Space and Social Structure in the A.D. 13th Century Occupation of Promontory Cave 1, Utah

by

Courtney D. Lakevold

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Arts

Department of Anthropology
University of Alberta

ABSTRACT

Promontory Cave 1, located on the north shore of Great Salt Lake in northern Utah, has yielded many extraordinary archaeological artifacts that are amazingly well-preserved. Promontory phase deposits in Cave 1 are extremely thick, and rich with perishables and other material culture. Bison bones, fur, leather and hide processing artifacts have been recovered at the site, in addition to gaming pieces, basketry, pottery, juniper bark for bedding, knife handles, ceramics and moccasins. A large central hearth area, pictograph panels, pathways and entrance and exit routes have also been identified. Bayesian modeling from AMS dates indicates a high probability that the cave was occupied for one or two human generations over a 20-50 year interval (A.D. 1240-1290). Excavations have taken place at the cave from 2011-2014 by an interdisciplinary research team with members from the University of Alberta (Institute of Prairie Archaeology), the Natural History Museum of Utah (NHMU), Oxford, the Desert Research Institute and Brigham Young University.

The extraordinary preservation and narrow time frame (A.D. 1240-1290) for the occupation of Promontory Cave 1 on Great Salt Lake allow for unusual insights into the demography of its Promontory Culture inhabitants. This thesis looks at the cave as a humanly inhabited space and examines what the Promontory Culture group may have looked like in terms of population size and group composition, and how they used or organized space in the cave. This is accomplished by combining accurate data on the livable space in Cave 1 with calculated space needs per person from ethnographic accounts of Western North American hunter-gatherer groups in order to estimate likely group size. These data, combined with work done with by Billinger and Ives (2015) on moccasin data from the cave (indicating age and stature of the inhabitants), allow insights into group composition.

Space in the cave is analyzed using space syntax analysis and soundscapes, and common patterns of spatial organization of built dwellings of Western North American hunter-gatherer groups are compared to areas of cultural deposition and excavation data from the cave. Models of how the space may have been used are presented.

In addition, defensibility of several sites located on Promontory Point are calculated and compared to defensible sites on the Northwest Coast and in the Fraser Canyon area of British Columbia. I argue that the three Promontory Culture sites located on Promontory Point are highly defensible.

ACKNOWLEDGEMENTS

To my family – thank you for your unconditional love and support.

I would like to express my gratitude to my supervisor, Dr. John (Jack) Ives, for taking me on as a graduate student and giving me the opportunity to work on the Promontory project. It has been an invaluable and amazing experience that I will carry with me for the rest of my life and career. Thank you for your support and guidance throughout this process and for your patience as I juggled a full time job, life, and thesis writing.

To my IPA cohort – thank you for being there to listen and to run ideas by, for providing support and guidance when needed, for your comic relief and visits to the pub. Having the support and understanding of good friends has made all the difference. And, thanks to Todd for including me in your NWT adventures!

Thank you to George and Kumeroa Chournos for your kindness, generosity, warmth, and for your willingness to share such a special place with us. Thank you also to the Brigham Young University crew of Dr. Joel Janetski, Lindsay Johannson and Katie Richards for a great field season and for showing us Canadians the ropes down in Utah. Thanks also to Scott Ure for assistance with the 3D point cloud data. I must also thank Dr. Sally Rice and Conor Snoek for their help with the acoustic testing in Cave 1.

Many thanks to my thesis committee: Dr. Kisha Supernant, Dr. Robert Losey, and Dr. Ruth Gruhn, for your comments, feedback and support. Kisha has also provided mentorship, guidance, and TA opportunities throughout this process and for that I am grateful. In addition to all of that, she is also a wonderful role model!

I am grateful to John Kristensen who provided valuable feedback on earlier drafts of this thesis. Others that kindly provided assistance throughout this process include Pierre Boulanger (University of Alberta), Dr. David McGee (M.I.T.) and R. Kyle Bocinsky (Washington State University).

Thank you to the Baikal–Hokkaido Archaeology Project for use of their 3D modeling software and for the opportunity to attend the Leica 3D scanner workshop. Special thanks to Erin Jessup for accommodating me.

Funding for this research was provided in part by the Department of Anthropology, University of Alberta, the Faculty of Graduate Studies and Research (QEII Scholarship) and Dr. John Ives' SSHRC Insight Grant 435-2012-0140 (Apachean Origins: New Explorations of the Canadian Heritage of A. D. 13th Century Dene at Promontory Point, Utah) and Landrex Distinguished Professorship.

TABLE OF CONTENTS

ABSTRACT ... ii
ACKNOWLEDGEMENTS...iv
TABLE OF CONTENTS ...v
LIST OF TABLES... vii
LIST OF FIGURES ... viii
LIST OF PLATES ...x
CHAPTER 1 INTRODUCTION ...1
CHAPTER 2 BACKGROUND ...4
2.1 Region...5
2.2 Environmental History...8
2.3 Regional Culture History ...21
2.4 Promontory Cave 1 ...30
2.5 Other Promontory Culture Research...40
2.6 Chapter Summary ...43
CHAPTER 3THEORETICAL APPROACH ...44
3.1 Theories of Space and Place ...44
3.2 Space Syntax Theory ...46
3.3 Anthropological Theory...52
3.4 Ethnographic Analogy in Archaeological Research ...56
3.5 3D Modeling and Its Uses in Archaeology...58
3.6 Archaeoacoustics ...60
3.7 Chapter Summary ...62
CHAPTER 4 USE OF SPACE AND SOCIAL STRUCTURE: ...
WESTERN NORTH AMERICAN HUNTER-GATHERER GROUPS ...63
4.1 Group Hierarchies...64
4.2 Group Sizes ...66
4.3 Patterns of Group Composition and Co-residence...67
Social Structure and Use of Space among Hunter-Gatherer Groups in Western North America ...69
4.4 Subarctic Athapaskans...69
4.5 Subarctic Algonquians...80
4.6 Plains Groups...88
4.7 Great Basin/Numic-Speaking Groups ...98
4.8 Apacheans...103
4.9 Kinship, Sociopolitical Organization, and How They Relate to Dwellings...109
4.10 Space Syntax Analysis of Western North American Hunter-Gatherer Dwellings...112
4.11 Space Needs per Person of Hunter-Gatherer Groups...119
4.12 Chapter Summary ...120
CHAPTER 5 SPACE IN PROMONTORY CAVE 1, UTAH: ...
METHODS, RESULTS AND INTERPRETATION ...122
5.1 Sound...122
5.2 Fire...133
5.3 Routes in the Cave ...136
5.4 3D Laser Scanning and Model ...141
5.5 Promontory Cave 1 Group Size ...143
5.6 Promontory Cave 1 Group Composition ...147
5.7 Dwelling Models ...153
5.8 Space Syntax Analysis...158
5.9 Space in Cave 1 and What It Can Tell Us ...161
5.10 Chapter Summary ...167
CHAPTER 6 DEFENSIBILITY OF PROMONTORY POINT SITES ...169
6.1 Evidence of Conflict and Turmoil A.D. 1250-1300 ...171
6.2 Defensibility ...176
6.3 Chapter Summary ...207

CHAPTER 7 CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS 209
7.1 Research Objectives Revisited 209
7.2 Research Contributions 219
7.3 Future and Other Research 220
REFERENCES CITED 223

LIST OF TABLES

Table 2.1. Lake Bonneville shoreline chronology and levels. 15
Table 4.1. Group Hierarchies, Sizes and Classifications 67
Table 4.2. Athapaskan group sizes compiled from various ethnographic accounts. 77
Table 4.3. Athapaskan space needs per person calculated from ethnographic accounts. 80
Table 4.4. Algonquian group sizes compiled from various ethnographic accounts. 83
Table 4.5. Algonquian space needs per person calculated from various ethnographic accounts. 87
Table 4.6. Plains group sizes compiled from various ethnographic accounts. 91
Table 4.7. Plains space needs per person calculated from various ethnographic accounts. 98
Table 4.8. Great Basin/Numic group sizes compiled from various ethnographic accounts. 101
Table 4.9. Apachean group sizes compiled from various ethnographic accounts. 105
Table 4.10. Apachean space needs per person calculated from various ethnographic accounts. 107
Table 4.11. Measurements of spatial configuration from floor plans of Athapaskan, Algonquian, Plains and Apachean dwellings, using AGRAPH. 114
Table 4.12. Average space needs per person of Western North American hunter-gatherer groups. 120
Table 5.1. Measurement of sound intensity (decibels) from each source to each target in Cave 1 with the highest and lowest values of the alarm highlighted. 124
Table 5.2. Results of testing from the black roof stain samples from Cave 1; note the relatively high percentage of carbon in each sample. 135
Table 5.3. Promontory Cave 1 Group Size Calculations 145
Table 5.4. Average household sizes (HHSZ) of Western North American hunter-gatherer groups. 149
Table 6.1. Defensive Index Calculations for known sites on Promontory Point. 192
Table 6.2. Defensive Index calculations for select Northwest Coast and Lower Fraser River Canyon sites with exclusion of the variable Area (A) (Martindale and Supernant 2009; Supernant 2014). 194
Table 6.3. Visibility between sites on Promontory Point. 199

LIST OF FIGURES

Figure 2.1. Ecoregions of Western North America and the hydrographic boundary of the Great Basin. 7
Figure 2.2. Historic Lake Bonneville at its greatest extent. 14
Figure 2.3. Shoreline chronology of Lake Bonneville and the Great Salt Lake with elevations of Caves 1 and 2 plotted for reference (From Broughton et al. 2000). 15
Figure 2.4. General Culture History of the Great Basin Region. 25
Figure 2.5. Plan map of Cave 1 with different areas and characteristics of the cave identified. .. 31
Figure 2.6. Stratigraphic profile of Feature 20 under Post-Bonneville rockfall on the west side of the cave and associated radiocarbon dates. 37
Figure 2.7. Stratigraphic profile and radiocarbon dates from F28 excavation. 39
Figure 2.8. Stratigraphic profile and associated radiocarbon dates for Features 3, 15 and 55 in Area A. Courtesy of Gabriel Yanicki, Jennifer Hallson and John Ives. 41
Figure 3.1. a) Mapping of a space by assigning each room a node, and its associated justified graph; b) Mapping the same space using the convex map method, and its associated justified graph (from Bafna 2003). 50
Figure 3.2. Axial map and corresponding graph (from Bafna 2003). 50
Figure 4.1. Approximate distribution of groups/areas discussed in the text, ca. early 19th century. 70
Figure 4.2. Athapaskan dwellings (conical lodge and cabin) and organization of space, from Janes' ethnographic work with the Willow Lake Dene (Janes 1983). 79
Figure 4.3. Algonquian dwellings (conical lodge and multifamily winter house) and organization of space, as illustrated in Nabokov and Easton (1989). 87
Figure 4.4. Plains dwellings (tipi) and organization of space, as illustrated in Laubin and Laubin (1964) and Oetelaar (2000). 95
Figure 4.5. Plains dwellings (tipi and earthlodge) and organization of space, as illustrated in Peck and Vickers (2006) and Wilson (1934). 96
Figure 4.6. Apachean dwellings (hogan and wickiup) and organization of space, as illustrated in Jett and Spencer (1981) and Longacre and Ayres (1968) 108
Figure 4.7. Space syntax analysis applied to Athapaskan dwellings and associated j-graphs, based on both physical and social barriers (RRA values beside nodes). 115
Figure 4.8. Space syntax analysis applied to Algonquian dwellings and associated j-graphs; conical lodge and winter house (RRA values beside nodes). 116
Figure 4.9. Space syntax analysis applied to Plains dwellings and associated j-graphs; tipi and earthlodge (RRA values beside nodes). 117
Figure 4.10. Space syntax analysis applied to Apachean dwellings and associated j-graphs; wickiup and hogan (RRA values beside nodes). 118
Figure 5.1. Sound Target 1 sound map. 125
Figure 5.2. Sound Target 2 sound map. 126
Figure 5.3. Sound Target 3 sound map. 127
Figure 5.4. Sound Target 4 sound map. 128
Figure 5.5. Sound Target 5 sound map. 129
Figure 5.6. Sound Target 6 sound map. 130
Figure 5.7. Sound Target 7 sound map. 131
Figure 5.8. Sound Target 8 sound map. 132

Figure 5.9. Map and photos showing black staining on the roof of Cave 1 and locations where samples were collected for testing. 135
Figure 5.10. Locations of smooth spots and results of least cost path analysis, Cave 1.......... 139
Figure 5.11. Areas of flat, livable space in Cave 1 as calculated from the 2013 3D scan data (figure courtesy of Scott Ure, Brigham Young University). 142
Figure 5.12. 3D scan cross section of Cave 1 showing the shape of the cave and the high cathedral like ceiling. 142
Figure 5.13. Areas of Promontory Culture deposition or the "livable area" (mapped by Jennifer Hallson). 144
Figure 5.14 Basic Dwelling Model of Western North American Hunter-Gatherer Groups. 153
Figure 5.15. The "One-Dwelling Model": Possible layout if Area A and Area B (the areas with cultural deposition) were occupied as one large dwelling. 154
Figure 5.16. The Two-Dwelling Model: Basic Western North American hunter-gatherer dwelling model overlain on each Area A and Area B in Cave 1 to show possible organization of space. 155
Figure 5.17. Space syntax analysis of Promontory Cave 1 159
Figure 6.1. Defensibility Index calculations for Promontory Caves 1 (42B01) and 2 (42B02), if approach to the caves were from above (upslope). 185
Figure 6.2. Defensibility Index calculations for Promontory Caves 1 (42B01) and 2 (42B02), if approach to the caves were from below (downslope). 186
Figure 6.3. Defensibility Index calculation for Promontory Cave 3 (42B01916). 188
Figure 6.4. Defensibility Index calculation for Chournos Springs (42B01915). 191
Figure 6.5. Viewshed analysis from the mouth of Promontory Cave 1 (42B01). 201
Figure 6.6. Viewshed analysis from the rock cleft above Promontory Cave 1 (42B01). 202
Figure 6.7. Viewshed analysis from the mouth of Promontory Cave 2 (42B02). 203
Figure 6.8. Viewshed analysis from the mouth of Promontory Cave 3 (42B01916). 204
Figure 6.9. Viewshed analysis from Chournos Springs site (42B01915). 205
Figure 6.10. Combined viewshed analysis from all sites. Note the high amount of visibility between sites and on the whole of Promontory Point. Inset shows general terrain in the area. . 206

LIST OF PLATES

Plate 2.1. Strandlines visible on Promontory point, reflecting phases of Lake Bonneville's extent (Photo courtesy of Dr. John W. Ives). 16
Plate 2.2. Sample of deep-lake carbonate from Cave 2 (Courtesy of David McGee). 18
Plate 5.1. Smooth spot at location SS13 on the east side of the cave at entrance to Area B. 136
Plate 5.2. Smooth spot at locations SS15 and SS16 on the east side of the cave. This is the main access to Area B and is the step people would have used over and over again. 137
Plate 5.3. Smooth spots SS2, SS3, and SS4 in central rockfall area with close up of SS2. 137
Plate 5.4. Smooth spot SS10; this pattern of smoothing is different than the areas used for access. It may be the result of other activities such as rubbing hides or other material back and forth over the rock. 138
Plate 6.1. View to the south from Cave 1; Chournos Springs site can be seen. 181
Plate 6.2. Entrance to Cave 1, side slope approach from below. 182
Plate 6.3. View to the south from Cave 2; Chournos Springs site can be seen. 183
Plate 6.4. Entrance to Cave 2, side slope approach from below. 184
Plate 6.5. View to the south-southwest from Cave 3; Chournos Springs site can be seen. 187
Plate 6.6. View to the north-northeast of Cave 3, note the steep slope as the cave is approached. 187
Plate 6.7. View to the northwest from Chournos Springs; Caves 1, 2, and 3 can be seen. 190
Plate 6.8. View west to the Chournos Springs site, note the wide open approach. 190
Plate 6.9. View southeast from saddle above Cave 1, rock cleft middle-right (Courtesy of Reid Graham). 201
Plate 6.10. View to the north from the saddle area above Cave 1 (42B01) (Courtesy of Reid Graham). 197
Plate 6.11. View to the south from the cleft directly above Cave 1 (42B01) (Courtesy of Reid Graham). 198
Plate 6.12. View of the rock cleft directly above Cave 1 (42B01) (Courtesy of Joseph Bryce, Brigham Young University). 198

CHAPTER 1

INTRODUCTION

"The Promontory Cave moccasins take us yet farther in assessing the age structure of a residential base camp population with men, women and children engaging in every facet of domestic life—hunting, hide processing, sewing, pottery making and gaming. The moccasin data suggest that the Promontory caves were inhabited for one or two generations by a population with a high proportion of children and subadults. With further research in this vein, we hope to gain a deeper understanding of demography and group composition, in continuing efforts to see the cave confines as a humanly inhabited space" [Ives and Billinger 2012:9].

Promontory Cave 1, Utah, is a unique, exceptionally well-preserved archaeological site first excavated by Julian Steward in the early 1930's. Steward, the father of cultural ecology and very familiar with Native groups in the Great Basin, noted that the Promontory assemblages were unusual compared to other sites in the region. He hypothesized that the group(s) who occupied this cave were not related to current Numic speakers, and were perhaps an Athapaskan-speaking tribe on their southward migration (Ives 2014; Steward 1937). This issue, not resolved at the time, has recently been further investigated by Dr. John Ives and an interdisciplinary research team with members from the University of Alberta (Institute of Prairie Archaeology), Brigham Young University, the Natural History Museum of Utah, Oxford, and the Desert Research Institute. Further excavations were carried out in 2011, 2013 and 2014; point cloud data for Cave 1 was also collected with a 3D Scanner in 2011. A total of 95 AMS radiocarbon ages have been determined for the Promontory Culture in Cave 1 (Ives, personal communication). Bayesian modeling indicates a high probability that the cave was occupied during the Promontory Culture era for one or two human generations over a 20-50 year interval, ca. A.D. 1240-1290 (Ives et al. 2014).

Promontory Phase deposits in Cave 1 are rich with perishables and other material culture. The occupants of Cave 1 were heavily focused on bison and antelope hunting. Many bison bones, fur, leather and hide processing artifacts have been recovered at the site, in addition to gaming pieces, basketry, pottery, juniper bark for bedding, knife handles and moccasins (Ives 2014; Steward 1937). A large central hearth area, pictograph panels, pathways and entrance and exit routes have also been identified.

The goal of this thesis is to delve into the vein of research mentioned in Ives and Billinger (2012:9) of seeing the cave as a "humanly inhabited space" in order to gain a deeper understanding of how people used this space, and what this group of people may have looked like in terms of demography and group composition. The following research objectives will be explored in the following chapters:

1) How did people inhabit Promontory Cave 1, and in doing so, how did they partition space for activities? This will be explored using methods of space syntax analysis, analysis of black roof staining and smooth spots in the cave, and archaeoacoustics.

2) Steward (1938) provided extensive data of Numic social structure and group composition for the Great Basin, and Ives (1990, 1998) and other researchers have provided similar data for northern Dene groups and other North American hunter-gatherer groups. I will compile data for Western North American hunter-gatherer groups including group size, group composition, space needs per person and characteristics of their built dwellings and apply this data to Cave 1 to gain insights into how space in the cave was used.

3) How many people could have occupied the cave at one time? Steward (1937) speculated that the livable space in Cave 1 would only be approximately 200-300 square metres, enough room for roughly 100-150 people. I will explore this idea by comparing livable space in the cave (calculated from 3D scan data) with space needs per person values (compiled in the second research question). Using those calculations, I can then determine how many people the cave likely accommodated at any one time, given the variety of activities taking place.

4) By using moccasin lengths as a proxy for stature, and stature as a proxy for age, Billinger and Ives (2015) examined the population structure of Cave 1. This information can be integrated with results from the first two research questions to provide insights into the social structure of the group(s) inhabiting Cave 1.

5) Were Caves 1, 2 and 3 chosen for occupation because of their defensibility? This idea will be explored by calculating the defensibility of known Promontory site locations and comparing their values to other sites.

Part of this research will be accomplished by using space syntax theory to relate space within the cave to social structure. Space syntax is used to "accurately describe the dynamism of social life in space" (Bafna 2003:23; Osicki 2012). It was first developed for the field of architecture to look at social effects of different designs of built structures (Hillier and Hanson 1984). Although the cave is not a built environment it does resemble a built environment and, as examined in chapter four, it could be utilized in much the same way as a built environment.

The topics of the chapters of this thesis are as follows. Chapter two provides background information on Promontory Cave 1, the Great Basin region including landscape and culture history and other research that has been carried out on the cave. Chapter three provides a theoretical background for the theories applied in this thesis, including ideas of space and place, space syntax analysis, anthropological theories related to space, ethnographic analogy, 3D modelling and archaeoacoustics. Chapter four is a compilation and discussion of group size data from ethnographic and archaeological data, group composition data, space needs per person data, and layouts of built dwellings of Western North American hunter-gatherer groups including the Athapaskan, Algonquian, Plains, Great Basin and Apachean groups. Chapter five applies the theories from chapter three, and the ethnographic data from chapter four, to Promontory Cave 1 in order to start gaining insight into the research objectives outlined above. Space needs per person are calculated, space syntax is applied, and space and layout of the cave is analyzed in order to gain insight into how people inhabited this space. Chapter six explores the defensibility of known sites on Promontory Point, including Caves 1, 2, 3 and Chournos Springs, and the idea that Promontory sites were chosen for defensibility. Chapter seven provides a summary and possible future research directions.

CHAPTER 2

BACKGROUND

"From the point of view of richness, Cave No.1 on Promontory Point is the most interesting, as it contained, in its upper levels, extremely abundant remains of a culture which is entirely new…" [Steward 1937:6].

Promontory Cave 1, the focus of this thesis, is located on Promontory Point in northern Utah in a geographic region known as the Great Basin (Figure 2.1). This cave is one of 12 "Promontory" caves that Julian Steward identified in the region. Steward carried out excavations in Promontory Caves 1 and 2 in 1930 and 1931. The dry, sheltered environment these caves offer led to remarkable finds including, but not limited to, basketry, matting, moccasins, hafted arrows, cordage, animal bones, fur, hide and hair (including that of bison, deer, rabbit and others), porcupine quills, leather, gaming pieces and many bone and stone tools (Steward 1937; Ives 2014). What Steward found most intriguing about the artifacts observed in these caves was how unusual they were in comparison to cultural material from other sites in the region. The style of artifacts was not characteristic of typical Great Basin cultural groups and it appeared that bison hunting was a prominent activity, something also not characteristic of the Great Basin archaeological record. Steward (1937) named the group of people that occupied these caves the "Promontory Culture." There are several interpretations of the Promontory Culture, but Steward and others suspected these people were northern in origin; Dene people migrating south toward what is now Apache and Navajo territory in the southwestern United States. In order to have a broader understanding of the cave itself, the activities taking place, space use, and the cultural group that occupied Cave 1, it is important to have some background regarding Great Basin geography, environment, and culture history and to be aware of previous and current archaeological research concerning the Promontory Culture. These topics will be discussed in this chapter.

2.1 Region

The Great Basin in the western United States encompasses most of Nevada and western Utah, the eastern edge of California, and small areas of the southern parts of Oregon, Idaho and Colorado (Blackwelder 1948). This region, covering an area of approximately 492,000 km^2, is part of the Basin and Range Province, where topography is characterized by north-south trending mountain ranges divided by low, broad valleys and deserts (United States Geological Service 2004). John C. Fremont, on his trek westward, was the first to use the term "Great Basin" to describe this area in his October 1843 journal entry (Grayson 2011).

The most common boundary for this area of north-south trending mountain ranges and basins is based on hydrography (Figure 2.1). This hydrographic boundary is defined by the Sierra Nevada mountain range to the west, the Wasatch Mountains to the east, the Columbia Plateau to the north and the Mojave Desert to the south (Beck and Jones 1997; Grayson 2011). One of the main characteristics of the Great Basin is that it is an area of internal drainage. Unlike most hydrographic systems, the moisture that accumulates in this area does not reach the ocean. While the region receives very little rainfall (150 to 300 mm) each year, in part due to the rainshadow effect caused by the Sierra Nevada mountain range to the west that prevents moisture-bearing winds off the Pacific Ocean from entering the Great Basin, the moisture that does fall, mostly in the form of snow, drains into low, saline lakes or playas, or seeps into underground systems (Beck and Jones 1997; Grayson 2011). The largest and most well-known saline lake in this region is the Great Salt Lake in northern Utah. This basin and range topography features an arid climate, few rivers and many saline lakes.

