that would hinder research here is the smaller volumes of material excavated in the lower levels. However, it would still be interesting to see how artifact types and densities changed over time. An examination of the types and forms of artifacts could also potentially demonstrate if any new technologies were being brought in or learned during interaction with surrounding groups.

If further excavation were to take place in Cave 1, I would argue that placing an excavation unit elsewhere in Area A to test the density would be beneficial. This would be difficult due to the unknown boundaries of Steward's excavation. If Steward's larger excavation area in Area A could be better defined, then this would also improve the comparison between the modern excavation densities and his densities. Further tests to get a better idea of the extent and depths of the livable areas would also increase accuracy for projections.

The methods I applied here could also be applied to other well-preserved sites, so that a comparison can be made to better understand the diversity in past life. If a database of many well-preserved sites can be compiled, then these can be compared to each other and to poorly preserved sites. This research would allow us to learn more about those sites than we could with just analysis of non-perishable artifacts. Using more sites can provide more values for discard rates and use-lives so that a comparison can be made between different areas and groups. The difference in the non-perishable to perishable artifacts ratio between Promontory Cave 1 and the Northwest Coast sites already suggests a difference between these two areas. Inclusion of more sites can allow further comparisons to be made.

There are some limitations to using my results at other archaeological sites. The first of which is that it may be difficult to apply my methods to other sites because the variables are harder to obtain. Promontory Cave 1 is a unique site in which factors like the preservation, the bounded space, and the precise radiocarbon dating all act together to allow for accurate calculations. I had to treat the cave and its inhabitants as static and isolated, and not dynamic; activities occurring outside the cave had to be ignored because there is no archaeological data to indicate how much may have been occurring elsewhere. Further limiting application at other sites is that we are confident that the same group created the Promontory Culture deposits; this knowledge is harder to come by at other sites, and at sites that span hundreds or thousands of years of occupation. Another important consideration is that not every group will act and treat artifacts the same way; this variation can be examined if more preserved sites are studied in the way I examined Promontory Cave 1. My calculated use-lives and discard rates also did not take into account different usage during different times of the year. Nonetheless, my methods and results can act as comparisons to other sites. Archaeologists cannot know everything about past sites and lifeways, but my research has taken us a step closer to learning about life in Promontory Cave 1.

Final Thoughts

Promontory Cave 1 is an exemplary site, one that has many qualities that allow numerous avenues of interesting research. Sites that exhibit this excellent preservation have so much potential for studying the archaeological record in incredible detail compared to the usual situation, and my research has only scratched the surface of what can be done. This research has exemplified the need to include thoughts on perishable artifacts in our interpretation of sites, even when they do not survive. It also serves as a reminder that certain perishable materials are a large part of identity, and archaeologists will likely never fully understand these past identities. But, when perishable artifacts survive the archaeological record, we can begin to ask questions about the relationships of these artifacts to each other and to the people who created and used them. This research, a study of the Cave 1 artifacts through mathematical and statistical equations, has served to provide a better understanding of the past inhabitants of Promontory Cave 1 and takes us that much closer to understanding how these people lived and survived in a world we can only imagine.

And if we do imagine the population living in Cave 1, we would picture groups of men and women performing daily tasks like cooking, mending moccasins, flintknapping, gaming, and enjoying each other's company. We would see children running around in smaller versions of what their parents wore, playing and learning skills from their elders. So few of these activities would leave a trace in the typical archaeological record, but they were important not only for survival but for quality of life. The presence of stone artifacts symbolizes not only that hunting, hide working, or flint knapping took place, but also the many other tasks required to live life in the past that do not leave a trace. I implore archaeologists to remember this point every time they excavate a site, as I know I will.

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