Great Basin plant communities are controlled by both elevation and limited moisture regimes. Billings (1951) identified six different vegetation zones within the Great Basin: the Shadscale Zone, the Sagebrush-Grass Zone, the Pinyon-Juniper Zone, the Upper Sagebrush

Zone, the Limber Pine-Bristlecone Pine Zone and the Alpine-Tundra Zone. The Shadscale and Sagebrush-Grass Zones are present in the low valleys that support plants tolerant of saline soils, such as shadscale, saltbush, yellow-flowered rabbitbrush, and sagebrush. As elevation rises and one enters the Pinyon-Juniper Zone and Upper Sagebrush Zone, plants such as large sagebrush, rabbitbrush, Mormon tea, juniper, pinyon pine, and silver buffaloberry can be found. The highest elevation zones, the Limber Pine-Bristlecone Pine Zone and the Alpine-Tundra Zone, support larger trees such as grand fir, red fir, incense cedar, Jeffrey pine, western white pine, ponderosa pine, bristlecone pine, whitebark pine, and Engelmann spruce (Grayson 2011).

Animals characteristic of the Great Basin include bighorn sheep, pronghorn antelope, deer, jackrabbits, cottontail rabbits, pygmy rabbits, pika, ground squirrels, gophers, kangaroo rats, snakes, lizards, turtles and frogs, as well as hundreds of species of birds including the golden eagle, the common raven, the mourning dove and the sage grouse (Commission for Environmental Cooperation 1997; Grayson 2011; Simms 1985).

The Great Basin is geographically encompassed by two larger Level 1 ecoregions: the Northwestern Forested Mountains and the North American Deserts (Figure 2.1) (Commission for Environmental Cooperation 1997). The Northwestern Forested Mountains ecoregion stretches as far north as the Yukon and Alaska and as far south as the north-central portion of New Mexico. This ecoregion is characterized by high mountains and wide valleys and lowlands. It has a variety of vegetation, largely determined by elevation, including alpine tundra, conifer forests, and dry sagebrush and grasslands. Alpine vegetation includes herb, lichen and shrubs. Subalpine vegetation consists of lodgepole pine, subalpine fir, silver fir, grand fir and Engelmann spruce. As the lower mountainous slopes and rolling plains are reached, the vegetation varies with latitude. The north is dominated by white and black spruce while the southeast and central

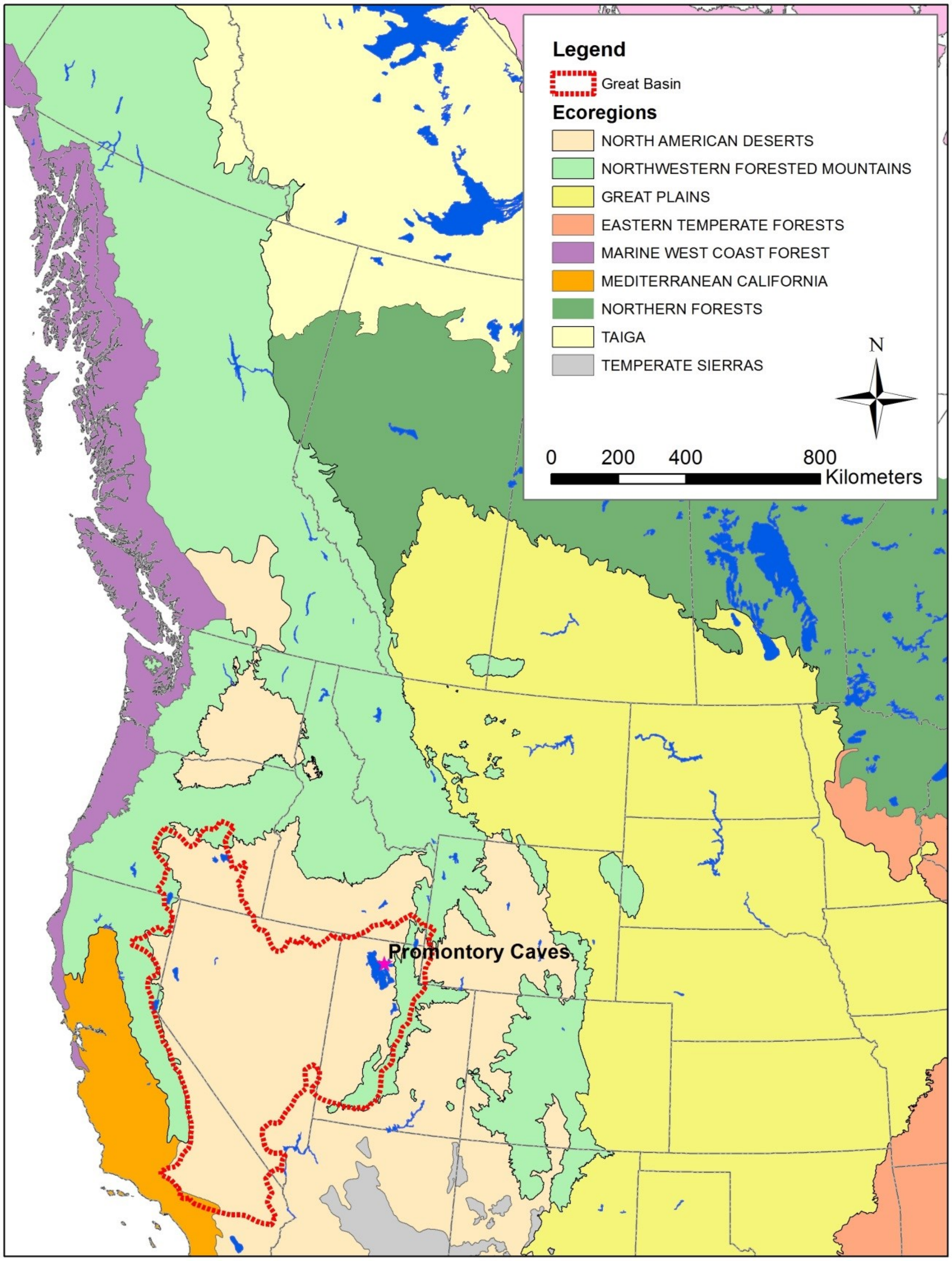


Figure 2.1. Ecoregions of Western North America and the hydrographic boundary of the Great Basin.

areas are characterized by ponderosa pine, Douglas fir, lodgepole pine and trembling aspen. The west and southwest are characterized by western hemlock, western red cedar and western white pine; the southern interior is more arid, and consists of shrub vegetation including sagebrush, rabbitbrush and antelope brush (Commission for Environmental Cooperation 1997).

The North American Deserts ecoregion stretches from eastern British Columbia to north central Mexico. This ecoregion is extremely arid, largely due to rainshadow effects produced by the Northwestern Forested Mountains, and therefore has unique shrub and cactus vegetation. It generally has lower relief, but there are some plains with hills and mountains. The climate is classified as desert and steppe with seasonal temperature extremes (Commission for Environmental Cooperation 1997).

While the Great Basin is completely covered by the two ecoregions described above, there are several neighboring ecoregions, including Mediterranean California on the U.S. west coast, the Temperate Sierra and Southern Semi-Arid Highlands to the south and the Great Plains to the northeast, east, and southeast. The Great Plains are dominated by grasslands and, like the North American Deserts, are also arid with seasonal temperature fluctuations. The Great Plains, in the past, "supported millions of bison, pronghorn antelope, elk and mule deer" (Commission for Environmental Cooperation 1997:27). These animals, notably bison, may have moved in and out of the Great Basin area at times, depending on climatic conditions. This is important to note when considering past human subsistence practices in the Great Basin and is discussed further under section 2.2.4.

2.2 Environmental History

This section explores several aspects of the Great Basin environment including the geology of the area, the history of pluvial Lake Bonneville and the formation of Caves 1 and 2. The Holocene paleoclimate of the Great Basin is also discussed.

2.2.1 Geology

The geological foundation of the Great Basin began in the Precambrian but the Basin and Range topography that defines the Great Basin today did not begin forming until the Miocene. About 17 million years ago, crustal unrest resulted in the formation of north-south trending mountain ranges (a result of fault controlled uplift and the down-dropping of basins), the rearrangement of rivers, and the production of basins (Blackwelder 1948; Fiero 2009; Madsen 2000). This initial uplift was followed by a relatively quiet period in the Pliocene (~3-5 million years ago), with some wearing down of mountains from erosion; however, additional compressive movement in the early Pleistocene (~2.5 million years ago) resulted in further uplift of the basin and formation of the western mountain ranges, including the Wasatch, Ruby and Sierra Nevada ranges (Blackwelder 1948; Fiero 2009).

The late Pleistocene and the Holocene have seen little major change in the geological landscape. Environments of erosion and deposition, mostly from transgression and regression of pluvial lakes, as well as stream erosion, have been dominant. Many geomorphological features that are reminders of these large pluvial lakes, such as deltas, terraces, shorelines and other coastal features have formed on the landscape, and consist primarily of silts, sands and gravel (Madsen 2000; Olson 1960). Since the retreat of the major pluvial lakes, ~12,000 years ago, only small streams have been active and the landscape has generally changed very little geologically (Fiero 2009).

Olson (1960) carried out a geological survey of the Promontory Mountain Range in the 1950's. He was able to identify Precambrian strata at the southernmost tip, consisting of quartzite, mafic extrusives, shale, argillite, silicified dolomite, phyllite and limestone (Blackwelder 1948; Fiero 2009; Olson 1960). These Precambrian strata are divided into two units, one being an older, strongly metamorphosed unit and the other a younger complex that is "only slightly metamorphosed" (Olson 1960:24). The oldest, more metamorphosed unit is further divided into three structurally separate blocks. The oldest of these is exposed only at the very most southern point of the Promontory Range, but matches other outcrops found on Antelope Island to the south. The intermediate block is exposed from the tip of the point to the terrace fronts of Lake Bonneville to the north, and the youngest block is found "along two westward trending spurs between Brushy Canyon and Little Valley," and most noticeably at Long Canyon (Olson 1960:24). Brushy Canyon is located approximately two kilometers straight east of Chournos Springs (42B01915) and about five kilometers southeast from the Promontory Caves. This location represents a divide between lithologies in the Promontory Mountain Range, with more sedimentaries to the north and more metamorphics to the south (Olson 1960). In addition to the Precambrian strata dominant on the southern portion of the point, Olson also identified 24 Paleozoic formations consisting of limestone, shale, dolomite, and quartzite and undifferentiated Pleistocene strata. It was noted that "the characteristic structural features are large fault blocks bounded by high-angle faults" (Olson 1960: ii). Overall, the lithology of the Promontory range is dominated by limestone and shale formations (Butler and Heikes 1916; Madsen 2000; Olson 1960). This lithology is evidenced at Caves 1 and 2, which are both carved into limestone formations (Steward 1937).

2.2.2 Lake Bonneville and the Great Salt Lake

The Great Basin of the western United States is an area of internal drainage and has been home to lakes of varying sizes for the past 15 million years (Currey et al. 1984). Presently, the Great Salt Lake is the largest lake in the basin, with an area of 4184 km^2 and a maximum depth of 10 metres (Utah Geological Survey, n.d). The Great Salt Lake is a remnant of a much larger lake known as Lake Bonneville (Figure 2.2), which was named and studied by G.K. Gilbert in the 1870's. Gilbert identified the greatest extent and several stages of the transgressive and regressive cycle of the lake, based on the study of prehistoric lake features such as beaches, deltas, spits, and shorelines (Currey et al. 1984). The formation of Lake Bonneville began approximately 130,000 to 30,000 years ago when the Bear River was diverted into the basin following a series of volcanic eruptions in southeastern Idaho (Currey et al. 1984). The influx of water draining into the basin, combined with changing climate associated with the most recent major ice age, caused lake levels in the basin to start rising approximately 25,000 years ago (Currey et al. 1984). Prior to this rise, the lake was at approximately the same level as present day Great Salt Lake (Oviatt et al. 1992). From 25,000 years ago onwards, the lake went through several oscillations and eventually reached its greatest extent, known as the Bonneville level, around 15,000 years ago. A catastrophic overflow through a break in a canyon to the north then led to a rapid fall in lake levels. Subsequent draining of the lake caused it to reach its present day level again by approximately 12,000 years ago, with a few small oscillations (Currey et al. 1984). Lake Bonneville was the deepest and most extensive lake that occupied the Great Basin. At its greatest extent it covered an area of 51,282 km^2 and had a depth of 372 metres (Sack 1989). The Promontory Caves were formed during the rise and fall of Lake Bonneville.

Throughout the transgressive and regressive cycle of Lake Bonneville there were several periods of still stands when the lake level remained relatively stable for 1,000 to 2,000 years at a time. During these periods of stability the lake had time to make its mark on the landscape. Owing to the large size of the lake, many coastal landforms were carved out along the shorelines of Lake Bonneville, features that one might not expect to see in the landlocked Great Basin. These are the landforms that G.K. Gilbert used to conduct his original study of Lake Bonneville. They include erosional features such as strandlines (shorelines), sea caves and sea stacks as well as depositional features like beach gravels, deltas, spits, barriers and tombolos (Stratford 1999).

Four major shorelines, each representing a unique time-restricted lake level, have been identified as part of the Lake Bonneville cycle. They are known as Stansbury, Bonneville, Provo and Gilbert shorelines (Table 2.1; Figure 2.3). The oldest of these is the Stansbury shoreline. Approximately 25,000 ^{14}C years ago, lake levels began to rise as climate changed during the last major ice age and the Bear River was diverted into the basin after the series of volcanic eruptions that changed its course (Currey et al. 1984). The lake rose significantly over the next couple of thousand years and then, from approximately 23,000 to 20,000 ^{14}C years ago (27,500-24,000 cal. yrs B.P.), had a still stand during which the Stansbury shoreline was formed (Currey et al. 1984). The Stansbury shoreline can be traced throughout the basin between 1347 and 1378 metres a.s.l. (Oviatt et al. 1990).

From 20,000 to 18,000 ^{14}C years ago the lake began to rise rapidly during what is called the Middle Transgressive Phase. The rise slowed from 18,000 to 16,000 ^{14}C years ago (Late Transgressive Phase) but still continued, and by 16,000 ^{14}C years ago (19,100 cal. yrs B.P.), Lake Bonneville had reached its greatest extent. It began overflowing at Zenda, Idaho, near Red Rock Pass (Oviatt et al. 1992). The lake fluctuated and intermittently overflowed at this level for about 1500 years, during which time the Bonneville shoreline was formed (Currey et al. 1984).

A catastrophic flood into the Snake River drainage basin occurred 14,500 ^{14}C years ago (17,600 cal. yrs B.P.) when Lake Bonneville suddenly broke through the threshold of the rim at Red Rock Pass. This event drastically affected the lake level, which dropped more than 100 metres in less than a year (Currey et al. 1984). After the initial flood, the lake re-stabilized but still continuously overflowed during the development of the Provo shoreline, from 14,500 to 14,000 ^{14}C years ago (17,600-17,200 cal. yrs B.P.). Even though the lake did not remain at the Provo level as long as it did at the Stansbury or Bonneville levels, there was a much greater amount of tufa deposition and formation of much larger coastal landforms (Godsey et al. 2011).

Some areas of the basin are marked by a complex of several beach ridges, which suggest changes in lake level during the Provo stage shoreline. These changes are attributed to isostatic rebound, an uplift of the earth's crust as a result of a reduced load or mass of water sitting in the basin (Godsey et al. 2011). The end of the Provo shoreline stage is marked at 14,000 ^{14}C years B.P. (17,200 cal yrs B.P.) when the lake began to regress rapidly (Oviatt et al. 1992). From 14,000 to 13,000 ^{14}C years ago the lake continued to overflow at Red Rock Pass, and as well, there was a significant change in climate as the last major ice age came to an end. The lake continued its final major regression until it reached levels about the same or lower than today's Great Salt Lake. (Currey et al. 1984).

Gilbert is the fourth major shoreline and was formed during a transgressive phase from 11,000 to 10,000 ^{14}C years ago (12,900-11,500 cal. yrs B.P.). The lake rose slightly, to levels just above the modern level of the Great Salt Lake, formed the Gilbert shoreline and then declined again (Currey et al. 1984). This shoreline is less obvious than the others and it does not have as many associated coastal landforms (Stratford 1999).

Since the decline from the Gilbert shoreline, approximately 10,000 ^{14}C years ago, lake levels have remained relatively stable. The most significant source of inflow to the Great Salt Lake is from the Bear River, but accumulation from precipitation, ground water and other minor streams can also contribute to input. Since the Great Salt Lake is a closed basin, there are no outlet rivers or streams, so loss of water from the lake is largely due to evaporation (Currey et al. 1984). Rates of input and evaporation change from year to year depending on climate, which causes lake levels to fluctuate, but the Holocene transgressions have been minor and at much lower elevations than any of the previous shorelines (Smith et al. 1997).

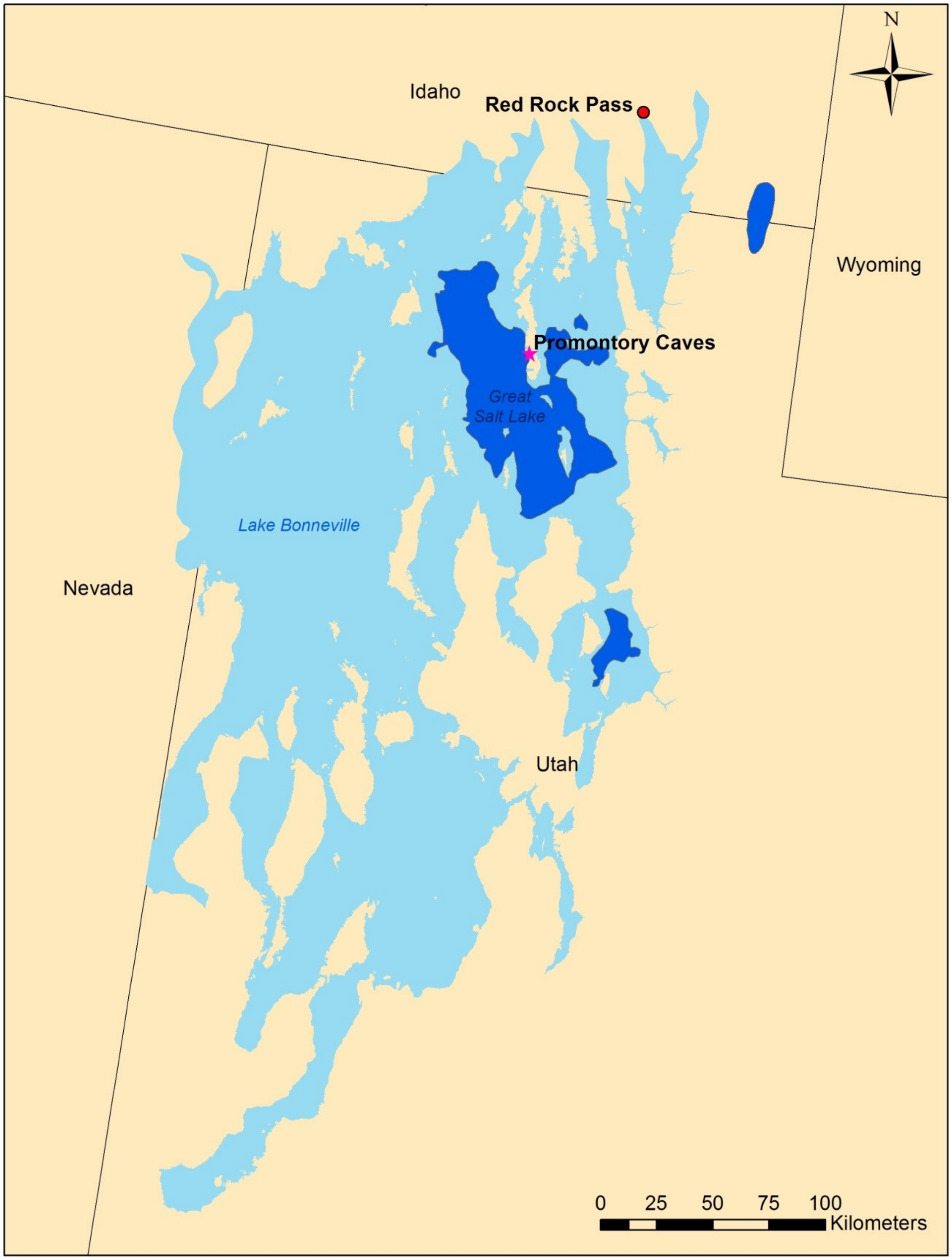


Figure 2.2. Lake Bonneville at its greatest extent.

Shoreline	Approx. Age (years B.P.)		Elevation (meters a.s.l.)	Level controlled by	Characteristics
Stansbury	14C	23,000-20,000	1347-1378	climate	tufa deposits; poorly preserved in some places; type locality on Stansbury Island; moderately saline
	Calendar	27,500-24,000			
Bonneville	14C	16,000-14,500	1552-1626	threshold at Zenda near Red Rock Pass; overflow to Snake River	highest shoreline; distinct; Bonneville flood bed deposited during flood; freshwater
	Calendar	19,100-17,600			
Provo	14C	14,500-14,000	1444-1503	threshold at Red Rock Pass; overflow to Snake River; climate	tufa deposits; distinct; large coastal landforms; freshwater
	Calendar	17,600-17,200			
Gilbert	14C	11,000-10,000	1311-1293	climate	not distinct; closed basin; saline
	Calendar	12,900-11,500			

*table modified from Currey, et al., 1984

**elevation values from Oviatt, et al., 1990

Table 2.1. Lake Bonneville shoreline chronology and levels.

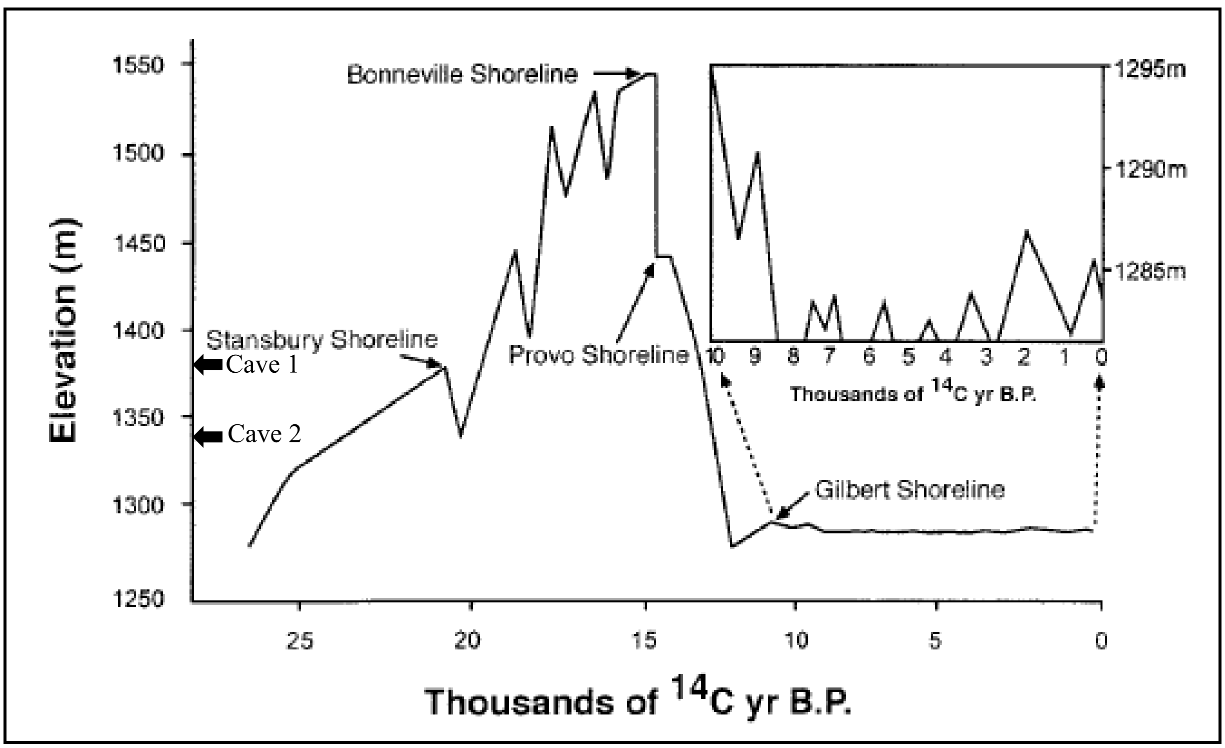


Figure 2.3. Shoreline chronology of Lake Bonneville and the Great Salt Lake with elevations of Caves 1 and 2 plotted for reference (From Broughton et al. 2000).

Plate 2.1. Strandlines visible on Promontory point, reflecting phases of Lake Bonneville's extent (Photo courtesy of Dr. John W. Ives).

2.2.3 Caves

One major geological process accompanying the formation of Lake Bonneville shorelines, the formation of caves, is particularly important to this study. There are three types of caves present in the Great Basin: corrosion caves, solution caves and lava caves (Fiero 2009). Corrosion caves are common in the Great Basin and are the result of wave or current action of pluvial lakes in the area. Faulting and fracturing, a common characteristic of the geology of the Great Basin, weakens rock and makes it more susceptible to mechanical weathering, therefore making the rocks of the Great Basin susceptible to corrosive cave formation. Solution caves are formed by the dissolving action of water, particularly on carbonate rocks. This type of cave formation most often results in underground caverns in which water collects below the water table (Fiero 2009). Lastly, lava caves form from lava pipes or tubes. When "the lava source is cut off and the lava still flows from the end of the tube, a cave will result as the lava flows out of the end of the tube" (Fiero 2009:206).

Promontory Caves 1 and 2 are likely corrosion caves formed by mechanical erosion from wave action. Steward (1937) noted that the caves are located in a metamorphosed cliff of limestone, a rock type that is easily eroded, and that there are many natural faults and bedding planes in the cave areas. Olson (1960) also noted in his geological survey of Promontory Point that the most prominent rock type was limestone. Faulting and erosion of the caves is evident by the large amount of rock fall inside the caves themselves and on the cliffs and slopes above and below the caves.

We are able to get an idea of when Cave 1 and Cave 2 may have been formed based on the presence of deep lake carbonates. During the high stand of Lake Bonneville, dense carbonates precipitated in caves and other protected spaces that were flooded by water. These lacustrine cave deposits are "dense, with almost no pore spaces, have a vitreous appearance and tend to form continuous sheets of carbonate coating cave and crevice walls" (McGee et al. 2012:184). Deep-lake carbonates are found in caves and other protected spaces throughout the basin. They can provide maximum ages for when these areas were covered by lake water because, for the deposits to form, a cave needs to be inundated with water and "sufficiently saturated with calcium carbonate to precipitate calcite or aragonite" (McGee et al. 2012:188). Uranium-Thorium (U-Th) dating can be carried out on these samples to provide effective dates of formation. A sample of these dense deposits of deep-lake carbonates was collected from Cave 2 by Dr. David Rhode during the 2011 Promontory Project field season. The sample from Cave 2 contains aragonite and calcite, both of which allow application of U-Th dating. Aragonite

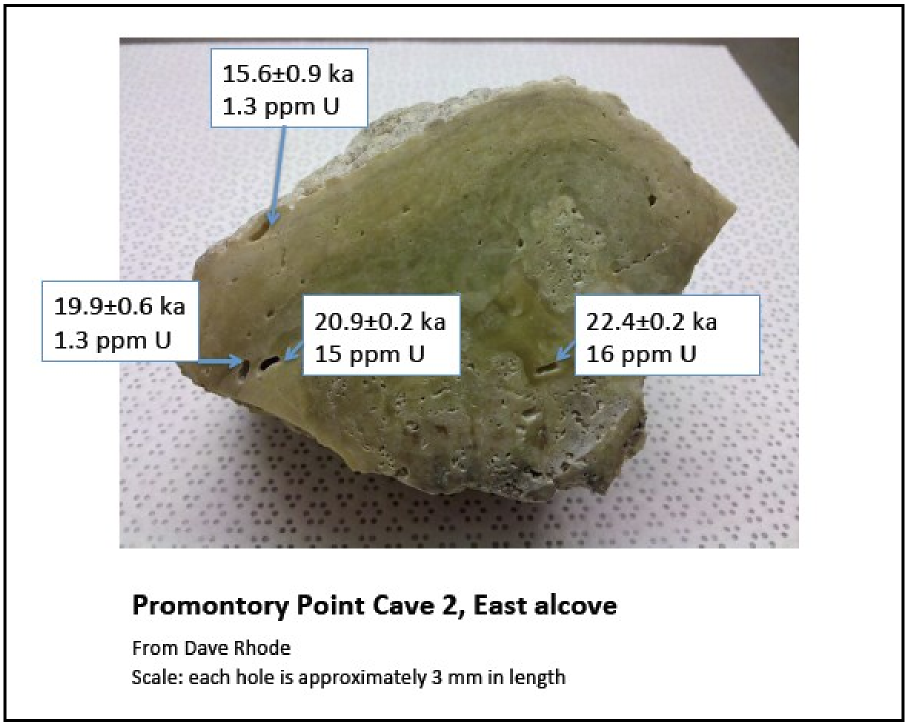


Plate 2.2. Sample of deep-lake carbonate from Cave 2 (Courtesy of David McGee).

contains higher uranium concentrations and so can be dated with more confidence than the calcite (David McGee, personal communication 2012). Plate 2.2 shows the sample and the preliminary U-Th dates for each "layer." The oldest deposit dates to 22.4 ka U-Th date (27,000 cal. yrs B.P.) suggesting that Cave 2 must have formed before then in order for these deposits to have accumulated in the cave. If Cave 2 was in fact formed by wave erosion, it would have had to have been during the Stansbury stand of Lake Bonneville, or from an earlier pluvial lake. This means that Cave 2, and likely Cave 1, were formed well before the first humans entered the region, suggesting there was no limit to human occupation of these cave sites.

2.2.4 Holocene Paleoclimate

While the geology of the Great Basin area has changed relatively little during the Holocene, there have been significant fluctuations in the climate, flora and fauna. Prior to approximately 13,000 B.P. Lake Bonneville was still at a relatively high stand. This cool, dry environment supported mountain shrub vegetation such as limber pine and subalpine fir and spruce as well as declining populations of large Pleistocene megafauna including mammoths, short-faced bears and camels (Madsen 2000). By the onset of the Younger Dryas interval from 12,900-11,600 years B.P., Lake Bonneville had declined significantly; reaching levels lower than the modern day Great Salt Lake. During the Younger Dryas, the lake transgressed again (indicating a wetter environment) to the level of the Gilbert shoreline at 1300 metres. This transgression formed Lake Gunnison and Lake Gilbert, two sub-basin lakes significantly smaller than Lake Bonneville (Goebel et al. 2011; Madsen 2000). By this time, the megafauna had gone extinct or left the area.

The decline of pluvial lakes Bonneville, Gilbert and Gunnison resulted in the formation of resource-rich marshes and wetlands that may have drawn animals and people to this area (Rhode et al. 2005, 2006). The floor of the Bonneville Basin was wet, in areas, from ~15,000 to ~9800 B.P. and there is evidence to show that humans occupied these extensive wetland habitats (Madsen and O'Connell 1982; Oviatt et al 2003). The earliest evidence of this occupation in the Great Basin dates to approximately 13,000 B.P., as seen at Bonneville Estates Rockshelter, Smith Creek Cave, Danger Cave, Sunshine Well, the Buhl Site, Handprint Cave, Pyramid Lakes Cave, Paisley Caves, Fort Rock Cave and Connley Cave (Goebel et al. 2007, 2011; Rhode et al 2006). Remains from the caves suggest that these earliest humans would have had diets consisting of, but not limited to, mule deer, bighorn sheep, pronghorn antelope, jackrabbits, sage grouse, salmon (from the Snake River drainage), grasshoppers, and cactus pads (Goebel et al. 2011). During the latter part of the Younger Dryas (11,600 B.P.) the Great Basin climate began to trend towards warmer temperatures and increased aridity. Pollen analysis of sediment cores indicates that pine and sagebrush were dominant. After this period, xerophytic shrubs such as shadscale, saltbrush, rabbitbrush and sagebrush became common (Goebel et al. 2011; Madsen 2000).

A change occurred again at approximately 9,000 B.P., when there was a shift to yet warmer climates. Pinyon pine began to appear in the basin, while animals such as waterfowl, gulls, Ord's kangaroo rat, pygmy rabbit, bushy-tailed woodrat and marmot disappeared (Madsen 2000). By 8000 B.P., Utah Juniper and pinyon pine had become more dominant and limber pines were no longer at lower elevations. By 6000 B.P. the Great Basin was probably very similar to the regional ecosystem today (Madsen 2000; Rhode et al. 2005). A cooling event occurred between 2000-3000 B.P. and the Great Salt Lake Desert may have flooded, but overall the vegetation and climate of the Great Basin were characteristic of the modern day environment, with only some proportions of certain plants being different (Madsen 2000). Remains from cave sites suggest that the warmest and driest period in the Bonneville Basin occurred from 600-1000 B.P. Drought between 600-700 B.P. "caused dramatic changes in the distribution and subsistence focus of prehistoric peoples in the region, with farmers dependent on corn, bean and squash crops shifting to full-time foraging" (Madsen 2000:174).

Bison remains outnumber any other mammal species found at Promontory Cave 1, a clear indication that the inhabitants were bison hunters (Johansson 2013). Lupo and Schmitt (1997) and Grayson (2006) both provide evidence of the presence of bison in the Great Basin in the past. Grayson (2006) compiled data from archaeological and paleontological sites in the Great Basin that had bison remains. The results indicated that bison were actually fairly widespread throughout the northern and eastern Great Basin, particularly in the northeast corner of Utah, near Promontory Point, and most commonly from ~1500-600 B.P., a time period which corresponds with the Fremont period and the Promontory Culture occupation of Cave 1 (see section 2.3). The abundance of bison during this time period is associated by many scholars with a change in the climate featuring increased summer temperatures and precipitation and, in turn, an expansion of grass forage. While bison remains are commonly found in Fremont sites, there are also many sites that do not contain bison remains. Lupo and Schmitt (1997) suggest that this is a result of bison distribution, and therefore availability. It may be that bison distribution was irregular and they were more available in certain locations at certain times (Lupo and Schmitt 1997). The period after 600 B.P. is associated with declines in summer temperature, precipitation and grasses. Bison also seem to have become less abundant, likely having moved northward (Grayson 2006; Lupo and Schmitt 1997).

2.3 **Regional Culture History**

This section looks at the history of human presence in the Great Basin and where the Promontory Culture fits into this history. It also looks at how the Promontory Culture was discovered and identified.

2.3.1 Human Presence in the Great Basin

The culture history of the Great Basin is most often divided into four main time periods: the Paleoarchaic (13,000-9,000 B.P.), the Archaic (9,000-1,600 B.P.), the Formative or Fremont Period (1,600-700 B.P.) and the Late Prehistoric (700-150 B.P.) (Johansson 2013; Knoll 2009; Simms 2008). These time periods are defined by changes in technology, subsistence strategies and settlement patterns.

The earliest evidence of human occupation in the Great Basin comes from several cave sites, mentioned above, dating to ~13,000 B.P, marking the beginning of the Paleoarchaic period. This time period is often characterized across North America by big game hunters hunting now extinct mammoth, camel, *Bison antiquus*, and horse. These earliest cultures are known as Paleoindians, peoples with a unique toolkit, high mobility and a reputation for big game subsistence (Meltzer 2009). However, material culture in the Great Basin during the same time period (the terminal Pleistocene/early Holocene) features several different projectile point technologies. In addition to fluted points, which are not well dated or numerous in the Great Basin, there were unfluted lanceolate points, Great Basin Concave Base points and large stemmed bifacial knives/projectile points, often referred to as the Great Basin Stemmed Series or the Western Stemmed Tradition, that dominated Paleoarchaic lithic assemblages (Beck and Jones 1997; Jones et al. 2003). These stemmed projectile points are found at some of the earliest sites in the region and continue through time to about 7,500-8,000 years ago (Arkush and Pitblado 2000; Beck and Jones 1997). Some scholars have also shown that the earliest Great Basin human populations had a wider subsistence base than just big game (Knoll 2009; Simms 2008). Paleoarchaic peoples in the Great Basin, though still highly mobile, utilized the resource-rich wetlands of the Younger Dryas and lived off of a wide variety of animals and plants including pronghorn antelope, deer, elk, bighorn sheep, small mammals, waterfowl, fish, insects, pickleweed seeds, and pine nuts (Jones et al. 2003; Knoll 2009; Meltzer 2009; Simms 2008). The Great Basin Paleoarchaic toolkit was made up of fluted and stemmed points, crescents (a tool type largely limited to the Great Basin), knives, spokeshaves, scrapers, gravers and milling and grinding stones used to process plants (Beck and Jones 1997; Knoll 2009; Meltzer 2009).

The Archaic period can be divided into the early, middle and late Archaic. Sites dating to the Early Archaic (9,000-7,000 B.P.) indicate that people were still relying heavily on low marshland areas and a wide variety of plants and animals. What distinguishes the early Archaic from the Paleoarchaic is an increase in the utilization of seeds and technologies associated with seed processing, most notably milling stones and coiled basketry (Knoll 2009). Other changes in technology include different styles of projectile points and the introduction of the atlatl. The atlatl makes its appearance in the Great Basin around 8500-8000 B.P. Common projectile point series include Elko, Pinto and Humboldt (Madsen 1982).

The Middle Archaic (7,000-3,000 B.P.) marks a noted increase in upland sites. Lowland marsh areas began to dry up, forcing people to find other resources, most often in the form of game hunting in the uplands. People probably began to work in a more extensive seasonal round in which resources from both the uplands and the lowlands were exploited (Knoll 2009; Madsen 1982). Technology remained largely the same as the Early Archaic.

The Late Archaic (3,000-1,600 B.P.) was a period of cooling and decreased evaporation that resulted in a renewal of marshlands. This change in climate resulted in larger human populations settling in the resource-rich lowland areas, in addition to scattered populations of high desert foragers (Knoll 2009; Madsen 1982). The Basketmaker II culture, people who constructed pithouses, farmed, settled in larger groups and had more complex social structure, were present in the Four Corners area of the southwest during the Late Archaic period. Berry and Berry (2003) identify an early maize period in their radiocarbon data that they hypothesize may have been an initial, but failed, attempt of Basketmaker II settlement farther north, in what would later become known as the traditional Fremont area. Technology during the Late Archaic still remained largely the same (Knoll 2009).

The Formative or Fremont period (1,600-700 B.P.) marks the arrival of farming/horticulture, ceramics and bow and arrow technology in the Great Basin (Knoll 2009; Madsen 1989; Simms 2008). Larger and more complex settlement systems began to form, with smaller encampments surrounding centrally located villages. Corn horticulture became a major form of subsistence along with hunting and gathering. This time period also marks the reign of the Fremont Culture in the Great Basin. The Fremont Culture was first defined by Noel Morss in 1931, based on excavations in the Fremont River area (Madsen 1989; Marwitt 1970). While groups of people in the Great Basin, before and after the Fremont Culture, relied mainly on hunting and gathering, the main distinguishing feature of the Fremont is that they were horticulturists with unique material culture and architecture. Four main artifact types define the Fremont Culture: one-rod-and-bundle basketry, gray coil-made pottery, a distinct style of moccasin and unique trapezoidal clay figurines (Madsen 1989; National Park Service n.d.). In addition to these unique artifacts, Fremont populations constructed a variety of structures including semi-subterranean dwellings called “pithouses.” These were permanent structures made of adobe and usually part of a village of three or more pithouses. Ramadas, structures used for storage, are normally associated with these pithouses (Madsen 1989). Berry and Berry’s (2003) radiocarbon data suggest that village agriculture expanded in a south to north pattern, with Fremont being the northernmost expression of this economy. Fremont villages were established in the northeastern Great Basin starting around 1500 B.P. and thrived (with a peak at approximately 1000 years ago) until approximately 850 B.P., when a decline is noted. Final abandonment of the Fremont lifeway occurred around 700 B.P., which marks the start of the Late Prehistoric period (Berry and Berry 2003; Knoll 2009). However, abandonment of agriculture probably did not occur uniformly across the Great Basin. Coltrain and Leavitt (2002) have shown through stable isotope and radiocarbon analysis of bone collagen from human remains that farming on the east shore of the Great Salt Lake (close to Promontory Point) was likely abandoned completely by A.D. 1150 (800 years B.P.), approximately 100 years earlier than abandonment throughout the whole Great Basin region. Following the end of the Fremont culture, the archaeological record shows occupation by hunter-gatherers occurring in the region (Berry and Berry 2003).

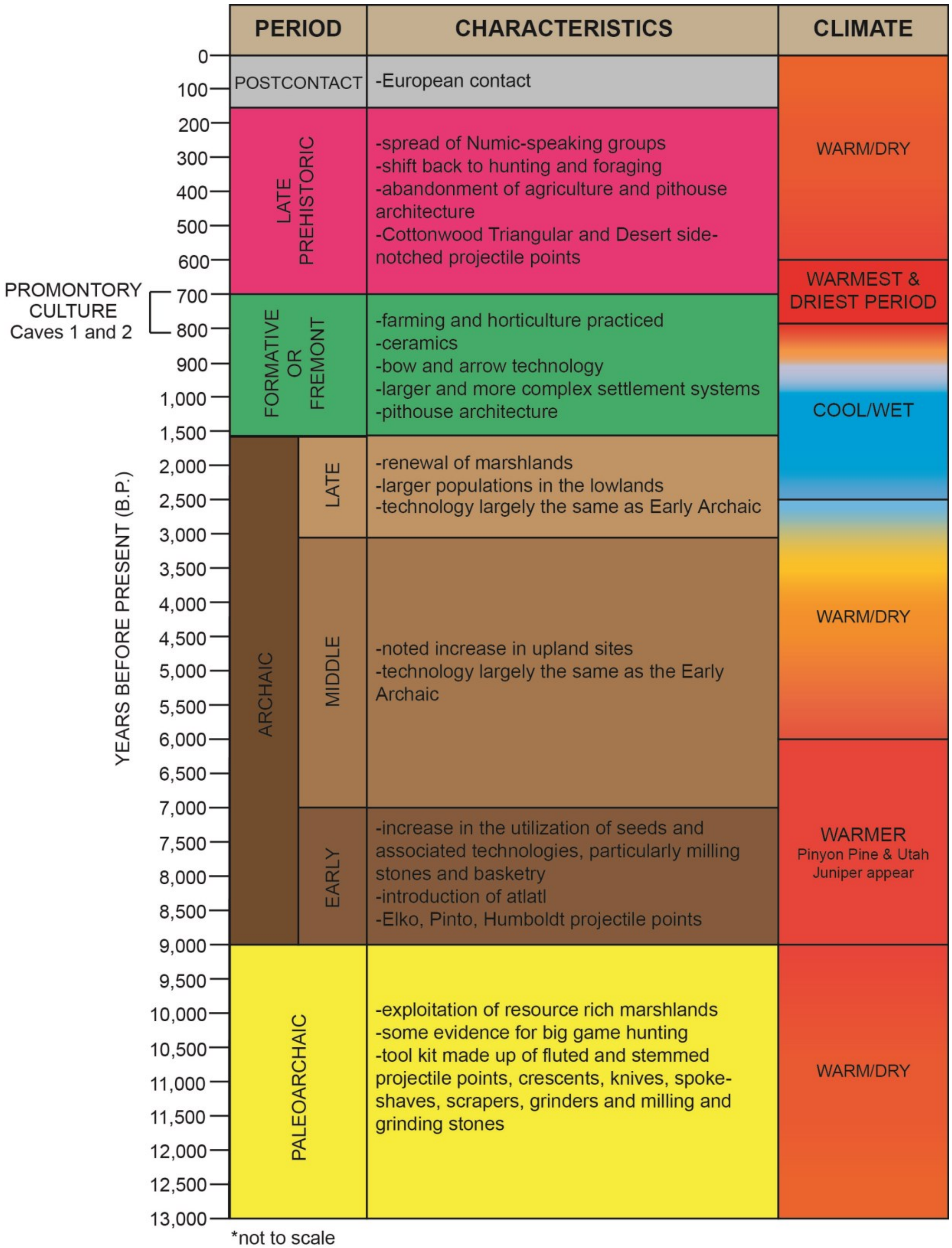


Figure 2.4. General Culture History of the Great Basin Region.

Although the topic is debated, Great Basin archaeologists frequently connect the Late Prehistoric period (700-150 B.P.) with the spread of Numic-speaking peoples into the Great Basin. This language group includes the Shoshone, Paiute, Gosiute and Ute. The earliest Shoshonean pottery and basketry appear in the area approximately 600-700 years ago. There are a large number of sites with overlapping Fremont and Paiute/Shoshone artifacts, suggesting there was likely interaction between these groups (Madsen 1989). The Late Prehistoric is marked by a shift back to hunting and foraging, the abandonment of agriculture and pithouse architecture, and the introduction of Cottonwood Triangular and Desert side-notched points from the west (Simms 2008). By the time of European contact, Numic-speaking forager groups were widespread throughout the Great Basin, including the Promontory Point area.

2.3.2 The Promontory Culture and Phase in the Late Prehistoric Period of the Eastern Great Basin

Another of the Late Prehistoric period hunter-gatherer archaeological manifestations in the eastern Great Basin involved the Promontory Culture, the principal subject of this thesis. Promontory Cave 1 is the type site for the Promontory Culture as defined by Julian Steward (1937). This cave was first reported as an official archaeological site by Professor Cummings of the University of Utah in 1913, though he credits Thomas Whitaker, a local rancher and sheep herder, as being “the first white man to enter the cave” (Salt Lake Tribune, 21 April 1913:3). Steward was the first to carry out excavations in the cave, in the early 1930’s, because he feared that the cultural material in Caves 1 and 2 would be stolen or destroyed by looters. He noted that there was already “considerable damage” done by amateurs who had previously visited the site (Steward 1937:7).

Extensive radiocarbon dating has been carried out on artifacts from the primary Promontory Culture occupation of Promontory Caves 1 and 2. The dates range from 662-826 ^{14}C

yr B.P. (cal. A.D. 1166-1391) (Ives et al. 2014). When Bayesian modeling was applied, the date range was narrowed down to ca. A.D. 1250-1290, all falling within the Fremont/Formative period or near/at the transition between the Fremont and Late Prehistoric periods (Ives et al. 2014; Knoll 2009; Madsen 1989). The recognized cultural groups or phases in the area at A.D. 1250-1290, based on archaeological records, are the Fremont, the Promontory, and possibly ancestors of the modern day Shoshone, Ute, or Paiute. The climate in the region at this time had shifted to conditions less favourable for farming and the Fremont material culture was beginning to disappear. As discussed above, farming would have been abandoned significantly earlier than A.D. 1250 on the eastern side of the Great Salt Lake (Coltrain and Leavitt 2002). Fremont peoples living on Promontory Point coevally with Promontory Culture would have likely already shifted to foraging.

As mentioned above, Promontory, as a distinct culture, was first defined by Steward after his excavations in 1930 and 1931. The remains from the 12 caves and particularly Cave 1 led him to the conclusion that the people occupying these caves had distinct enough material culture to differentiate them from other known Great Basin groups. The most notable characteristics that Steward described were the differences in the moccasin styles, the end scrapers, netting, ceramic style and the abundance of bison remains, indicating a bison hunting culture. He described the Promontory Culture as "basically one of a northern hunting people…that…existed in northern Utah sufficiently long to acquire southern and local traits" (Steward 1937:86).

In other sites throughout the Great Basin, Promontory is distinguished mainly by the presence of gray ware ceramics, since the material culture at most sites are not as well preserved as in the caves. However, archaeologists must be careful because gray ware ceramics are a trait present at both Fremont and Promontory sites. In the Fremont-Promontory cultural debate, some scholars have claimed that the Promontory Culture is a sub-type of the Fremont Culture, especially based on the fact that they both have a gray ware ceramic tradition. However, both Forsyth (1986) and Smith (2004) have shown clear distinctions between the two pottery types, based on several characteristics of the ceramics.

Janetski and Smith (2007) looked at open air hunter-gatherer sites in the Utah Valley region of the Great Basin, approximately 130 kilometers south of the Promontory Point cave sites. Several of these sites were classified as Promontory sites but some of the sites contained material culture from ancestors of the modern day Numic-speaking groups. The Promontory sites they looked at were defined by the presence of gray ware ceramics. Janetski and Smith (2007) recognized two phases of the Late Prehistoric period based on work done in Utah Valley – the Promontory Phase (650-350 B.P.) and the Protohistoric Phase (350 B.P. to historic contact).

In the period leading up to the Promontory Phase, the use of domesticated plants in the Utah Valley was abandoned and there was a shift to a hunter-gatherer lifestyle with multi-seasonal, longer term use of lowlands with shorter trips into the uplands. Lake resources were used most heavily at this time. During the Promontory Phase the most common projectile point types were Desert Side-Notched and Cottonwood Triangular (as in the Promontory occupations of the cave sites), something that differs from the Protohistoric sites in the valley. Promontory ceramics were abundant in the Utah valley from 700-350 B.P. These ceramics are characterized by "poorly finished surfaces, thick vessel walls, and coarsely crushed temper" (Janetski and Smith 2007:335). These pots were generally fairly fragile, which suggests that the makers did not expect them to have a long use life. They were also large enough that they may not have been transported and may have been "site furniture." These open air sites at Utah Valley represent the southernmost expression of Promontory Culture or Phase material.

Farther north, Dr. Brooke Arkush of Weber State University excavated an open air Promontory site (10-Oa-275), interpreted to be a repeatedly used short-term camp with the primary activity being bison hunting, in Curlew National Grassland in southeastern Idaho. The site contained instances of both Promontory Gray ware and Great Salt Lake Gray ware and contained primarily bison bone and lithics made from local Malad Obsidian. Several Promontory Gray ware ceramic sherds found at the site were radiocarbon dated and resulted in a date range of A.D. 1320-1440, which dates a bit later than the usual Great Salt Lake Gray ware. The dates obtained from the ceramics are also supported by radiocarbon dates from six in-situ artiodactyl bones which resulted in a range of A.D. 1145-1630. Given that both types of ceramics were present at the site, there may have been Fremont-Promontory interaction (Arkush 2014). Evidence of interaction is found not only in the ceramic type, but also in the geochemical makeup of the ceramic sherds from 10Oa275, 42B01 (Cave 1), 42B02 (Cave 2) and 42B01915 (Chournos Springs). When tested, three sherds from 10Oa275 and five sherds from the Promontory Cave sites were grouped together, based on their temper composition, to form the "Secondary Promontory Caves" subgroup. This is strong evidence that there was interaction and "ceramic circulation" between this region of southeastern Idaho and the Promontory Point region (Arkush 2014:34). This site, in addition to others in Idaho that contain Promontory Gray ware, provides evidence that Promontory groups were visiting the Snake River Plain region repeatedly (Arkush 2014; Butler 1983). Butler (1983) mentioned Promontory Gray ware being found in a cave site near Franklin, at the Wasden site in southern Idaho and at several open air sites on the Snake River Plain. Given this, Arkush (2014) proposed that the northernmost extent of the Promontory range be extended from northern Utah into southern Idaho. Assuming that Promontory Gray ware has been correctly identified, known Promontory site distribution ranges from southern Idaho to north central Utah with clusters on the east sides of Great Salt Lake and Utah Lake.

2.4 Promontory Cave 1

Cave 1 is one of the largest caves on Promontory Point. It measures approximately 40 metres from front to back (N-S) and 50 metres wide (E-W). The cathedral ceiling varies in height throughout, but at its tallest is more than ten metres high and in most places in the cave an average person can remain standing, except for the edges where the roof meets the floor. The total floor area of the cave is approximately 1300 m^2, although it may be slightly more, as measurements could not account for the extreme edges. The central rockfall occupies over 350 m^2 of the floor area and has been labeled as Area D (Figure 2.5). The mouth of the cave provides a generous entrance at just over 20 metres wide, with the high ceiling carrying all the way to the back. The entrance leads into a relatively level area that extends to the west, in front of the main rockfall area, labeled as Area A. On the far eastern side of the entrance there is a small opening that leads into the eastern portion of the cave, labeled as Area B (where Steward's Trench B is located). If Area B is followed around the rockfall to the back of the cave, it leads to Area C (Figure 2.5). Areas A, B and C are all considered "livable areas"; areas that are not covered by rockfall or that do not have other limiting factors such as low roof height or poor lighting. Although these areas are considered "livable," only Areas A and B, closer to the front of the cave, had evidence of Promontory Culture material.

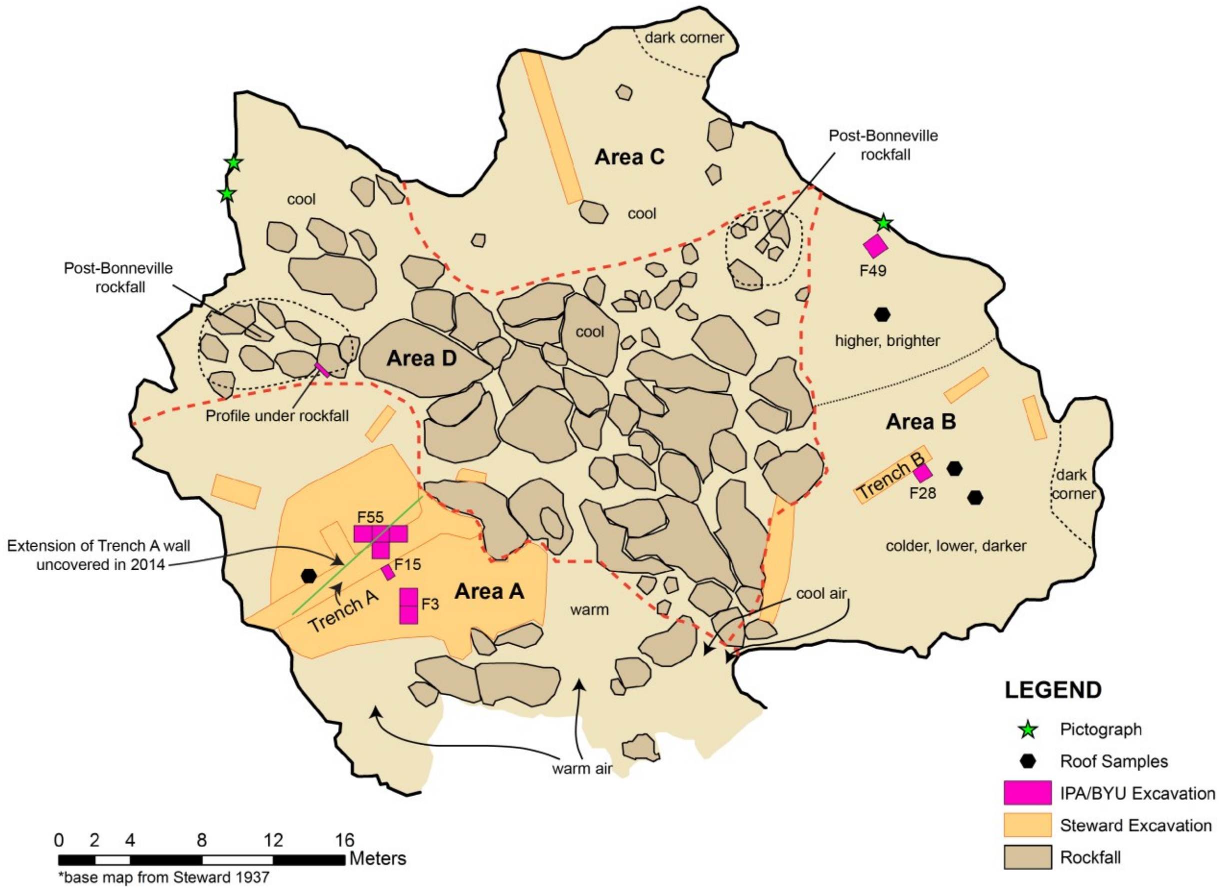


Figure 2.5. Plan map of Cave 1 with different areas and characteristics of the cave identified.

Area A is in the front portion of the cave and is the most accessible space in the cave, closest to the entrance. The main entrance is divided by rockfall into three separate entrances; one on the far western side, a central entrance and one on the far eastern side (also used to access Area B). All of these entrances lead into Area A. This area slopes down from east to west, with a larger useable area on the west side where Steward's main trench and the Institute of Prairie Archaeology and Brigham Young University's F3, F15 and F55 excavations were located. The roof is high throughout this area and only a bit of useable space is lost at the edges where the roof meets the floor. This area is very bright and receives a lot more light than the rest of the cave. It is also much warmer in this area and has extremely good views to the outside. This area contained the densest concentration of cultural material and will be discussed more below.

Area B, in the eastern portion of the cave, is generally dark, cool and stuffy. The roof is low in some spots but it is still possible to stand in most of the space, except where the roof dips down in the middle of the area. Even close to the walls, not a lot of space is lost from roof height. This area is accessible from the eastern cave entrance, so it has fairly direct access to the outside. This area is lower in elevation than the other portions of the cave and is isolated by the rockfall. Since it is relatively dark, even when the sun is brightest, it would be difficult to carry out fine tasks in this area without an additional lighting source. While excavating, we wore headlamps and had other lanterns to supplement. Cold air can be felt flowing from the back to the front. On the eastern edge of this area there is a rectangular nook in the wall; it is very low-lying and can only be accessed by crawling into the space, but it could be a good area for storage. The floor is scattered with small rocks that have fallen over time, animal bones, and dust. The floor slopes up to the north as it approaches the rock art panel in the back, making this back area near the rock art higher and brighter. The rock art is placed on a smooth rock face panel that is easily reached. From most of Area B, the views to the rest of the cave and the outside are extremely limited by the rockfall. However, from the rock art it is possible to see over the rockfall and outside to the mountains in the distance and the Great Salt Lake below; it is also possible to see the other rock art panel from here. Area B also contained a significant amount of cultural material that is discussed more below.

Area C is located in the back portion of the cave and has no direct access from the outside. From the entrance, a route must be navigated over the rockfall (Area D), or around and through Area B on the east side of the cave. This area is large and open and has a high enough roof through most of it to stand; almost no useable space is lost to roof heights. The floor here is somewhat uneven and slopes a bit from north to south. The air is cool in this area and when standing there I could feel cool air flowing through from the back to the front. During mid-day in the spring/summer there is enough light to carry out tasks, except for the extreme back corner which is very dark. There is some black staining on the roof in the central portion of this area. Both rock art panels can be seen from the central portion of this area. Area A cannot be seen from Area C due to the rockfall, and views to the outside are much more limited.

Area D is the central portion of the cave that is made up mostly of rockfall. This rockfall consists of hundreds of rocks and boulders, some that are extremely large. The majority of this rockfall fell during the formation of the cave but some is post-Bonneville in age (Figure 2.5). This age is evidenced by the presence or absence of deep lake carbonates on the rock. If there are deep lake carbonates deposited on the rocks, they must have fallen before or during the highstand of Lake Bonneville. If deep lake carbonates are not deposited, the rockfall occurred after the highstand, when the cave was no longer inundated with water (see section 2.2). While geologists from MIT examined the cave, two areas were identified as post-Bonneville rockfall. One is in the western portion of the cave and the other is at the back, central area, close to the eastern rock art panel. This area is elevated above the other areas and is uneven, jagged and difficult to navigate in some spots.

There are dozens of nooks and crannies among the boulders. The roof in this area is very high and is not a limiting factor for occupation. This area is directly accessible from all of the other areas and is what creates separation in the cave. Although daily living activities were likely not carried out here, people most likely climbed over this area or used some of the larger boulders for sitting, visiting, or for children playing. This area is cool but bright in most places and has excellent views to most areas of the cave and to the outside. A rock art panel is located on the western wall, closer to the back. The rockfall extends into this area and must be climbed over to get to the panel. Like the other rock art panel, this one is also located on a smooth, flat surface of the roof that is easy to reach. The view from this instance of rock art is good; the other rock art panel can be seen, and there are as well good views out the entrance of the cave.

The cave today is likely similar, in most ways, to the situation when the people of the Promontory Culture occupied it. The general size, layout, temperature and lighting have probably changed very little. The floor is likely different, since a lot of what we see as the floor surface in the front portion of the cave is actually a build-up of cultural deposits. However, significant portions of the back part of the cave, where there is less cultural deposition, may have been quite similar. From an archaeological perspective there has been significant disturbance of the site, mostly due to human activity. Leading up to 1930 there was a considerable amount of damage done by looters (Steward 1937). There have also been a lot of names written on the walls, including by Steward and his crew. Boy Scouts have camped in the cave in more recent years and ranchers have continuously had their animals on this land (George Chournos, personal communication). Evidence of these animals in the cave was observed by Steward (1937), who noted that there were four to six inches of cow manure in the top layer of his excavations, and by ourselves, when we observed a relatively recent sheep skeleton in one of the rockfall crevices.

During excavation in 2013, the majority of the cave was usually a pleasant temperature. While the temperatures outside the cave sometimes became uncomfortably hot, the interior of the cave was noticeably cooler. Fiero (2009:208) noted that “caves sometimes form a unique ecosystem. The interior of caves is a delightful escape from summer heat or winter cold. Temperatures in caves are close to the average annual temperature of the region. Thus, they seem warm in the winter and cool in the summer”. This is likely true of Promontory Cave 1. With the entrance of the cave facing south, it receives a significant amount of sunlight, a feature which is important both for lighting and for solar heating. If the cave was occupied primarily in the fall and/or winter, the increased amount of sunlight combined with the “unique ecosystem” of the cave, likely provided a comfortable environment, as it was when we were there in the spring. While at the cave, it was observed that there was some air flow from the back of the cave to the front, as well as into the cave from the outside. The warm air was felt entering through the westernmost and middle portions of the cave, while cool air flowed from inside to outside on the easternmost side of the cave. This air flow makes up part of the cave’s unique environment.

2.4.1 Excavation

Excavation in Cave 1 was first carried out by Julian Steward in 1930 and 1931. Steward dug three main trenches, one in each of Area A, Area B and Area C, as well as several smaller test pits. The trench in Area A is known as “Trench A” and is the largest area of excavation that Steward carried out; it also had the densest deposits. The trench in Area B is known as “Trench B” and also had dense cultural deposits. Steward’s last trench, in Area C at the back of the cave, and the other test pits at various locations did not contain cultural material (Steward 1937:10) (Figure 2.5).

Steward recovered thousands of artifacts from the excavation of Trenches A and B, as well as from the surface of the cave floor. Many of these artifacts are organic materials that may not have been preserved in other environments. An impressive amount of amazingly well-preserved material was found, including arrows and arrow points, arrow smoothers, bows, fire drills, digging sticks, gaming pieces of wood and bone, bone awls, various bone implements, horn, antler, shell, matting, tule bags, netting, cordage, ornaments, ceramics, hide mittens and bags, bison robes, scrapers, lithics, a pipe, and most impressively, more than 340 moccasins or moccasin fragments. In addition to these artifacts, Steward noted that the “material is exceedingly fibrous, containing juniper bark, hair from scraped hides, straw, scraps of hide, many bones and bone fragments, and all manner of objects" (Steward 1937:9). He concluded that Cave 1 was occupied as a permanent home and the material represents a single culture that he named Promontory. Steward also found Promontory Culture remains in Cave 2, as well as evidence of earlier occupations, leading him to believe that the cave had been occupied intermittently by several cultures over the last 3,000 years (Steward 1937).

Billinger and Ives (2015) used the moccasins recovered from Steward's excavations to develop a model of demography for the inhabitants of Promontory Cave 1, based on the relationship between the length of a moccasin (foot size) and stature estimates. The stature values were used to assign each moccasin an estimate of the age of the individual. The results indicated that the cave was occupied by a large proportion of children and subadults, suggestive of a growing population (Billinger and Ives 2015).

After Steward's initial excavation in the 1930's, the Promontory Caves were not investigated archaeologically again until 2011, when Dr. John W. Ives and Dr. Joel Janetski led an interdisciplinary team of researchers, with members from the University of Alberta (Institute of Prairie Archaeology), Brigham Young University, the Natural History Museum of Utah, Oxford, the Desert Research Institute and Weber State University, and began their own excavations. Excavations in Cave 1 (42B01) and Cave 2 (42B02) took place in April and November of 2011, May of 2013, and May of 2014. Excavations also took place in 2013 and 2014 at the nearby Chournos Spring site (42B01915), which features a contemporaneous terminal Fremont occupation.

From 2011-2014, two square metres were opened near the mouth of Cave 1 next to Steward's "Trench A" area (F3), a slit trench and four additional units were also dug in Area A to glean insight into stratigraphy (F55), one square metre was opened below the rock art panel on the east side of the cave (F49) and a 0.75 m x 0.75 m unit was opened up adjacent to Steward's

"Trench B" (F28), and a stratigraphic profile was drawn for some deposits beneath the post-Bonneville rockfall on the west side of the cave (Figure 2.5). The unit below the rock art yielded only one obsidian microflake (Feature 49/50, FS1218). There was very little natural or cultural deposition in this area of the cave and the cave floor was encountered within the first centimeter of excavation.

The profile that was completed under the rockfall on the west side of the cave was done because Dr. Janetski noticed stratified deposits under one of the larger rocks in this area. These deposits were under one of the areas of post-Bonneville rockfall. Some materials recovered from underneath this rockfall were radiocarbon dated. Five dates were obtained in all, ranging from 2225 +/- 20 ^{14}C years B.P. to 5210 +/- 20 ^{14}C years B.P (Figure 2.6). The material that was dated was under a very large rock that could not have been moved by people, so the material was likely deposited before the rock fell, indicating that this area was free from rockfall as late as approximately 2250 calendar years B.P. However, this date is still prior to Promontory Culture occupation of the cave.

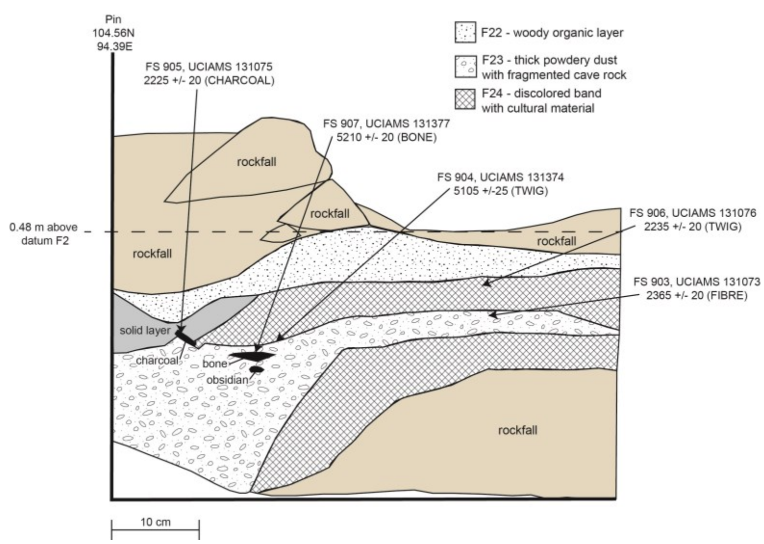
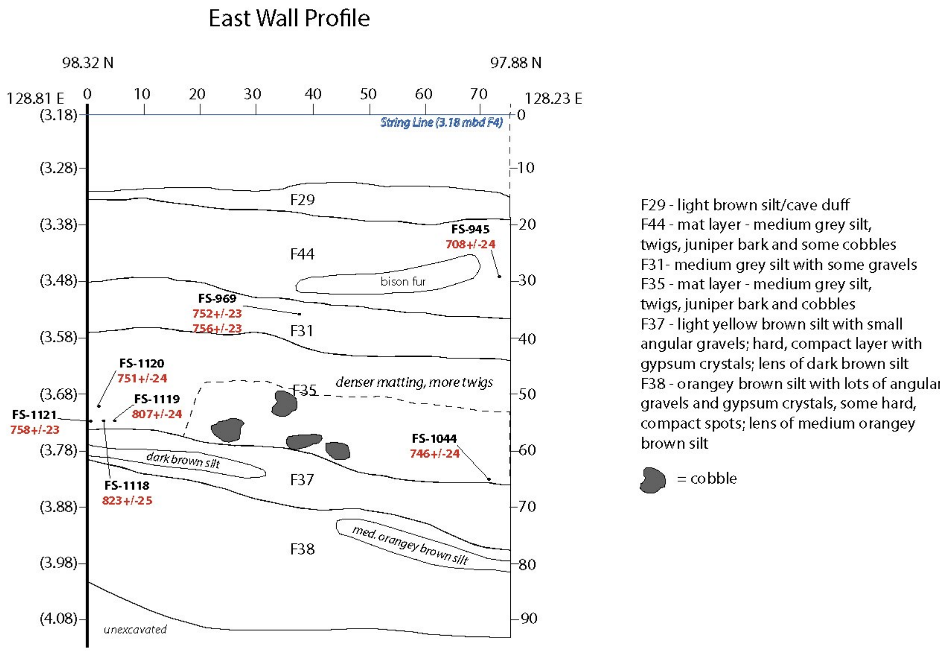


Figure 2.6. Stratigraphic profile of Feature 20 under post-Bonneville rockfall on the west side of the cave and associated radiocarbon dates.

The 0.75 m x 0.75 m unit adjacent to Trench B (F28) on the east side of the cave was completed during the course of the 2013 field season. The deposits here were dense but not nearly as thick as at the front of the cave near Trench A. As shown in Figure 2.7, the cultural material deposits in this excavation were about 50-60 cm thick, followed by sterile silt underneath. While the unit at first glance appeared to yield many of the same artifacts as near the front of the cave, further analysis revealed that overall there was less artifact diversity in this area (Hallson 2017). Radiocarbon dates acquired from materials recovered during this excavation range from 823 +/- 25 ^{14}C B.P. to 708 +/-24 ^{14}C B.P., which fit in with Promontory Culture dates obtained from other parts of Cave 1 (Figure 2.7).

Excavations near the mouth of the cave included the 2 x 1 m excavation (F3), a slit trench and an additional four square metres at F55, as well as a small test at F15. F55 and F15 were both dug to explore the stratigraphy in this area and compare it to Steward's descriptions. Excavations at F3 were more than two metres deep and the Promontory Culture deposits are over 1.8 metres thick (in contrast to the 60 cm thick Promontory Culture layer Steward encountered throughout much of the Trench A and B areas of Cave 1). It is unknown how deep the pre-Promontory cultural deposits in this area are, but fainter traces of mid-Holocene occupation (fragmentary bone and some lithics) are present (Ives, personal communication). Thousands of artifacts have been recovered from this small 2 x 1 m area.

Figure 2.8 shows the stratigraphy of F3 and F15. The unit at F15 did not extend nearly as deep as F3. This profile also shows that the original 2 x 1 m excavation narrowed in size quite a bit, owing to the difficulty of digging through juniper bark layers and leaving intact artifacts in place in the walls of the excavation unit. Large rocks also provided obstacles. This difference in depth suggests that the area of F3 may have at one time been more of a depression in the cave.



FS#	Sample ref.	OxA	Material	Object	Date (c14 BP)
945	PCE #25	28316	tissue, Bison	Moccasin leather	708 +/- 24
969	PCE #26	28317	tissue, Bison	Moccasin leather	752 +/- 23, 756 +/- 23
1044	PCE #23	28439	hair, Rabbit	Cordage	746 +/- 24
1118	PCE #20	28437	twig, greasewood	Greasewood	823 +/- 25
1119	PCE #22	28438	plant fibre, juniper bark	Cordage	807 +/- 24
1120	PCE #21	28314	tissue, Bison	Bison Hide and Fur	751 +/- 24
1121	PCE #24	28315	bone, likely Bison	Scapula Fragment	758 +/- 23

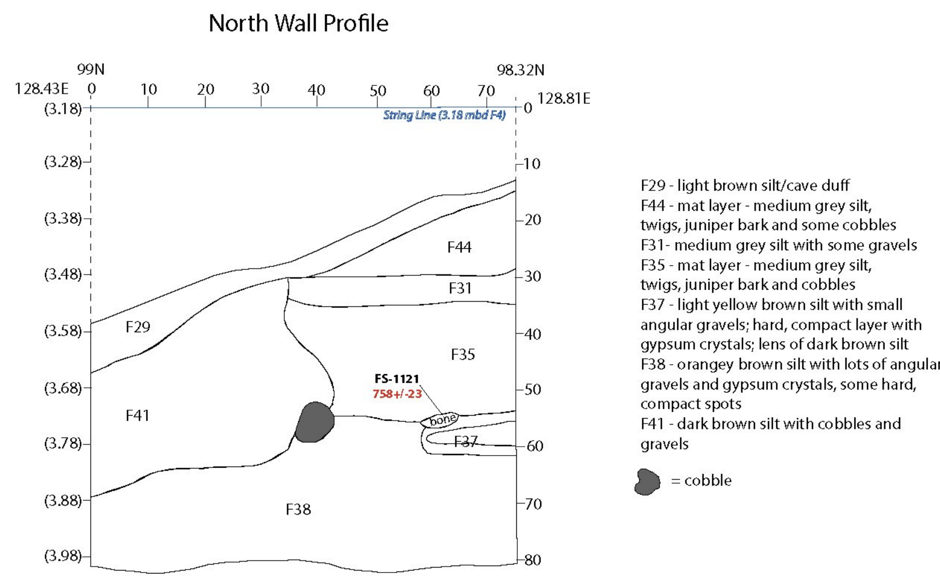


Figure 2.7. Stratigraphic profile and radiocarbon dates from F28 excavation.

The radiocarbon dates for the Promontory Culture occupation in this area are reasonably clustered around 700 to 800 years B.P. but their stratigraphic distribution is a bit mixed. Due to this variation, along with the sheer density of material in this area, this deposit is interpreted as midden accumulation, in which materials from the main occupation area of Area A were pushed and discarded towards this depression, closer to the mouth of the cave (Hallson 2017; Ives, personal communication). In contrast to the F3 area, the excavations at F15 and F55 were not nearly as plentiful or deep and were more consistent with stratigraphy that Steward described.

Overall, excavations revealed that the main areas of occupation were Areas A and B. These two areas contain the vast majority of artifacts recovered from the cave, while the other areas have very sparse to no cultural deposits. The artifacts in both areas are similar, but Area A is significantly denser and more diverse than Area B (Hallson 2017). This distribution suggests that similar activities were taking place in both areas but that Area A was more heavily used than Area B. The artifact assemblages are made up of artifacts that represent everyday activities like food processing, flintknapping, gaming, hide processing, and basketmaking.

2.5 Other Promontory Culture Research

Linguistic and genetic research has shown that Apacheans and Navajos residing in the southwest United States have Athapaskan ancestors (Ives and Rice 2008). The Athapaskan homeland is thought to lie in parts of Alaska, the Yukon and northern British Columbia (Ives 1990; Krauss and Golla 1981; Magne 2012; Sapir 1936). Ives (2014) revisited Steward's ideas on culture identity, making further comparisons between northern Athapaskan material culture and the remains from the Promontory Caves, in order to test the hypothesis of the inhabitants of Promontory Cave 1 having northern ancestry. There are striking similarities in the style of moccasins, netting fragments and hide processing implements, specifically tabular bifaces or chi-

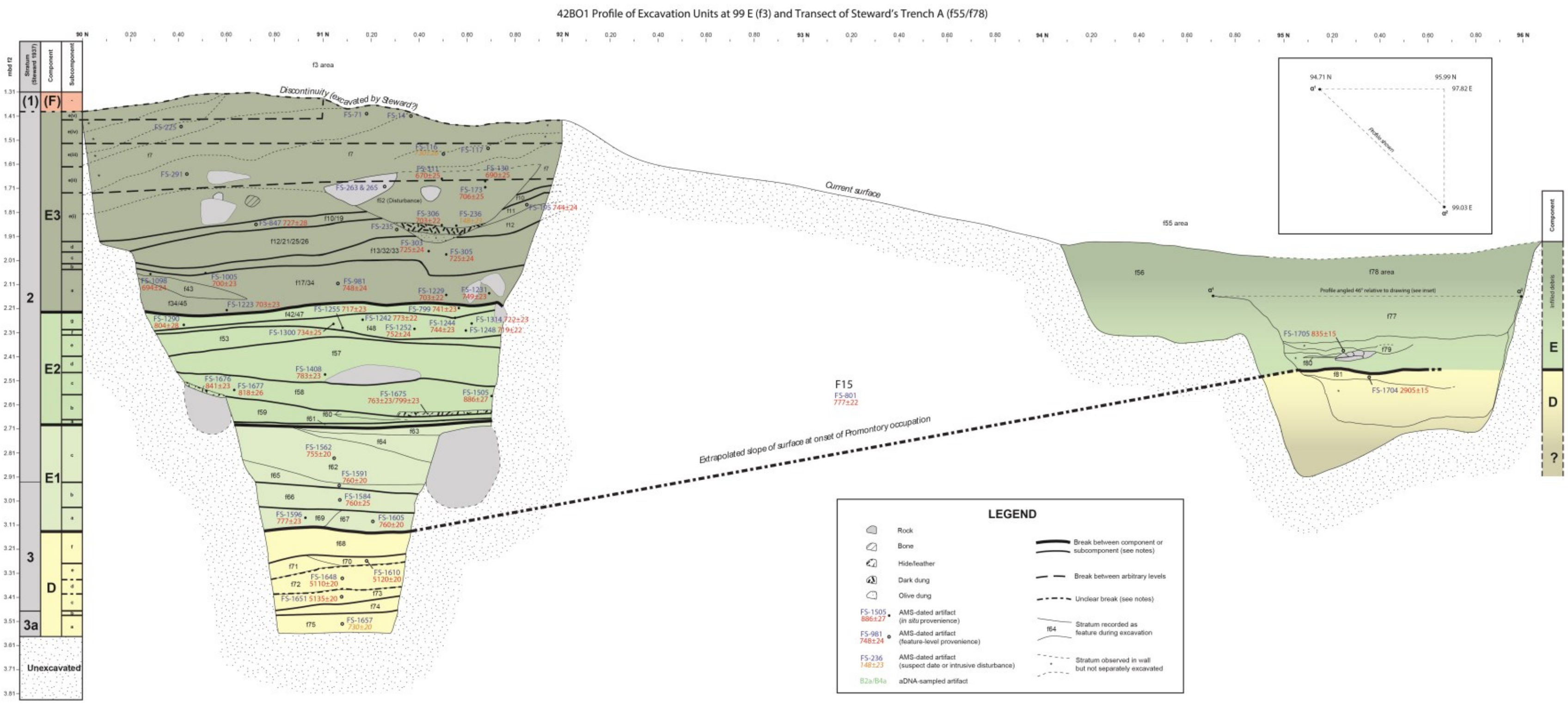


Figure 2.8. Stratigraphic profile and associated radiocarbon dates for Features 3, 15 and 55 in Area A. Courtesy of Gabriel Yanicki, Jennifer Hallson and John Ives.

thos. In addition, the Promontory Cave remains have geographic links to the north, including a predominance of Malad obsidian as the source for 80% of the obsidian lithics found at the site and similarity between rock art in the cave to a panel of rock art in Grotto Canyon in Banff, Alberta (Ives 2014).

A profound emphasis on bison hunting also indicates that this group is unique among other cultures in the region and is suggestive of an influence involving northern Plains bison hunting cultures. While Steward kept relatively few faunal remains, there is no doubt from his general description that large game hunting, with a specific focus on bison, provided the economic basis for the Promontory cave inhabitants. Analyses of Promontory faunal remains is in progress, but initial results show that Steward was entirely correct in his subsistence conclusions. Johansson (2013) analyzed the faunal remains from Caves 1 and 2 recovered during both Steward's excavations and Ives and Janetski's excavations in 2011. She found that Steward was correct in identifying the Promontory Culture as one oriented toward hunting large mammals. The majority of the identifiable bone from Cave 1 was indeed that of large mammals, with less than 10% of the faunal remains being attributed to small mammals, birds and reptiles.

Johansson (2013) also studied the seasonality of occupation of Cave 1, based on analysis of two mule deer crania and twelve artiodactyl mandibles. This analysis "indicated that there were at least two seasonal occupations in Cave 1, one in the winter, between December to February, and one during the late spring through early fall" (Johansson 2013:42). Faunal analysis from Cave 2 for the Promontory Culture layers demonstrated that 80% of the remains were of small artiodactyls, ~15% were large artiodactyls (bison or elk) and the other 5% were of various other mammals including a very small percentage of bird remains. These percentages, when compared with earlier occupations of Cave 2, indicate that the Promontory people were hunting more large game than their predecessors. Seasonality analysis of the faunal remains from Cave 2 indicates that it was occupied in a variety of seasons (Johansson 2013). Subsequent research by Hallson (2017:157) has suggested that the cave was likely occupied for “a few months at a time…over the 20 to 40 year period”.

2.6 Chapter Summary

The caves carved out by pluvial Lake Bonneville on Promontory Point in the Great Basin have become the setting for an intriguing time in the region’s history. Julian Steward’s work on these caves in the 1930’s resulted in a highly significant find—a new culture arriving in the region at a time when climate change had forced the people of the dominant Fremont Culture to abandon their horticulturist lifestyle. Steward named this new group “Promontory Culture.” Research on open air sites around Utah Lake in the 1990’s by Janetski revealed that Promontory material culture extended farther south into central Utah, and Arkush (2014) and others in Idaho have now found evidence of this group in the southern portion of that state (Butler 1983). Who these people were has been debated, and somewhat ignored, since Steward’s work. He believed they were a group with northern Athapaskan origins (Steward 1937). Extensive research on Promontory Caves 1 and 2 by Dr. Jack Ives and his colleagues has injected new life into the question of who these people were and where they came from. Based on previous and continuing research, it is clear that Promontory Cave 1 was occupied by a “Promontory Culture” group from ca. A.D. 1240-1290 for one to two human generations at a time when bison were present in this part of the Great Basin. Other cave sites on Promontory Point were also occupied by this group around the same time period and one nearby open air site, Chournos Springs (42B01915), has a contemporaneous terminal Fremont occupation, that with artifacts such as Fremont basketry in the caves, strongly suggest that Fremont-Promontory interaction took place.

CHAPTER 3

THEORETICAL APPROACH

"…we find that through the idiosyncrasies of style, building and settlement form becomes one of the primary – though most puzzling and variable – expressions of culture" [Hillier 1996:10].

One of the main goals of this study is to analyze the human habitability of Promontory Cave 1, including the organization of space in the cave and what it can tell us about the people that occupied it. The main theoretical approach used to look at this is space syntax analysis, which is a theory developed for architecture, and therefore, built spaces. However, caves can resemble built environments so space syntax theories can thus effectively be applied to study how the surrounding environment in Promontory Cave 1 affected social interaction and activities. This theory is explained below. Other theories of space, place and archaeoacoustics are also explored and applied to this study.

3.1 Theories of Space and Place

Before delving into the theory of space syntax analysis, it is important to define "space." In the field of landscape archaeology, several different terms are used to talk about space in a cultural context. The term "space" is more of an abstract idea and does not represent any exact location. It can be infinite and meaningless (Casey 2008). When humans use space, have experiences in it, and integrate it into their lives, it gains meaning and becomes a "place." Places become part of the mental map and, when put together, form the landscape in which everyday life is carried out (Casey 2008; Lefebvre 1991; Strang 2008). Lefebvre's concept of "production of space" sees space itself as an abstraction that contains things. When human activity and social relationships take place in space it is transformed into "social space." "Social space" is produced through experience, perception, and imagination of the people of a society (Lefebvre 1991:84). It is when people experience spaces and give meaning to them that they become part of the cultural landscape. These cultural landscapes or social spaces are the "spatial and temporal fields of action in which material and conceptual contexts are constructed and negotiated through the processual articulation of social action, structure and the physical environment." These are spaces that people not only inhabit, but also in which they "dwell" (Johansen 2004:310; Heidegger 1971). "Dwelling," as defined by Heidegger (1971), is the manner in which humans are on the earth. Spaces are in the dwelling of man and it is through "place" and construction of "place" that man and space are related (Heidegger 1971). It is because of this meaning that societies give to "space" that we can apply space syntax analysis to gain insight into culture.

Space syntax analysis is usually applied to the built environment, for spaces that people design. While built environments and social spaces are a product of human activity and social processes, it is also important to note that these built environments and social spaces can, in turn, shape society. A famous example of how space shapes society, and how the design of space can be used for power or control, is Jeremy Bentham's Panopticon. The Panopticon is a prison design in which the inmates can all be seen from one central position. However, the inmates cannot see any of the other inmates; they can only see the central tower (Foucault 1977; Leone 1995). This arrangement gives the inmates the feeling that they are always being watched. It also separates the inmates into individuals, rather than grouping them as a collective. This design takes the power or control away from the inmates, who are greater in number, and gives it to the prison guards (Foucault 1977; Leone 1995). The design of the Panopticon is not restricted to the design of prisons. It can be applied to any space in which power and control is desired, whether it is schools, hospitals or political institutions. The Panopticon is a classic example of how space can be used to shape society. For archaeologists, it is important to recognize that the form and function of a building can offer insight into how a society may have been organized. It can also tell us about how individuals may have carried out their lives or what their status may have been.

Space means different things to different people. Harvey (1989) compared the ideas of space among several different scholars including Foucault, De Certeau, Hagerstrand and Bourdieu. Each of them has a slightly different idea of exactly what "space" is; however, no matter the viewpoint, it is obvious that space and society cannot be separated. There must be a society for social spaces to form, and in turn, there must be space in which a society functions. This relationship between space and society is essentially what becomes quantified, measured and analyzed when space syntax techniques are applied to social spaces and can become a powerful tool in the interpretation of culture.

3.2 Space Syntax Theory

Space syntax theory was first developed for the field of architecture by Bill Hillier and Julienne Hanson (1984) in order to look at the social effects of different designs of built structures. Since space syntax was designed to deal strictly with the built environment, the term "space" in this context refers to "social space" or a specific "place". The idea behind it is to see how architecture, built designs and urban layouts can affect, and produce or reproduce, social processes. When space is ordered, through the construction of buildings or settlements, it is argued that there must be certain logic to the design and ordering of space. Some societies put a lot of effort into complex, structured order, while others are much more random (Hillier and Hanson 1984). Differences in the spatial order or "configuration" are one of the main ways in which cultural differences can be recognized (Bafna 2003; Hillier 1996). Spatial configuration reflects social hierarchies, relationships, activity areas, and movement patterns that can reveal how a society functions (Bafna 2003; Hillier 1996; Hillier and Hanson 1984).

Buildings are often multifunctional. They provide several amenities including shelter, and space for activities and social relations. They also house objects and provide opportunities for "cultural expression" (Hillier 1996:14). Buildings are socially significant in at least two ways: 1) they "elaborate spaces into socially workable patterns to generate and constrain some socially sanctioned…pattern of encounter and avoidance" and; 2) they "elaborate physical forms and surfaces into patterns through which culturally or aesthetically sanctioned identities are expressed" (Hillier 1996:16). Space syntax analysis can help us identify the spatial patterns of encounter and avoidance and reveal variations in the form and function of buildings (church vs. yurt vs. Bedouin tent) which help us to identify cultural identities, norms and practices (Hillier and Hanson 1984). In spite of the variation of form and function among buildings, there is one relationship that can always be recognized and that is differences in space use within the building for the 'inhabitant' and the 'visitor'. The inhabitant occupies the "deeper, non-distributed parts of the building and interfaces with the visitor through the shallower, often distributed parts of the building that form its principal circulation system" (Hillier and Hanson 1984:184). However, there are exceptions to this rule, known as reversed buildings, when the visitors occupy the deeper spaces of the building and the inhabitants the shallower. Common examples of reversed buildings are hospitals or prisons (Hillier and Hanson 1984).

The methods of space syntax theory are what allow us to quantify and compare spatial configuration in order to recognize and define aspects of social interaction and organization. If we consider the layout of buildings and urban complexes, they consist of boundaries and permeabilities of various kinds (Hillier and Hanson 1984). While there may be countless numbers of ways to organize boundaries and permeabilities, there are a finite number of organizing principles that are used to manipulate space for social purposes (Hillier and Hanson 1984). Several methods can be used to look at the relationships between boundaries and permeabilities in both settlements and individual buildings. These include construction of justified graphs, convex and axial maps, visibility polygons or isovists, and calculations of depth, real relative asymmetry (RRA) or integration, and connectivity analysis (Bafna 2003).

Justified graphs (j-graphs) are a visual way of expressing spatial patterns within built environments (Hillier 1996). J-graphs are the easiest way to readily recognize differences in which spaces are public or private domains. To construct a j-graph, a base or root must be chosen. This can be any space in the building, but often the exterior is chosen as the root. The root space is represented by a circle with a cross in it and all other spaces are represented as plain circles. The circles are then aligned in relation to the root space and access between them is connected with lines (Figure 3.1). The resulting j-graph provides a visual representation of depth and symmetry (Bafna 2003; Hillier 1996). The depth of a space is measured in relation to the root by how many connections it takes to get to it. If a space is connected directly to the root, it has a depth of 1. If another space has to be passed through to get to a destination, it would have a depth of 2, and so on. Generally, shallower spaces tend to be public domains (visitors), while deeper spaces tend to be more private and used only by the inhabitants. For example, in modern day Euro-Canadian house layouts, bedrooms usually have more depth than a kitchen or living room. The depth can also illustrate symmetry or asymmetry of spaces. If two or three spaces in a layout have the same depth, they are hierarchically the same and therefore those spaces are symmetrical. If they have different depths, they are hierarchically different and are considered asymmetrical (Bafna 2003; Hillier 1996). Using the example of a Euro-Canadian house layout, if the living room and kitchen both have a depth of 1, they are considered to be symmetrical. If there are three bedrooms, each with a depth of 3, the bedrooms are also symmetrical in relation to each other, but the bedrooms and the kitchen and living room are asymmetrical.

Measuring symmetry of spaces provides ‘real relative asymmetry’ (RRA) values that are assigned by calculating the average depth of a space in relation to all of the other spaces in the justified graph (Bafna 2003; Hillier 1996; Hillier and Hanson 1984). The inverse of the RRA (1/RRA) is known as integration. Integration values are often used to determine how public or private a space is, which helps provide an indication as to the function of the space. Higher integration values indicate that the space is shallower, more public and easier to access, while lower integration values indicate that the space is more private and has limited access points (Bafna 2003; Hillier 1996; Hillier and Hanson 1984). Justified graphs also illustrate choice. This is shown through accessibility options and if there are alternative routes available from one space to another (Hillier et al. 1987).

Axial and convex maps look at spatial configuration in terms of movement patterns, integration, permeability and visibility. Convex maps can be used to construct justified graphs in terms of convex space. Convex space is when a "straight line can be drawn from any point in the space to any other point in the space without going outside of the boundary itself" (Hillier and Hanson 1984:97-98). To construct the convex map, the largest convex space in the configuration is identified, then the next largest, and so on until the entire area has been divided into a set of convex spaces (Bafna 2003: Hillier and Hanson 1984). Points of access into each convex space are represented by a line. A j-graph can then be constructed to analyze depth and integration of these convex spaces (Figures 3.1 and 3.2). Convex maps capture social relationships more effectively than the basic method of j-graph construction in which each labeled room is assigned a node. In the convex space partitioning method, visibility and access are represented more accurately (Bafna 2003; Hillier and Hanson 1984).

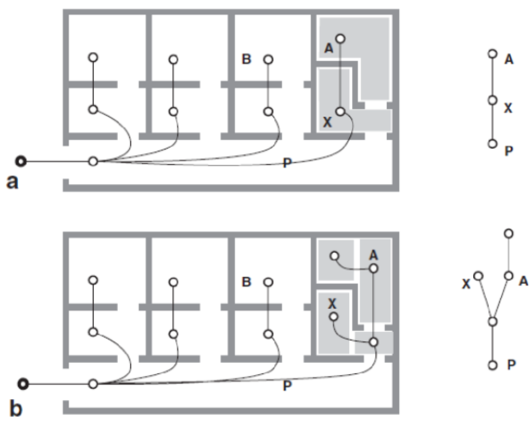


Figure 3.1. a) Mapping of a space by assigning each room a node, and its associated justified graph; b) Mapping the same space using the convex map method, and its associated justified graph (from Bafna 2003).

Axial maps represent movement through convex spaces. Axial lines are drawn through convex spaces based on lines of sight. This forms a set of intersecting lines that represent how movement can take place through the space (Figure 3.2) (Hillier and Hanson 1984; Turner et al. 2001). Axial lines that are longer and intersected more often are more highly integrated in the system and represent routes with more public movement where encounters among people are more likely to occur. Axial lines are also important in predicting behaviour because people will often choose their paths and orient themselves based on “what they can see and where they can go” (Hanson 1999:54).

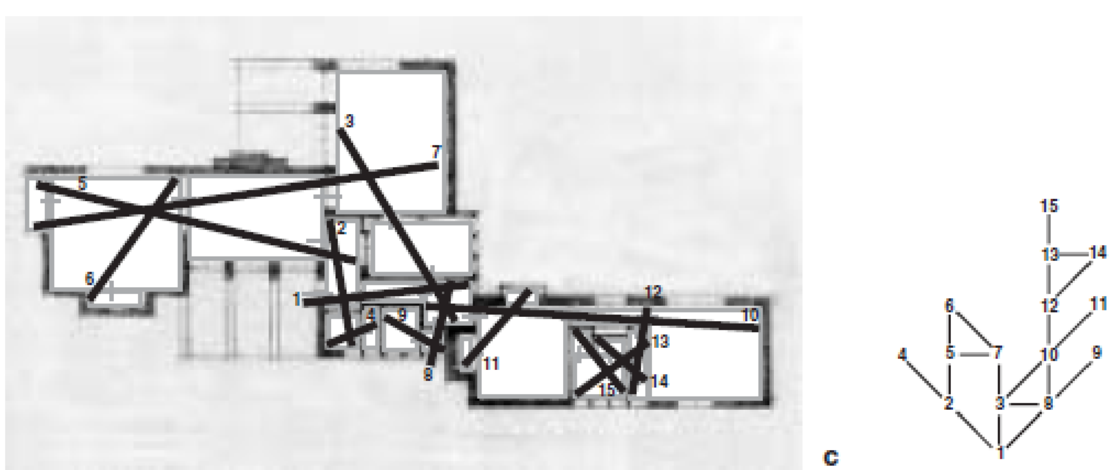


Figure 3.2. Axial map and corresponding graph (from Bafna 2003).

Convex maps, axial maps, visibility graphs and justified graphs can be constructed manually or generated in software programs that have been specifically designed for space syntax analysis. These programs can also be used to calculate or analyze depth, integration, choice, symmetry, connectivity and other analyses. Programs that can be used include Axman, Netbox, NewWave, Pesh, Spacebox, Depthmap, Confeego and AGRAPH as well as several others. Some of these are standalone programs and others are used as plug-ins to other programs such as ArcMap (UCL and the Space Syntax Laboratory 2004).

Applying space syntax analysis to a single building is fairly straightforward, but things become more complicated when performing analysis on a whole settlement. Space syntax was developed for architecture, a field that uses top down blueprints to represent space. Today, architects may use computer and 3D images to represent space but generally, space is shown through neat, geometric lines that represent permanent structures and their boundaries and permeabilities (Hillier and Hanson 1984). These architectural plans do not account for other objects, obstructions or impermanent structures that may be part of the space, nor do they account for topography. Space syntax analysis only considers the permanent, built structures in the space, and only on a 2D plane. In reality, a settlement that is being analyzed may have very dramatic topography that could affect the access between two spaces (Ramadanta and Darjosanjoto 2012). Or, there may be other impermanent or natural boundaries that block access or field of view between two spaces. These would completely change the results of the j-graphs, axial maps, convex maps and visibility graphs. When space syntax analysis is applied to an entire settlement, it is highly likely that topography would affect the movement routes that people take and therefore the results of the axial map would not be accurate. Ramadanta and Darjosanjoto (2012) suggest that using a combination of GIS and space syntax analysis is a better approach in order to account for topography. In addition, where possible, it would be valuable to obtain information about the placement of objects, impermanent structures or natural features within the study space. These variables will have an effect on the choices people make about how they travel through and inhabit a social space.

Space syntax analysis has been successfully applied to other archaeological research including at built dwellings in Mexico, the American Southwest, and the Canadian Arctic (Bustard 1999; Dawson 2002; Morton et al. 2012; Shapiro 1999; Van Dyke 1999). The theory has also been successfully applied to a natural environment with Osicki's (2012) study of human movement and land use in Jasper National Park. These studies all show that this approach can be used effectively in the field of archaeology and can contribute a great deal to the interpretation of building form and function, movement patterns, social organization, and variation in culture through different forms of spatial configuration. The fact that space syntax theory has been applied successfully in the examples above to prehistoric built dwellings and to natural environments logically renders it an appropriate technique to use for Promontory Cave 1, a natural environment and a dwelling.

3.3 Anthropological Theory

Spatial organization as an indication of cultural practices is not a new idea in anthropology. Settlement pattern analysis is a common method used in archaeology. A form of settlement pattern analysis was first carried out by Julian Steward in the 1930's and his work inspired other researchers, including Gordon Willey's pioneering settlement pattern analysis work on sites in the Viru Valley in Peru (Trigger 2006). Through time, techniques used to carry out settlement pattern analysis have become more sophisticated, such as the introduction of Geographic Information Systems. Their use has also expanded to intrasite analysis of distribution of artifacts and features and comparison of site patterns to ethnographic accounts in order to glean insights into social organization at both the individual site level and the broader regional scale (Silberman 2012).

When thinking about space in Promontory Cave 1, there are two approaches that can be taken. The first is to think about space in the cave being organized with discrete areas for separate families. Since the cave is so large, there is potential for that sort of division. This idea of space use could be related to the idea of village organization, discussed below, with discrete dwelling areas in different portions of the cave. Each of these separate dwelling areas may have been organized similarly. The second way to approach spatial analysis is to think of the cave as one large dwelling and apply the idea of organization of space in one dwelling to the entire cave. Use of space in Cave 1 will be explored further in chapter five, but for each of these approaches there has been past research about organization of space at both the village and the individual dwelling scales.

Village organization has been explored in several studies in North America. Hunter-gatherer and horticultural groups, in many cases, will organize their villages in circular patterns. In the Late Prehistoric Monongahela Tradition, a culture dependent on maize, beans and squash, villages were often ring-shaped with a central open space, formally defined as a plaza, surrounded by a ring of dwellings. The plaza often had far fewer artifacts than the surrounding areas (Means 2007). There were variations within this basic form as villages organized themselves based on the size and complexity of their own group. Despite the variation among these ring-shaped villages, each one did show some model of social organization based on the organization of space. Means (2007:5) noted that "the layout of a ring-shaped settlement is intentionally manipulated to reinforce the local social order."

This type of village organization is also seen in the historic period, as witnessed among the Peel River Kutchin where camps formed an ellipse (Slobodin 1962). Families often clustered together based on sibling ties. The families of the largest sibling group would place their dwellings on either side of the ellipse's main axis and an outdoor fireplace would be placed outside of the leader's dwelling. The wealthiest families were located closest to this outdoor fireplace (Slobodin 1962). Evidence of this ring-shaped settlement pattern is also seen in the early prehistoric period at the Paleoindian Bull Brook site. At this site, areas of concentric activity patterning show discrete activity areas that suggest division of space by gender (Robinson et al. 2009). This ring-shaped settlement organization can be seen at many other archaeological sites, including sites that were occupied by some Plains groups of western North America (Means 2007).

Levi-Strauss (1963) also observed circular village organization among groups in several regions including Melanesia and in the Mato Grosse area of South America. He observed, like Morgan below, that within this circular organization were divisions between groups based on kin, which Levi-Strauss attributed to moieties. He used the idea of dual organization to explain these divisions and the organization of space. For example, if a circular village was divided in two halves, each half represented one moiety, with a purpose to control marriage, religion, politics, economics, etc. The spatial organization therefore represented the social organization of the group. Dual organization could be expressed many ways, sometimes representing divisions between family groups, genders, or sacred vs. profane (Levi-Strauss 1963).

In the same vein of thought, Susan Kent (1993) linked the use of space and architecture to the sociopolitical organization of society, suggesting that one is a reflection of the other. This idea is discussed further in chapter four but basically suggests that the more complex sociopolitical organization a society has, the more complex their architecture will be, with more divisions of space and segmented activity areas (Kent 1993).

Spatial organization within individual dwellings has also been previously explored in archaeology. Chapter four explores dwellings of Western North American hunter-gatherer groups in more detail but some of the same patterns that arise in that analysis have been explored by others. Like village organization, organization of space in individual dwellings can reflect social organization. Lewis Henry Morgan, in his 1881 book, *House and House-Life of the American Aborigines,* looked at many ethnographic accounts that commented on dwellings. Morgan noted similarities in architecture from northern to southern North America; these he attributed to the reflection of a culture of hospitality and communism. Morgan (1881:131) stated that among these groups the "household was formed of a number of families of gentile kin, that they practiced communism in living in the household, and that this principle found expression in their house architecture and predetermined its character." Morgan observed that the system of architecture between groups had a lot in common; many groups had joint tenement houses with central fires, stalls or assigned places for sleeping, and some type of covering on the floor, whether it was reeds, spruce, hemlock, blankets, skins, grass or mats. This organization of space into multi-family dwellings led Morgan to determine that North American hunter-gatherer groups were dependent on groups larger than just the nuclear family (Morgan 1881).

In the Plains tipi, space is often organized based on gender and status. Women occupied the left side of the tipi and men were on the right. The back of the tipi represented sacred or higher status space, while closer to the front (or the door) was profane or lower status space (Oetelaar 2000). The tipi can also be divided into public and private space. Despite the fact that there were no physical barriers, "social rules serve as mechanisms to delineate space for private activities" (Oetelaar 2000:41). The central part of the tipi served as public space and the periphery served as private space. Dr. Eldon Yellowhorn also observed this organization of space among the Piikani of southern Alberta. When the Piikani first moved into cabins on the reserve, they used space in their cabins like they would in a tipi, the same way Oetelaar described, with division between male and female and sacred and profane, all examples of Levi-Strauss' idea of dual organization (Yellowhorn 2015).

3.4 Ethnographic Analogy in Archaeological Research

The research presented in this thesis uses ethnographic accounts and ethnographic analogy to look at space needs per person and how space is organized in dwellings. Ethnography is "a subset of cultural anthropology concerned with the study of contemporary cultures through first-hand observation" (Renfrew and Bahn 2010:323). When the practices of these contemporary cultures are used as comparators for archaeological problems or interpretations, they become ethnographic analogies. Analogy is one of the most widely used tools in archaeological interpretation, and while it can be extremely useful and effective, it also has limitations and downfalls that must be recognized (Ascher 1961).

In the earliest uses of ethnographic analogy, the most common approach was the direct-historical approach (Ascher 1961; Steward 1942; Wylie 1985). This approach made a direct link between a living culture and their ancestors, so essentially what was known about living peoples was extended directly back to the archaeological record (Ascher 1961; Steward 1942). There were problems with this approach, as it was sometimes assumed that there were direct ancestral and genetic links between populations regardless of space and time, so the analogies sometimes were not logical (Ascher 1961; Binford 1967; Wylie 1985). This approach of course becomes problematic because, as we know now, groups move or migrate, and are replaced by other groups. Therefore, as the archaeological record gets older, the less likely it is that practices of the current contemporary culture of the region could be extended back in time, since there likely wouldn't be a direct genetic link between the two groups being compared (Lyman and O'Brien

2001). Of course, this approach can be applied when appropriate but it was found that it was being applied even when it was not logical to do so (Wylie 1985).

A solution to the direct historical approach was presented as “new analogy” (Ascher 1961; Wylie 1985; Lyman and O’Brien 2001). This approach suggested that analogs be chosen differently; separate from direct ancestral links. Ascher (1961:319) suggested that researchers should instead “seek analogies in cultures which manipulate similar environments in similar ways.” Binford (1967) also supported this approach, saying that relevance of the analog should be established, and if it cannot be shown to be relevant in terms of direct historical connection, that relevance could be established based on cultures that use their environment in similar ways. Anthropologists and archaeologists were also encouraged at this time to increase the inventory of analogs, as the more comparators there were, the more reliably these comparisons could be made (Wylie 1985).

Regardless of which approach is taken, ethnographic analogy in archaeological research is still open to criticism and it does have its limitations. First of all, assumptions are inherent when using analogs; we necessarily assume that groups in the past were the same or similar as contemporary groups (e.g., using tools the same way, occupying spaces the same way, having similar religions or beliefs) (Binford 1967). This requirement of assumption means that analogy can be prone to error (Wylie 1985). Another downfall of using analogies is that the hypothesis derived from the analogy cannot be definitively proved or fact-checked because we can’t actually go back in time and observe the group represented by the archaeological record (Wylie 1985). I would argue that is true for most archaeological research, however. Another issue is that looking at past cultures through the lens of contemporary cultures “inevitably distorts our understanding of the past because it requires that this understanding be constructed in the image of contemporary cultural forms” (Wylie 1985:68). Further, when using analogies one must be mindful that "different aspects of culture are liable to different degrees of divergent variability;" an example of this element is the persistence of language versus change in material culture and dwelling types among Athapaskan-speaking groups (Ives and Rice 2008; Wylie 1985:74). And lastly, ethnographic analogy has a danger of fueling circular reasoning when a researcher selects evidence only from cultures that support their own hypothesis or interpretation.

Despite its downfalls and limitations, ethnographic analogy, when used properly, can be a very effective tool for archaeological interpretation. It gives researchers a basis on which to develop hypotheses beyond just arbitrary speculation (Wylie 1985). I would argue that without these analogies, there would be even more room for error in cases where "blind guesses" are made. In the research presented in this thesis, ethnographic data were used to calculate space needs per person and to provide footing for interpretations of organization of space in dwellings. Without these ethnographic accounts or analogies, it would have been much more difficult to provide interpretations that weren't based on uninformed guesses. Where ethnographic analogies are made credible, based on relevance and supported by numerous accounts and similarities, and used with consideration, they can be effective (Wylie 1985). It must also be recognized that "analogical conclusions must be treated as tentative and must consciously be held open to revision as archaeologists expand and refine the background knowledge and archaeological evidence on which they are based" (Wylie 1985:80).

3.5 3D Modeling and Its Uses in Archaeology

Virtual reality and 3D modeling started being used as tools in archaeology in the 1980's and by 2004 there were many archaeological projects using these technologies. One of the most common uses for 3D modeling is communication of cultural heritage to the public (Hermon 2008). The website CyArk is one of the best examples of enhancing cultural heritage accessibility. CyArk houses 3D reconstructions of dozens of important cultural heritage sites around the world, making them accessible to "visitors" without having to leave the comfort of their homes (CyArk and Partners 2014). In addition to public outreach, 3D modeling is very useful as a visual way to express archaeological data. It allows tables and graphs to transform into reconstructed environments in which archaeologists can carry out experiments, take measurements, or create simulations (Dawson et al. 2013; Hermon 2008).

Another goal of archaeological researchers is the preservation and conservation of archaeological sites. 3D laser scanning is a very quick, efficient, and accurate way of collecting data and recording a site in its current state. If changes occur to the site, through human or natural agents, the 3D model can be used to document changes that have occurred (Dawson et al. 2013; English Heritage 2011). At different scales, this tool can also be used to discover new archaeological sites or features, or details such as tool marks on an artifact (English Heritage 2011). 3D modeling and virtual reality have also been used for experimental archaeology (Dawson and Levy 2005).

There are some precautions to take when using 3D modeling. Since so much of 3D reconstruction is focused on public consumption, it may have a tendency to indulge details or add things to the reconstruction that are inconsistent with the actual archaeological data and therefore may cause misinterpretation of the site (Levy et al. 2004).

Overall, virtual reality and 3D modeling in archaeology are very useful tools for recording, conservation, reconstruction, experimentation and transfer of information to the public. They have been used successfully in many projects all over the world (Ahmon 2004; Al-Kheder 2009; Barton 2009; Dawson et al. 2013; Dawson and Levy 2005; Levy et al. 2004; Rüther et al. 2009) and these techniques have been applied to Promontory Cave 1, Utah, as one way to illustrate, interpret and record the site. This 3D scan was used in chapter 5 to calculate floor space in the cave.

3.6 Archaeoacoustics

Archaeoacoustics is a relatively new field of archaeology that considers sound in space and how sound may have influenced the actions or behaviours of people in the past. We know that in modern built environments, such as churches and concert halls, the architect designs the building with certain acoustic properties; a practice that indicates sound is an important aspect of that social space. Sound is present in all spaces, past or present, and can play a major role in many environments. People in the past would have been equally responsive to sound, and therefore, acoustic environments may well have influenced their actions and behaviours. It is important to recognize in archaeological spaces whether the acoustic properties of the space were produced intentionally, or if they resulted as a by-product of other variables (Scarre 2006). Sound can be produced intentionally during the construction of built environments, as is seen at the Chavin temple in Peru; or actions, such as the placement of rock art, can be carried out as a result of the recognition of sound in the surrounding natural environments (Scarre 2006).

The Chavin temple was designed to produce special sound effects that likely enhanced the spiritual effects of the temple. Air ducts and water conduits present at the site were not needed for obvious practical reasons. In order to determine their function, archaeologists experimented with sound by pouring water through the ducts and conduits. The sound was surprisingly loud and, when a standing in the central plaza, sounded more like pulsating applause than running water. The archaeologists were also able to manipulate the sound by opening and closing vents, suggesting that the construction of these air ducts and water conduits was for the intentional production of sound (Scarre 2006).

Experiments with acoustics have also been carried out at sites such as Stonehenge in England and Chichen Itza in the Yucatan, Mexico. At Stonehenge, when sound is produced inside the stone circle, listeners standing outside the circle can hear sounds but they are indistinct and distorted, whereas listeners standing within the stone circle are “immersed in a dynamic soundscape” with very intense and audible sounds (Watson 2002:17). While it cannot be proven if the acoustic properties of the site were produced intentionally, there is no doubt that there are interesting features of the acoustics at the site (Watson 2002). At Chichen Itza, when a percussive sound such as a handclap is made in a certain spot to the north of the Kukulkan pyramid (El Castillo), a sound echoes back mimicking the chirp of a quetzal, a strikingly beautiful bird that is sacred to the Maya (Devereux 2002).

Acoustic experiments have been carried out by Steven J. Waller at many rock art sites around the world. What has been noted is that the placement of rock art is often associated with areas that have phenomenal acoustic properties such as echoes, reverberations, resonance or unusually far-reaching sound (Waller 2002a; 2002b). Scientific methods that have been applied to studies of rock art and its relationships to acoustics include the measurement of frequency (Hz), duration of echoes, and echo strength (in decibels) which can be used to chart echoes at different locations using an echogram chart. These measurements show that rock art is often placed in areas where the sound is most intense (Waller 2002a; 2002b). It is thought that this intense sound was significant to past peoples and was often explained as something supernatural. Additionally, echoes in legends are often represented as spirits (Waller 2002a). It is also thought that sound may have influenced the form or design of some rock art. For example, if the sound emanating from the echo mimics a certain sound, such as stampeding animals or hoof beats, then the artist may have chosen to depict a hoofed animal to associate with this sound (Blesser and Salter 2007; Waller 2002a).

While there are many more examples of the significance of sound at archaeological sites, there is still a lot of work to be done in perfecting the scientific methods and proof associated with the theories of archaeoacoustics. Blesser and Salter (2007:69) point out that, “…acoustic archaeology is a highly speculative field, supplementing sparse evidence with culturally linked inferences that necessarily include a modern perspective." However, there is no doubt that sound is an important aspect to consider when thinking about space. People in the past would have experienced sounds in every aspect of their daily lives, just as we do today, and this likely had an influence on their behaviour and beliefs. The challenge for archaeologists is to determine what sound would have meant to past peoples (Blesser and Salter 2007).

3.7 Chapter Summary

People give meaning to space through actions and experiences, and in turn spaces become part of a cultural landscape (Heidegger 1971; Johansen 2004). Built environments are a product of human activity and social processes, and can therefore tell us something about a culture or society. Space syntax theory is a powerful tool in analyzing these built environments or social spaces. Spatial configuration in social spaces has the potential to inform us about social hierarchies, relationships, activity areas, movement patterns, cultural identities, norms and practices (Hillier and Hanson 1984). Although space syntax theory was designed for built spaces, Promontory Cave 1 was, at one time, occupied as a social space and, as explained previously, the theory can therefore be effectively applied.

Another powerful tool for analyzing and visualizing space or social space is 3D modelling. Archaeological sites can be quickly and accurately recorded using this method. The space can be reconstructed, measured, interpreted, conserved, and illustrated (Hermon 2008; Dawson et al. 2013). These tools, combined with anthropological theory of space use as a representation of social organization and culture, will be a productive way to analyze space in Promontory Cave 1. Chapter five discusses methods applied to the cave and subsequent results.

CHAPTER 4

USE OF SPACE AND SOCIAL STRUCTURE: WESTERN NORTH AMERICAN HUNTER-GATHERER GROUPS

"Why now do men of 5 to 6 feet need houses which are 60 to 80… do we not find in our dwellings all the conveniences and advantages that you have in yours, such as reposing, drinking and sleeping, eating and amusing ourselves with friends…" – chief of the Abnaki when the French advised them to exchange their portable dwellings for European style homes [Nabokov and Easton 1989:12].

To understand the group that occupied Promontory Cave 1, and to have an idea of how many people there were and how they used the space, it is useful to have an understanding of hunter-gatherer group size and composition in general and, more specifically, in Western North America. It is also important to understand how these groups occupied and organized space in their built dwellings. This chapter looks at worldwide averages of hunter-gatherer group sizes and space needs per person, as well as specific ethnographic examples of groups in Western North America, including subarctic Athapaskans, subarctic Algonquians, Plains groups, Great Basin/Numic-speaking groups, and Apacheans. First, I examine broader group sizes and hierarchies. Then, I focus on specific groups and their social structure, the dwellings they occupy, their organization of space in these dwellings, and calculate space needs per person for each group. This is followed by space syntax analysis of Western North American hunter-gatherer dwellings, and observations on similarities and differences in how groups organize their space. The last section looks at comparisons of these specific hunter-gatherer groups with worldwide values or "constants" calculated for space needs per person. This analysis allows for greater insight into how many people may have occupied Promontory Cave 1, how space may have been used in the cave, and what the possibilities were for group organization and structure.

4.1 Group Hierarchies

Hunter-gatherer groups worldwide are organized into discrete social units. These social units are recognized by many different terms including band, tribe, local band, regional band, dispersed group, aggregated group, village, community, and microcosmic unit or macrocosmic unit (Hamilton et al. 2007; Helm 1968; Hill et al. 2011; Honigmann 1946). Despite what terms are used, it is evident that hunter-gatherer group sizes and hierarchies worldwide are organized in strikingly similar fashions (Hamilton et al. 2007). The quantity and quality of ethnographic data that has been collected on hunter-gatherer groups in the recent past has allowed researchers to recognize these similarities and quantify group sizes.

Binford's (2001) volume "Constructing Frames of Reference" was compiled from numerous ethnographic studies by many different researchers, and includes hunter-gatherer group size data for 339 societies worldwide. Binford included the average group size for three hierarchical categories that he defined, shown in table 4.1. Group 1 is defined as "the social unit camping together during the most dispersed phase of the settlement-subsistence system", Group 2 is "the camp-sharing groups during the most aggregated phase of the subsistence settlement system and, Group 3 defines groups of "social aggregations occurring annually or every several years that assemble for other reasons than strictly subsistence-related activities" (Binford 2001:213).

As seen in table 4.1 below, the terms for group hierarchies vary among researchers, but the approximate group sizes remain the same. This conclusion is based on a study done by Hamilton et al. (2007) in which the authors hypothesized that human societies would self-organize in hierarchical orders for optimization. Their model for this characteristic was the hierarchical networks that are common in nature. For their study they viewed hunter-gatherer groups as a social network in which interactions between individuals occur within the context of a hierarchical group structure. They applied statistical analysis to the data compiled by Binford of the 339 hunter-gatherer societies. What they found was that despite the geographic and cultural variability, all of these groups had very similar hierarchical organization and predictable group sizes. The statistical data did support the idea that social groups will self-organize for optimization. The hierarchical levels defined by Hamilton et al. (2007) were individual, family, dispersed group, aggregated group, periodic aggregation, and overall population. They explained that this self-organization may be a result of genetic, ecological, and social processes (Hamilton et al. 2007). While this explanation covers a fairly broad scope, some other researchers have gone into more detailed explanations for the cause of this natural hierarchical organization.

Zhou et al. (2005) looked at the social brain hypothesis as a possible explanation. This hypothesis "argues that the evolution of primate brains was driven by the need to coordinate and manage increasingly large social groups" (Zhou et al. 2005:439). Ethnographic and sociological studies analyzed by Dunbar (1993) have shown that individuals are limited to approximately 150 maintainable social relationships. The groupings identified by Zhou et al. (2005) correspond remarkably well with Hamilton et al.'s (2007) classifications. Zhou et al. (2005), using groupings first presented by Dunbar, identified the "support clique" consisting of 3-5 individuals, the "sympathy group" made up of 12-20 individuals, "bands" of 35-50 individuals, "clan or regional group" of 150 individuals, and beyond that, the "megaband" of 500 individuals and the "tribe" of 1000-2000 individuals. These numbers work very well with the numbers presented in table 4.1. Group size data from ethnographic records and sociological data from a wide variety of geographically diverse small and large scale societies were analyzed as a series of ratios, with the result that groups are formed in discrete hierarchies with a preferred scaling ratio of approximately three. Though it was apparent that social groups adhered to this scaling ratio, no conclusions were made about why this ratio is important; and if it is in fact a result of cognitive function or some other factor (Zhou et al. 2005).

Helm (1968) took another approach to explaining group hierarchies. During her ethnographic work with the T'licho Dene (Dogrib), a subarctic Athapaskan group, she classified socioterritorial groups based on three main factors: kinship, resource and range (Helm 1968). Helm's group classifications of local band, regional band and task group are shown in table 4.1. Kinship is the main factor in the formation of the local band, range is the main factor affecting formation of the regional band, and task groups are formed when certain resources need to be exploited. These are all also affected by spatial cohesion and temporal duration. A task group may resemble a local band in terms of size but the task groups are usually only together for a short period of time, whereas the local band is together for very long periods of time (Helm 1968).

Hamilton et al.'s (2007) description of genetic, ecological and social factors as determinants of group hierarchies is a good summation of the other studies presented. Although it is unclear exactly why these hierarchies form so uniformly among hunter-gatherer groups throughout the world, there is no doubt that multiple factors dictate their formation. The hierarchies in turn determine hunter-gatherer group sizes and compositions.

4.2 Group Sizes

Ethnographic sources are invaluable for analyzing hunter-gatherer group sizes worldwide. It has already been established that group hierarchies are formed in much the same way among hunter-gatherer groups throughout the world, and each of these hierarchies is made up of approximately the same size of group. Hamilton et al. (2007) used Binford's data to determine group size for each recognized hierarchy (Table 4.1). At each successive level of hierarchy, it was shown that the group size was scaling at a constant rate of approximately four

(Zhou et al. 2005 determined a scaling ratio of three); and therefore, group sizes become very predictable (Hamilton et al. 2007). The first classification, "individual", is made up of 1 person; a family, on average, consists of 5 people; the dispersed group or band is made up of approximately 15 people; the aggregated group or tribe consists of 54 people; groups that gather for periodic aggregation are made up of 165 people; and total populations consist of, on average, 839 people.

	Hamilton et al., 2007	Hill, et al., 2011	Helm, J., 1968	Honigmann, 1946	Binford, 2001
approx. # ppl					
1	individual	n/a	n/a	n/a	n/a
5	family	n/a	n/a	n/a	n/a
15	dispersed group	band	local band	microcosmic unit	Group 1
54	aggregated group	tribe	regional band	macrocosmic unit	Group 2
165	periodic aggregation	n/a	n/a	n/a	Group 3
839	population size	n/a	n/a	n/a	n/a
*Helm's third classification of "Task Group" can vary in size and age-sex composition					

Table 4.1. Group Hierarchies, Sizes and Classifications

4.3 Patterns of Group Composition and Co-residence

Co-residence patterns among 32 present-day hunter-gatherer societies were studied by Hill et al. (2011). The groups they looked at showed extensive cooperation (food sharing and acquisition, child care, provisioning of goods) within residential units or bands (5-15 people). In terms of band composition, the data supported a bisexual philopatry and dispersal model of co-residence developed by Chapais (Hill et al. 2011). Parents live with offspring of both sex, and brothers and sisters usually co-reside (form sibling cores), with an overall tendency for male kin to co-reside versus female kin. In all of the groups observed, "primary kin associations are typical, but most adult band members are not close kin" (Hill et al. 2011:1287). Hill et al. (2011) argued that this pattern of co-residence based on cooperation may be the reason why human societies have had great biological success. Included in this study were the Slavey and Dogrib (Subarctic Athapaskan), Ojibwa (Subarctic Algonquian) and Apache (Apachean). Among these groups it was shown that the Slavey and Dogrib had equal male and female co-residence, but the Ojibwa had significantly more male co-residence and the Apache had significantly more female co-residence (Hill et al. 2011). This observation is supported by other ethnographic data. Among the Athapaskans there seems to be no preference for marriage or residence based on gender, but the Algonquians prefer patrilocal residence (Rogers 1969). Also, we see among the Apacheans preference for matrilocal residence (Goodwin 1942).

"Group dynamics are governed by two basic kinds of forces: 1) cohesive forces that tend to draw and hold individuals together; and 2) disruptive forces that tend to pull individuals apart and to create barriers to exchanges between them" (Hamilton et al. 2007:2200). Cohesive forces can include kinship, information sharing, and exchange. Disruptive forces would be competition for material or mates, interpersonal conflict, and disease (Hamilton et al. 2007). Group composition is highly dependent on the way people perceive kinship, a cohesive force. In the ethnographic accounts seen above, it is clear that the family unit, which tends to be made up of a conjugal pair, their children, and perhaps one or both of either the husbands' or wives' parents, is one of the most important and constant social units. Beyond the family, kinship also heavily influences formation of microbands and macrobands. Group exogamy or endogamy, matrilineality or patrilineality, and marriage practices (e.g., the presence or absence of cross-cousin marriage) also dictate group formation. Endogamous groups grow through growth, ultimately fissioning into smaller new groups; exogamous groups grow through fusion (Ives and Rice 2008). Microbands are often made up of sibling cores, as observed in many different cultures. Eggan (1980) observed this feature among the Shoshone of the Great Basin; Asch (1980) noted it in Athapaskan groups; and Ives (1998) among each the Athapaskan, Algonquian and Numic groups. He noted that "sets of siblings (whether of the same sex or of the opposite sex) play a central role in alliance formation and in shaping the nuclei of local groups in their various forms" (Ives 1998:118).

Social Structure and Use of Space among Hunter-Gatherer Groups in Western North America

This section explores the dwellings, use of space, and basic kinship practices of hunter-gatherer groups in Western North America. Space needs per person are calculated and space syntax analysis is applied to different types of dwellings. The five groups that are considered are Subarctic Athapaskans, Subarctic Algonquians, Plains groups, Great Basin/Numic groups, and Apacheans. These groups were chosen because of their geographic proximity to Promontory Cave 1, as well as similar material culture and lifeways as the Cave 1 group. Figure 4.1 shows their approximate geographic distributions around the early 19th century.

4.4 Subarctic Athapaskans

Subarctic Athapaskan groups are located in northwestern North America and are represented by 23 Athapaskan languages (Ives 1990). The groups stretch all the way from western Alaska, across the Northwest Territories to the Hudson Bay, and throughout northern British Columbia and Alberta (Figure 4.1). There are several recognized divisions among the Subarctic Athapaskans, one being the "Dene," a term used to refer to the Slavey, Mountain, Hare, Bear Lakers, T'licho (Dogrib), Yellowknife, Chipewyan, and easternmost Kutchin groups as a collective (Ives 1990).

4.4.1 Subarctic Athapaskan Social Structure and Group Sizes

June Helm recorded high-quality ethnographic data for the T'licho (Dogrib) Dene group, located in the Mackenzie District of the Northwest Territories, and the Lynx Point peoples, a Slavey group located in the Upper Mackenzie Basin (Helm 1961; Helm 1968). As discussed before, Helm recognized group hierarchies or divisions among the T'licho and assigned the

Figure 4.1. Approximate distribution of groups/areas discussed in the text, ca. early 19th century.

terms local band, regional band, and task group to these different social units (Helm 1968). Among the T'licho (Dogrib) at Lac La Martre, emphasis was placed on the family unit, which consisted of a conjugal pair and their children (Helm and Lurie 1961). The males acted as the head of household, except in the case of two families in which the wives were widowed. The T'licho (Dogrib) at Marten Lake consisted of a total of twenty family units and approximately 100-130 people, which together represented what Helm classified as a regional group connected by kin relationships (Helm and Lurie 1961). The pattern of co-residence observed was bilateral descent, with both exogamy and endogamy practiced. The only "rule" that Helm noted for marriage practices was that right after a couple got married they would reside by, or with, the wife's parents so that the husband could work for the father-in-law until the first child was born (Helm 1968). After this time the couple could choose where they would like to live, either remaining with the wife's band, moving back to the husband's band, or joining a different band. However, Helm (1961:124) stated that, "no married pair is residing with a local band or within a regional band domain unless at least one spouse of that pair had at time of entry a primary consanguine, of either sex, already resident within the band."

At the time of Helm's fieldwork among the Slavey Lynx Point people there were 56 individuals residing in the village (Helm 1961). Like the T'licho (Dogrib) group, this was a grouping of nuclear family units, in this case nine. However, this group was larger than other Slavey communities; most of the others consisted of three to four families, a total of 20-25 individuals. All of the communities were formed based on kinship ties. Lynx Point was founded by a man named "Old Mink," mentioned previously, who had moved to the area to reside near his sister, whose family had a cabin there (Helm 1961). Like the T'licho, the practice of residence with the bride's family until the birth of the first child was also noted among the Lynx Point peoples. Similarly, the couple could choose where to live after this period. A difference to note among the Slavey that was not noted among the T'licho is that there was preferential cross-cousin marriage, sister exchange, and remarriage to a deceased spouse's sibling (Helm 1961).

Another high quality ethnographic account for the Dene is Robert Janes' (1983) work on the Willow Lake Slavey group. Like the Dogrib and Lynx Point groups, the Willow Lake Dene group was comprised of nuclear family units that formed a local band based on kinship ties. At the time of Janes' fieldwork in 1975, the Willow Lake group consisted of seven core families, consisting of eight adult males, nine adult females, nine male children and five female children ranging in age from one month to 78 years old. However, it was noted that the population changed at times due to family members moving between settlements and the bush, and visitors coming to the community. Social organization among the group was based on bilateral primary kin ties that linked conjugal pairs (Janes 1983).

In the Human Relations Area Files, data on the Chipewyans, an Athapaskan group who inhabited the central Canadian subarctic, indicate that they practiced bilateral kinship. The main domestic unit was the extended family but, since polygyny was practiced, family size ranged greatly. A family could consist of a single family in one tipi to a husband with several wives, and their children, occupying several tipis. Often two or more family units that were connected by kinship and/or marriage would camp together (Sharp 2001). In Kaj Birket-Smith's (1976:68) ethnology of the Chipewyan, based on fieldwork from 1921-24, he noted that his informant, Mgr. Turquetil, "estimates five births as the average for every married couple…". This figure would indicate an average family size of seven individuals. James G.E. Smith (1976) looked at eighteenth century Hudson's Bay company records that give accounts of the Caribou Eater Chipewyan. In these records, it indicates that the tent was the basic social unit and housed eight to ten individuals consisting of two related nuclear families; this includes two men, their wives, their children, and possibly elderly adults. Band membership was based on bilateral kinship and the band size and organization fluctuated greatly, depending on the seasonal distribution of caribou and other resources. Smith (1976) did give a few numbers that indicate how many people occupied each tent. In one case, five tents housed 40-50 people. Another case stated there was a local band of six to 28 hunters, or 30 to 140 people, and a winter hunting-trapping band consisting of 10 to 20 hunters, or 50 to 100 individuals. During Fidler's time with the Chipewyan Dene, he noted that there were 11 people sheltered in two tents and on another occasion there were 25 people in three tents (Helm 1993). On Samuel Hearne's journey to the Arctic with the Chipewyans, from 1769 to 1772, he mentioned on a few occasions the number of people per tent. He mentioned that at one point in time the group he was part of had over "seventy tents, which did not contain less than six hundred persons" (Hearne 2007:39). That figure is equal to approximately 8.5 people per tent. This occasion was during July, when the larger group was gathered. At another point in time, Hearne wrote that the size of their winter party, after having been joined by several people, was comprised of "seven tents, which in the whole contained not less than seventy persons" (Hearne 2007:69). The average number of people per tent in this case was about 10. These estimates are outlined in table 4.2 below.

The Kaska, another Athapaskan group located in British Columbia and Yukon Territory, have a kinship system based on exogamous matrilineal moieties, with the main domestic unit being the matriarchal extended family, which could also define the band (Honigmann 2012). This family unit could be very large, and typically consisted of a man, his wife, their children, the wives' sisters and their husbands and children, and married daughters and their families. Adopted children, or individuals with ties to the matriarchal family, could also be part of this family unit (Honigmann 2012).

Overall, among the Subarctic Athapaskan groups, the family was the main social unit, which was then incorporated into local bands through kinship ties. Helm described the local band as always exhibiting consanguineal links between individuals and conjugal pairs which usually tended to form around a set of adult siblings, as referenced in Ives (1990). As far as preference for exogamy or endogamy, it varied between groups. Among the Dogrib there seemed to be no preference (Helm 1968). The Wrigley Slavey and Caribou Eater Chipewyan groups highly favoured exogamy as a way to expand a group's range, and create alliances for political cooperation as well as additional sources of support in times of scarcity (Ives 1990). They also practiced unilocal residence in which one sex of sibling would remain together in the parental group, while the opposite sex would leave and likely join their spouse's group. The sex that stayed or left was not the same throughout all groups (Asch 1980; Ives 1990). The Slavey groups often consisted of same sex sibling cores, the ideal situation being "a group of brothers married to a group of sisters" (Ives 1990:169, 1998). Opposite to this preference for exogamy, the Beaver Athapaskan groups favoured local group endogamy as a way to expand the local group, strengthen their ties to their territory and produce strong sibling cores (Ridington 1968; Ives 1990). Their sibling cores had brothers and sisters present in circumstances in which cross cousin marriage was either allowed or favoured (Ridington 1968; Ives 1990).

Kinship plays an important role in Athapaskan group formation, but with variation in marriage and residence practices, it is obvious that there is a lot of fluidity in the group composition and size of the local band (Ives 1990; Janes 1983). Richard Perry (1991) highlighted this fluidity and variability when he looked at kinship and marriage practices among many different Athapaskan groups, both in the north (the subarctic/northern Canada) and the south (southwestern United States). In the northern groups, both matrilineal and bilateral descent was practiced, matrilocal residence was preferred but not always practiced, and some groups practiced mother-in-law avoidance while others did not. The most common practices seen among the northern Athapaskan groups were bride service and arranged marriage (Perry 1991). The southern groups, the Apache and Navajo, showed signs of less variability, with descent being, most often, bilateral; all groups were matrilocal, and almost all of them practiced mother-in-law avoidance and arranged marriages (Perry 1991, 1993).

Another way of looking at Dene social structure that gets away from the western and sociological ideas of families and households is an approach advocated by Asch (1980; 1988). Following Asch, Ives (1990; 1998) suggested that northern Dene social structure could be conceptualized in a different way by accepting precepts that knowledgeable Dene people used in describing their communities. In some instances, such as the Dehcho (Slavey), a local group was conceived of as a group of brothers married to a group of sisters. Because northern Dene kin semantics are founded upon Dravidian formal principles, this means that all the children of a founding sibling core will be siblings to each other as well. This logic forces local group exogamy upon descending generations. The very same semantic principles are at play in alternative northern Dene principles of group formation, but in these cases (e.g., the Dunne-za [Beaver], Kaska and Tutchone), the idealized sibling core at the nucleus of a local group is composed of opposite sex siblings – a group of brothers and sisters married to a group of brothers and sisters. When Dravidian kin semantics are applied in this case, first generation cross-cousins can marry, even at very small group sizes, allowing endogamy (Ives 1990;1998).

Considerable real world variability can accompany these idealized forms, as classificatory or fictive kin ties are applied to others who may join such sibling cores. A "Mackenzie Basin" pattern of kin terminology also occurs in some northern Dene communities. In these cases, Ives (1990; 1998) found that opposite sex sibling cores were common, but the kin terminology shifted so that all zero generation children were classed as siblings, forcing local group exogamy irrespective of sibling core composition. These tendencies toward exogamy or endogamy make for real and important differences with regard to spatial arrangements in communities.

Table 4.2 shows Athapaskan group size data compiled from the ethnographic sources described above and Binford's 2001 data. The overall average household size (HHSZ) for the subarctic Athapaskans is 9.36 individuals, the average family size is 4.42 individuals and Groups 1, 2 and 3 match the ranges outlined in table 4.1 (universal hunter-gatherer group sizes) fairly closely.

4.4.2 Subarctic Athapaskan Dwellings and Use of Space

Subarctic Athapaskan dwellings vary in shape and size. Some are circular tents, or conical lodges, covered with hides and very similar to Plains tipis. Other variations include rectangular tents, as mentioned in Birket-Smith's (1976) account of the Chipewyans, although he does note that they previously had tents with a conical wooden foundation covered with caribou skin. Hearne (2007) described the Chipewyan dwellings in 1769-1772 as circular tents held up by poles and covered with a tent cloth made most commonly from thin moose leather. The floor of the dwelling was cleared of moss, and then covered with pine branches and used as seats or beds.

The Human Relations Area Files mention that Kaska dwellings were conical pole lodges covered with sod or moss, or A-frame buildings constructed from two lean-tos placed together. The size of the dwellings varied, depending on the season (Honigmann 2012). By the time Janes (1983) carried out his ethnographic work in 1975, the Willow Lake Dene group's primary dwelling had become a western style log cabin, however, he mentions an elderly male that described a traditional tipi. Each tipi was large enough to accommodate up to four families, and each family had their own space within the structure. In 1975, tipis were still being used by the

Group	Location	GRPPAT*	Household Size	Family Size	# Family Units or Tents	Group 1/ Dispersed Group	Group 2/ Aggregated Group	Group 3/ Periodic Aggregation	Total Population	Source
Beaver	Alberta	1		3.87		20	58	110	1000	Binford 2001
Beaver	Alberta	1		4.5	7.6	34				Ives 1990
Carrier	British Columbia	2	13			18	54	170	525	Binford 2001
Chilcotin	British Columbia	2							2500	Binford 2001
Chipewyan	Caribou Eater	1		5	6 to 28		30 to 140			Smith 1976
Chipewyan	Caribou Eater	1		5	10 to 20		50 to 100			Smith 1976
Chipewyan	Caribou Eater	1	8 to 10	5			40 to 50			Smith 1976
Chipewyan	SK/AB/NWT	1	5.5			11				Helm 1993
Chipewyan	SK/AB/NWT	1	8.3			25				Helm 1993
Chipewyan	Saskatchewan	1	9	4.19		23	75	295	2850	Binford 2001
Chipewyan	NE Canada	1	7		10		70			Hearne 2007
Chipewyan	NE Canada	1	8.5		70				600	Hearne 2007
Dogrib	NWT	1	5.76			22	60	162	1590	Binford 2001
Dogrib	Marten Lake	2		5-6.5	20			~100 to 130		Helm 1961
Han	Yukon	1	9	4.5				214	1000	Binford 2001
Hare	NWT	1	5.06			13	26	120	572	Binford 2001
Holikachuk	Alaska	2	15	4.07			66	300	330	Binford 2001
Ingalik	Alaska	2	13.225				77		1500	Binford 2001
Kaska	British Columbia	1		3.43		16	58	139	540	Binford 2001
Koyukon	Alaska	1	15.27			14	38	105	2000	Binford 2001
Kutchin	Yukon	1	7.8			32	78	210	4863	Binford 2001
Mountain	NWT	1	5.87	4.72		15	60		780	Binford 2001
Sarsi	Alberta	1	7.55			43	140	300	700	Binford 2001
Satudene	NWT	1				12.5	29		825	Binford 2001
Sekani	Alberta	1				18	40	164	656	Binford 2001
Slave	NWT	1	5.3875			13	39	220	2454	Binford 2001
Slavey	Lynx Point	2		6.2	9		56			Helm 1961
Slavey	Varied	2		6.25-6.7	3 to 4	20 to 25				Helm 1961
Slavey	Alberta	1		3	5.2	15.8				Ives 1990
Slavey	Willow Lake	2		5	7	35				Janes 1983
Tahltan	British Columbia	1					71	165	810	Binford 2001
Tanaina	Alaska	2	17.92				68		4500	Binford 2001
Tutchone	Alaska	1		3.33		17	60		1500	Binford 2001
Average			**9.36**	**4.42**	**23**	**20**	**61**	**191**	**1528**	

*GRPPAT: 1 = groups that are mobile and move the entire group from camp to camp as they go about the subsistence round; 2= groups that move into and out of a central location that is maintained for more than one year or are completely sedentary (Binford 2001)

Table 4.2. Athapaskan group sizes compiled from various ethnographic accounts.

Willow Lake Dene but more as a space for storage, food processing, hide processing and other such tasks, but not slept in. Janes (1989) also observed tipi floors in later archaeological work that were hard packed and sloped around the hearth, and covered with spruce boughs.

The dwelling diagrams shown below are not of traditional Athapaskan dwellings. However, when compared to other examples of traditional dwellings, the use of space seems to be organized in very much the same way. The dwellings are relatively modest in size, and most often, they have only one entrance (the side the door is on varies). When entering the dwelling, it opens up into one big space with no additional physical barriers. Public, communal activities took place in the front and central part of the dwelling and private, individual activities took place in the back or the periphery of the structure. All of the dwellings illustrated had a central hearth (in the case of the cabins, a drum stove), and a central area for cooking and dining. The periphery of the dwellings were used for sleeping or storage and, in some cases, there was space in the back, opposite the entrance, reserved for religious or spiritual icons and activities (Janes 1983).

4.4.3 Subarctic Athapaskan Space Needs per Person

Janes (1983) calculated the total dwelling area at the Willow Creek settlement to be 315.04 m^2 and the community at the time had a population of 35 people. These figures indicate that the required space per person among the Willow Creek Dene in Janes' (1983:102) account was 9 m^2. Households are broken out individually in table 4.3 below, but likely have a level of inaccuracy, as Janes did not record the size of all the individual dwellings.

Clark (1996) did ethnographic and archaeological work on Koyukon sites in Alaska. She excavated three semi-subterranean dwellings that had been occupied around 1884-1885. Each house had a floor area of approximately 5 metres by 5 metres, with some slight variation. These houses were occupied in the winter and were constructed by digging down into the ground, putting up several posts, and covering the structure with birchbark sheets and dirt. The layout of the dwelling was a central hearth with sleeping benches or pads on the sides; the floor was covered with spruce boughs and caribou hides. Informants noted that if two families were sharing one dwelling, birchbark dividers would be placed to separate family spaces, one family in each half. The layout was also arranged based on sex, with women working and sleeping near

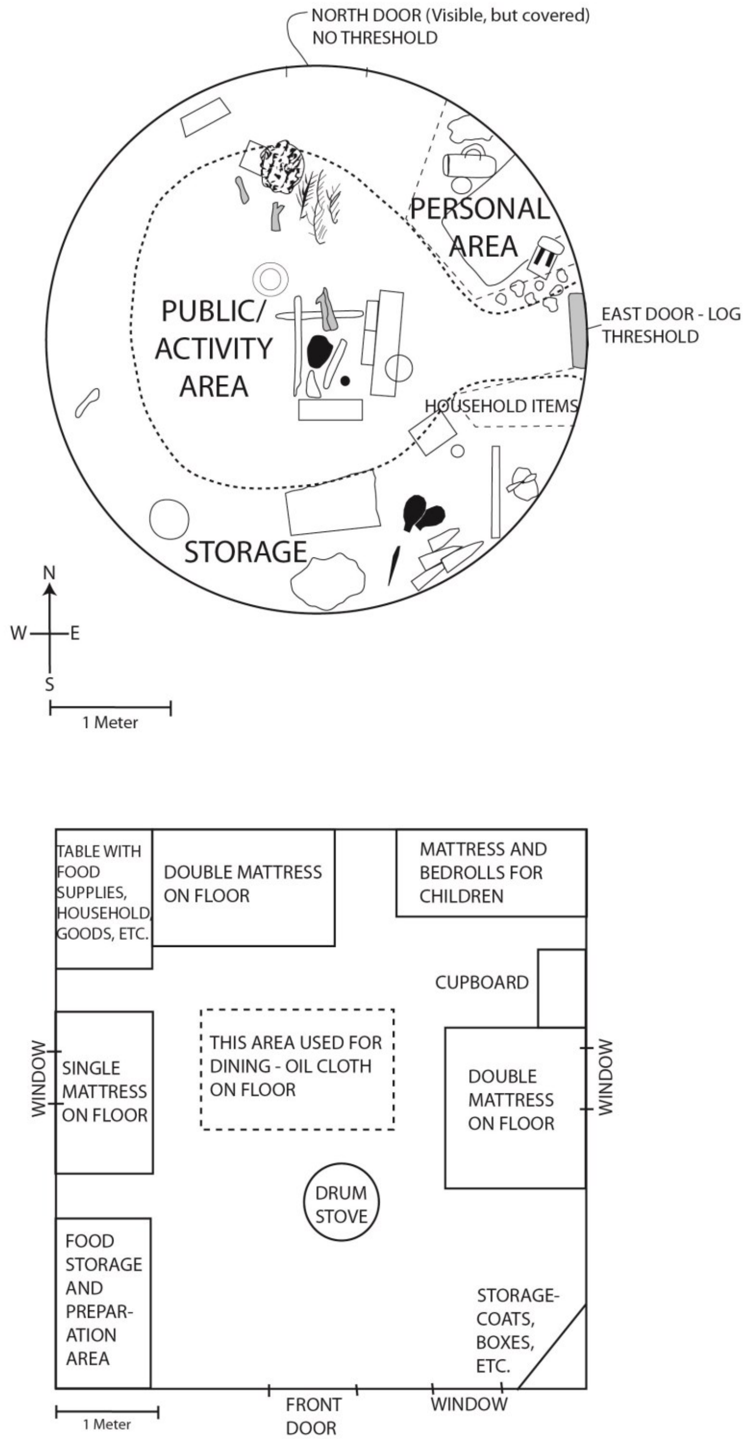


Figure 4.2. Athapaskan dwellings (conical lodge and cabin) and organization of space, from Janes' ethnographic work with the Willow Lake Dene (Janes 1983).

the front of the dwelling, men in the middle, and older relatives in the rear (Clark 1996). Clark (1996) noted two dwellings with a floor area of 26.7 square metres. If the average family size for Athapaskans is 4.53 and two families occupied the dwelling, the average space per person would be 2.94 square metres.

Unfortunately, there are limited accounts that provide information about both the size of a dwelling and the number of people that occupied it. Using Janes' and Clark's data, the space needs per person among the Athapaskans are estimated to be 6.31 m^2.

Group	Avg. Family Size	# of families	Dwelling Type	Season	Area of dwelling (sq. m)	Avg. Space per Person (sq. m)	Source
Athapaskan, Koyukon	*4.53	2	semisubterranean dwelling	winter	26.7	2.94	McFadyen Clark 1996
Athapaskan, Slavey	population = 35	7	cabins and conical lodges	year round	315.04	9	Janes 1983
Athapaskan, Slavey	5	1	cabin, household 2	year round	23.06	4.612	Janes 1983
Athapaskan, Slavey	5	1	cabin, household 3	year round	27.5	8.34	Janes 1983
			conical lodge, household 3	summer	14.186		
Athapaskan, Slavey	5	1	cabin, household 5	year round	20.45	4.09	Janes 1983
Athapaskan, Slavey	5	1	cabin, household 6	year round	28.46		Janes 1983
			conical lodge, household 6	summer	15.89	8.87	Janes 1983
					Average	**6.31**	
*average Athapaskan family size							

Table 4.3. Athapaskan space needs per person calculated from ethnographic accounts.

4.5 Subarctic Algonquians

The Algonquian cultural groups cover an extensive area in east and central North America. Their territory traditionally ranged from eastern Canada, northern Michigan, Wisconsin and Minnesota to North Dakota and southern and central Manitoba and Saskatchewan (Brown and Beierle 2000) (Figure 4.1). Subarctic Algonquian groups include the Ojibwa and Cree.

4.5.1 Subarctic Algonquian Social Structure and Group Sizes

Edward Rogers (1962; 1969) carried out ethnographic work on the Round Lake Ojibwa and Mistassini Cree in eastern Canada. The Round Lake Ojibwa were made up of five named groups including the Caribou Lake Group and the Round Lake Group. Like the Athapaskan groups, these groups were formed around family units, with varying local group size and composition. The population of the local groups ranged from as few as 25 to as many as 75 people. The groups were neither exogamous nor endogamous, cross-cousin marriage was encouraged in order to strengthen family bonds, and there was a patrilocal bias but groups were not strictly patrilineal (Rogers 1962; Rogers 1969). Each group was, in theory, unilateral, as there was a tendency to form groups based on a core of related males, ideally consanguineally. When this was not possible, the tie was through affinal male bonds, which actually made the groups, in practice, bilateral (Rogers 1969).

The Round Lake Group studied by Rogers in 1958 and 1959 had, by that time, lost some of their traditional practices, such as the type of dwelling and how many families lived in each dwelling. The most important social unit that Rogers observed was the nuclear family with dependents; this made up one household. By 1958/1959 a single dwelling was occupied by just one family. However, Rogers noted that in the past a single lodge was "frequently, if not always…occupied by several nuclear families" (Rogers 1962:B65). This single lodge is also what formed the winter camp or entire community.

The Mistassini Cree exhibited many of the same traits of group formation. Other than matrilineal residence for the first three years of marriage (similar to the Athapaskan groups), residence was patrilocal. Neither endogamy nor exogamy was preferred, and cross-cousin marriage was encouraged (Rogers 1969). The summer camp was an amalgamation of approximately 100 homes of all kinds; canvas tents, log cabins, and lodges. The winter camp was much smaller, consisting of only 1 to 3 lodges (Rogers 1967).

Like the Athapaskan groups, Rogers saw variability in group size and composition among the eastern Subarctic Algonquians. Rogers' summation for structure of these groups is:

> …perhaps one can define the local, named group or ‘band’ as a loosely structured unit with a patrilineal bias, comprising 75-125 people, inhabiting a drainage basin alone or in conjunction with other such groups, uniting during the summer on the shores of a lake within the territory and dispersing for the winter in groups to hunting areas. These groups were frequently bilateral extended families although ideally patrilineal extended, all of whom were generally under the leadership of a head man [Rogers 1969:46]

The Western Woods Cree cover a large area from the Hudson Bay west to the Peace River. Their settlement patterns varied seasonally, with smaller groups, known as local bands, being distributed in territorial hunting ranges in the fall, winter and spring and larger groups, known as regional bands, gathering together in the summer. The local band was the basic social unit and consisted of one or more extended families, usually equalling approximately 25 people (Smith 2009). The regional band consisted of approximately 100-200 people, and was made up of several local bands tied together by bilateral kinship. Kinship norms favoured marriage between opposite sex cross cousins, and it was through these ties that relationships between hunting groups were established (Smith 2009; Smith 1981). Even though descent was bilateral, there was a temporary period of matrilocal residence following marriage.

The Ojibwa, like the Western Woods Cree, have varied settlement patterns depending on the season. Settlements were largest in the summer, when people gathered at fishing and trading spots. In the fall, smaller kin groups consisting of, for example, two brothers and their wives and children, left the bigger lakes and rivers to canoe and portage inland, setting up winter camps in traditional hunting and trapping territories (Brown and Beierle 2000). Communities were usually made up of bands of interrelated families. In most areas, kin relations were structured based on patrilineal exogamous clans, with kinship following a bifurcate collateral pattern. Temporary matrilocal residence was common, but polygyny was not (Brown and Beierle 2000). The Ojibwa bands that were further south practiced agriculture and were made up of several hundred people. Groups living further north on the Canadian Shield were commonly comprised of approximately 50 to 150 people (Brown and Beierle 2000).

Overall, there is quite a bit of variation among the Algonquian groups. The groups that are nomadic and move on a seasonal round tend to have bilateral descent with a patrilocal bias and a temporary period of matrilocal residence after marriage. Group sizes seem to be heavily influenced by territory and seasonal rounds. Cross cousin, exogamous marriage is common among all groups (Ives 1998). The basic social unit varies, but is either the family or the local band. Table 4.4 shows Algonquian group size data compiled from the ethnographic sources described above and Binford's 2001 data. The overall average household size (HHSZ) for the subarctic Algonquians is 7.34 individuals, the average family size is 4.66 individuals and Groups 1, 2, and 3 match the ranges outlined in Table 4.1 very closely.

Group	Location	GRPPAT	Household Size	Family Size	Group 1/ Dispersed Group	Group 2/ Aggregated Group	Group 3/ Periodic Aggregation	Total Population	Source
Attawapiskat Cree	Ontario	1	6	4.18	17	35	172	4460	Binford 2001
Western Woods Cree	Subarctic Hudson Bay to Peace River		10 to 14		25	100-200			Smith 1981
Kitchibuan Ojibwa	Michigan	1			15	65	200	3000	Binford 2001
Rainy River Ojibwa	Ontario	1	8.2	4.2	21	57	190	230	Binford 2001
Pekangekum Ojibwa	Ontario	2	8.2		22	55	160	382	Binford 2001
Round Lake Ojibwa	Ontario	1	4.63	5.59	7	50	150	250	Binford 2001
Nipigon Ojibwa	Ontario	1			18	36	126	221	Binford 2001
Northern Albany Ojibwa	Ontario	1				50	225	225	Binford 2001
Weagamon Ojibwa	Ontario	1			10	50	140	250	Binford 2001
Round Lake Ojibwa	Round Lake		5					229	Rogers 1962
Average			**7.34**	**4.66**	**16.89**	**49.75***	**170.00**	**1027.00**	
*not including Western Woods Cree									
GRPPAT: 1 = groups that are mobile and move the entire group from camp to camp as they go about the subsistence round; 2= groups that move into and out of a central location that is maintained for more than one year or are completely sedentary (Binford 2001)									

Table 4.4. Algonquian group sizes compiled from various ethnographic accounts.

4.5.2 Subarctic Algonquian Dwellings and Use of Space

Traditional subarctic Algonquian dwellings include wigwams, conical lodges and other variants of each of these. They each vary in shape, size and the number of people that occupy them.

A wigwam is a round dome-shaped or conical bark-covered structure typically 3.65 to 4.57 metres in diameter (10.5-16.4 m^2 in area) and occupied by one or two families (Nabokov and Easton 1989). There are also extended wigwams; these structures still have rounded ends but are elongated to form a rectangular shape. The Chippewa used single or multi-family wigwams. The space inside did not have physical barriers, but divisions in space were created by rules that governed dwellers' movement within the structure in order to provide order and privacy within the space (Nabokov and Easton 1989). If it was a multi-family wigwam, each family would have their own door flap. Space was also divided according to sex; men and women had separate storage and work places. When men were gathered around the hearth to socialize, the women would not be present but, when the men left, the women would occupy the space around the hearth for their activities (Nabokov and Easton 1989).

The main dwelling used by the Western Woods Cree was a conical lodge made of anywhere between 30 and 40 sixteen to twenty foot long poles and covered with hides. Each lodge usually housed an extended family of 10 to 14 relatives (Smith 1981).

The Mistassini Cree employed several different types of shelters at the time of Rogers (1967) study, including the conical lodge, the dome-shaped lodge, the earth-covered conical lodge, communal lodges called inImicUwahp and sapUhtAwan (extended lodges or wigwams), tents, and log cabins (Figure 4.3). The arrangement of individuals in a lodge was according to age and sex. If only one family was occupying the lodge, men would sit at the rear and women and children along the sides. For sleeping, the family would be in the rear of the lodge but siblings of opposite sex who have reached puberty would be separated. If two families were occupying a lodge, each family would occupy one side of the lodge; the women and children would be closer to the door and the men would be toward the rear (Rogers 1967). Another interesting thing that Rogers mentioned when discussing Mistassini Cree lodges is that the floors of the lodges were covered in spruce or balsam fir boughs. He said that "new boughs were put down on an average of about every three days….usually placed directly over the old ones" (Rogers 1969:26). However, he also noted that if a camp was occupied for a long period of time, the boughs would be cleaned out every few weeks, no doubt to avoid too big of a pile forming. Nabokov and Easton (1989:24) also mentioned that "some subarctic tribes relayered their floors with fresh, fragrant pine boughs every week."

Overall, the arrangements of space in different types of Algonquian dwellings have some similarities. They all have central hearths that serve as communal, public space, in which activities such as cooking and eating took place. If a dwelling housed more than one family, each family had their own private space. In the Mistassini Cree winter houses, each family had their own section of the dwelling, each divided by physical barriers. However, the families still gathered in central areas around hearths. Sleeping and storage areas were arranged along the periphery of the dwellings and public spaces were located close to the entrances (Nabokov and Easton 1989; Reid 1996). Another similarity seen in some of the dwellings was the division of space by age and sex. Men and women occupied separate areas or used public space at different times. Men's space was usually located in the rear of the dwelling and women and children were arranged closer to the front, usually in order of their age (Rogers 1967).

4.5.3 Subarctic Algonquian Space Needs per Person

During Rogers' (1962) ethnographic account of the Round Lake Ojibwa group, there were forty six cabins in the community and each cabin housed, for the most part, just one nuclear family, which, on average, consisted of 5 people. Each cabin was made up of one to three rooms, and on average had two rooms per cabin. The floor space ranged from 10 to 46 square metres (average of 28 square metres) and one to five people occupied each room. Rogers (1962) calculated the average floor space per person to be approximately 4.6 square metres. This figure is strictly for the cabins. Dwelling type varied through the year, depending on season, and can include conical lodges and tents when men left the main village to hunt and trap. The Ojibwa were also included in Brown's data, which indicated average space requirements of 7 m^2 per person. (Kent 1984).

Rogers (1967) work among the Mistassini Cree mentioned one communal lodge, an inImicUwahp, that he observed was 4.87 metres wide by 5.48 metres long. Unfortunately, he did not say how many families or people lived in this lodge. He also observed an earth-covered conical lodge that had been occupied in the past that was 5.48 metres by 4.26 metres in size (23.3 m^2). One lodge in the summer encampment was 3.65 metres in diameter (11.46 m^2) and occupied by one family. If the average family size is 5 people then this figure would indicate space needs per person of 2.29 m^2.

When considering all of the ethnographic accounts discussed above, table 4.5 below shows an average space needs per person of 4.63 m^2 for subarctic Algonquians.

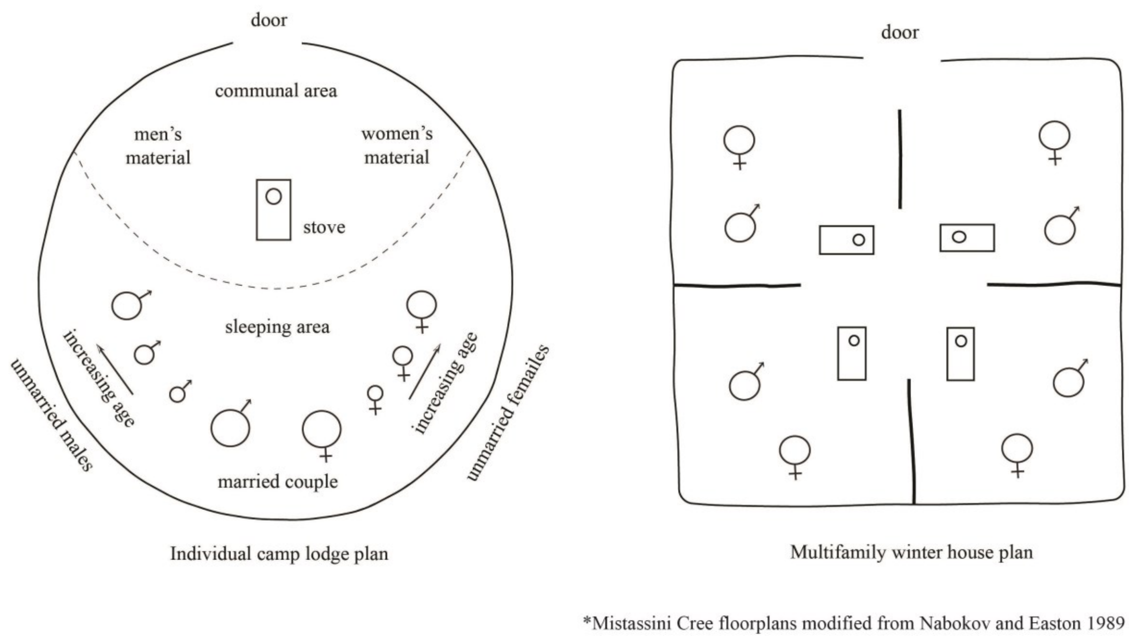


Figure 4.3. Algonquian dwellings (conical lodge and multifamily winter house) and organization of space, as illustrated in Nabokov and Easton (1989).

Group	Avg. Family Size	# of families	Dwelling Type	Area of dwelling (sq. m)	Avg. Space per Person (sq. m)	Source
Algonquian	*4.66	1	wigwam	10.46 to 16.39	2.88	Nabokov and Easton 1989
Algonquian	*4.66	matrinlineal clan, ~10 families	longhouse	297.36	6.38	Nabokov and Easton 1989
Algonquian, Mistassini Cree	5	1	earth-covered conical lodge	11.46	2.29	Rogers 1967
Algonquian, Mistassini Cree	5	unknown	inImicUwahp	26.69		Rogers 1967
Algonquian, Mistassini Cree	5	unknown	earth-covered conical lodge	23.34		Rogers 1967
Algonquian, Ojibwa					7	Kent 1984
Algonquian, Round Lake Ojibwa	5	46	cabin	10 to 46 (avg. 28)	4.6	Rogers 1962
				Average	**4.63**	
* this number is the average calculated from the group composition and size table						

Table 4.5. Algonquian space needs per person calculated from various ethnographic accounts.

4.6 Plains Groups

The Great Plains of North America covers a vast amount of land from the prairie provinces of Canada, south through the central United States down to Texas, and into the northern part of Mexico (Figure 4.1). This region, in the past, supported large expanses of grassland and many varieties of big and small game animals including bison, antelope, elk, deer, and rabbit (Commission for Environmental Cooperation 1997). The groups that occupied the Plains depended heavily on the bison for subsistence. This region, though ecologically similar throughout, has varying temperatures from north to south and, as a result, we see a variety of subsistence practices and dwellings among the groups that occupied this region.

4.6.1 Plains Social Structure and Group Sizes

At the time of contact the Plains supported many unique cultural groups. These included the Algonquian-speaking groups: Plains Cree, Blackfoot, Gros Ventre, Salteaux, Cheyenne, Besawunena, Arapaho, and Nawathinehena; the Siouan-speaking groups: Assiniboine, Crow, Hidatsa, Mandan, Teton, Yankton, Ponca, Omaha, Santee-Sisseton, Iowa, Otoe, Kansa, Missouria, Osage, and Quapaw; the Athapaskan speaking groups: Sarsi, Jicarilla, Plains Apache, and Lipan; the Caddoan-speaking groups: Arikara, Pawnee, Wichita, and Kitsai; the Kiowa; the Uto-Aztecan: Northern Shoshone and Comanche; and the Tonkawa. In general, for all of these groups, the basic social and political unit was the band or village, either nomadic or semi-sedentary, depending on the ecological factors of the area they occupied. One main distinction that is used to define these groups into broader definitions, known as the High Plains tribes or the Prairie tribes, is based on their subsistence practices, and whether they were primarily nomadic or lived, at certain times of the year, in villages (Sturtevant 2001).

The High Plains tribes, located mainly in the western portion of the Plains, included nomadic groups that were organized into tribes and bands. The tribes gathered in the early summer for hunts or ceremonies, but split up into smaller bands for the fall and winter. These bands were often organized through bilateral kinship, and were often made up of extended families. They generally lacked descent groups and had flexible marital residence. High Plains tribes lived in tipis all year round (each nuclear family had their own tipi) and had recognized hunting territories and seasonal rounds (Sturtevant 2001).

The Assiniboine, a High Plains tribe, practiced bilateral kinship but residence was most often patrilocal. Bands were made up of related families, with each nuclear family having its own lodge (a buffalo hide tipi with 3 pole foundation) (Sturtevant 2001). The Arapaho also practiced bilateral descent, but they practiced polygyny. One tipi often housed a nuclear family plus one or two unmarried relatives. The Stoney, Blackfoot and Teton were organized into patrilineal extended family groups whose primary dwelling was a hide-covered tipi (Conaty and Beierle 1999).

The Prairie tribes, while still dependent on the bison to a degree, lived in semi-sedentary villages and only used tipis for part of the year when they were out on hunting expeditions. The permanent villages were made up of large, multifamily dwellings, most often earthlodges, and served as the base from which these groups practiced agriculture. These groups often had more complex social structure than the High Plains groups. They practiced unilineal clan organization, a system which resulted in more complex and rigid tribal integration. Marriage was most often exogamous and took place between different villages (Sturtevant 2001).

One of the Prairie tribes, the Hidatsa, was made up of seven named matrilineal exogamous clans. Each village had representatives from each of the clans. The Hidatsa lived in large, dome-shaped earthlodges and practiced sororal polygyny. David Thompson noted in 1797-1798 that the average household size of the Hidatsa and the Mandan was 13 individuals (Sturtevant 2001). The Mandan were also organized into matrilineal exogamous clans, but they were made up of 13, grouped into east and west moieties. They also practiced sororal polygyny and their lineage was tied to matrilineally-related lodge groups. Other matrilineal clan societies are the Arikara, the Pawnee, and the Wichita. The Arikara were made up of villages of extended family households of 15-20 people (Sturtevant 2001).

The Omaha were structured into moieties, each one comprised of five patrilineal exogamous clans. They used three types of dwellings: earthlodges, bark or mat-covered lodges, and buffalo hide tipis. By the 1830s, however, log cabins and frame houses had taken over as the main types of dwellings (Sturtevant 2001). Other groups that were structured into patrilineal clans were the Ponca, the Iowa, the Otoe, the Missouria, Kansa, Osage, and the Quapaw (Sturtevant 2001).

The basic social unit of Plains groups is either the band or the village and, within these, there is a lot of variation in size of the groups and their kinship patterns. Table 4.6 shows Plains group size data compiled from the ethnographic sources described above and Binford's 2001 data. The overall average household size (HHSZ) for groups on the Plains is 8.90 individuals and the average family size is 4.27 individuals. These numbers are relatively close to the numbers obtained for household size and family size of the other groups discussed in this chapter. However, the numbers for Groups 1, 2, and 3 are quite a bit higher than the universal hunter-gatherer group size averages outlined in table 4.1. This difference would indicate that the Plains supported larger group sizes in general. This could be a factor of an abundance of resources available to them, able to support larger populations; or as a result of the more complex social systems of the semi-sedentary village groups.

Group	Location	GRPPAT	Household Size	Family Size	Group 1/ Dispersed Group	Group 2/ Aggregated Group	Group 3/ Periodic Aggregation	Total Population	Source
Arapahoe	Colorado	1	7.36		36	325	750	3000	Binford 2001
Assiniboine	Saskatchewan	1	6.225		35	159	850	4500	Binford 2001
Bannock	Idaho	1	6		43	170	650	1500	Binford 2001
Blackfoot	Alberta	1	8		70	346	1100	2425	Binford 2001
Blood	Alberta	1	8		42	250	800	3110	Binford 2001
Cheyenne	Colorado	1	6.765	5.6	45	275	687	2750	Binford 2001
Coeur d'Alene	Idaho	1	7.16	3.58	21	60	350	1000	Binford 2001
Crow	Wyoming	1	8.8		66	330	1500	4650	Binford 2001
Flathead	Montana	1	12.12		24	73	300	800	Binford 2001
Gros-Ventre	Montana	1	8.08		34	188	445	2260	Binford 2001
Hidatsa	North Dakota	2	13						Sturtevant 2001
Kalispel	Idaho	1	7.24	3.62	22	75	350	1000	Binford 2001
Kutenai	Montana	1				122		1200	Binford 2001
Nez-perce	Idaho	1				134	438	4000	Binford 2001
Peigan	Alberta	1	8.04		45	254	762	1525	Binford 2001
Plains Cree	Saskatchewan	1	4.28		40	75	285	4650	Binford 2001
Plains Ojibwa	North Dakota	1			40	250	500	2000	Binford 2001
Shuswap	Alberta	2				108	266	14582	Binford 2001
Thompson	British Columbia	2	22.5		18	113	265	5150	Binford 2001
Average			**8.90**	**4.27**	**38.73**	**183.72**	**605.00**	**3339.00**	

GRPPAT: 1 = groups that are mobile and move the entire group from camp to camp as they go about the subsistence round; 2= groups that move into and out of a central location that is maintained for more than one year or are completely sedentary (Binford 2001)

Table 4.6. Plains group sizes compiled from various ethnographic accounts.

4.6.2 Plains Dwellings and Use of Space

Common Plains dwellings include tipis (conical lodges), earthlodges and grass houses. Plains tipis or conical lodges are one of the most commonly used and recognized Native North American dwellings. All of the groups mentioned above used a tipi either all year round, or when they left their villages to exploit other resources. Most groups had a formal division of space in their tipis. In a typical layout, the door faced east, the hearth was centrally located, storage was located near the door, the north half was the men's and the south half was the women's. The east side of the tipi, nearest the door, was the public or secular space and the west half was private space, and included the altar and place of honour. The private space was also where the beds would have been located (Peck and Vickers 2006).

Mandelbaum's (1979) work with the Plains Cree gave numbers of 10 to 12 people housed in one three-pole foundation tipi. He did not give a floor size for the average tipi, but said that they are covered in anywhere from 12 to 20 buffalo hides. The layout of the interior space was fairly typical, with the hearth placed in the centre, the place of honor behind the fire opposite the door, and beds of bundled dry grass and buffalo robes along the sides (Mandelbaum 1979). The Teton lodge or tipi was laid out in much the same manner as the Plains Cree, with a place of honor opposite the doorway for the male head of household, a hearth in the centre, and lateral division of space with the right side being the male side and the left being the female side. Each individual had his or her own space, with willow-rod backrests hung from tripods providing physical barriers (Sturtevant 2001).

Gilbert Wilson carried out ethnographic fieldwork among the Hidatsa in the early 1900s. He accumulated data from 1906 to 1918 and conducted detailed work regarding the Hidatsa earthlodge. The earthlodges were circular dwellings excavated into the ground, with four central posts, 12 exterior supporting posts, and 100 roof posts or rafters. The roof was chinked (with willow) and covered with willows and grass and then the whole lodge was covered with earth or sod (Wilson 1934). Wilson (1934:394) also noted that "buffalo robes or skins covered the lodge floor…these were laid on a foundation of willow mats made by stringing willow sticks on four strands of sinew." In Wilson's diagram of the earthlodges, there was a centrally located hearth, storage and horse corrals near the entrance, an altar or sacred area in the back portion of the lodge, often opposite the door but not always, and beds arranged around the perimeter of the lodge. The entrance was separated from the rest of the lodge by a partition or log wall (Wilson 1934).

The Pawnee also lived in earthlodge villages with usually two, but as many as ten families or up to 50 people, living in one lodge. Each family had its own separate part of the lodge. The size of the lodge ranged from 9.14 to 18.3 metres in diameter, had a central hearth, sleeping platforms along the north and south sides, a doorway on the east, sacred space to the west, and the floor was covered with woven mats (Sturtevant 2001). This layout is almost identical to that of the Hidatsa earthlodge that Wilson observed.

The Wichita lived in clusters of beehive-shaped grass lodges varying in size from 4.57 to 12.19 metres in diameter. These lodges were constructed of posts and crossbeams and covered with grass thatching. Like the earthlodges, they had a central hearth and sleeping areas arranged around the interior walls. They also hung hide curtains around the beds for privacy. The occupants of these dwellings were often a woman, her husband, their children, and married daughters and their families (Sturtevant 2001).

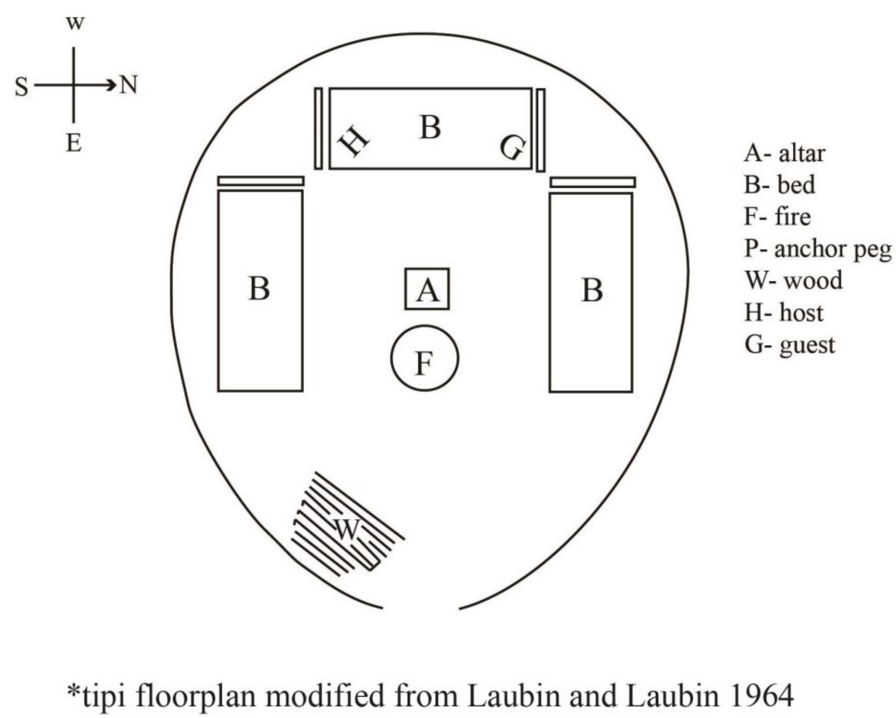
The Ponca lived in earthlodges, tipis, and a less permanent wigwam style structure made using bent frame construction covered with hides. The Iowa lived in lodges with a pole framework and covered with bark, slabs or woven mats. These lodges were rectangular or oval. Larger ones were approximately 6.1 by 12.19 metres in diameter and housed an extended family. Smaller lodges were approximately 3.04 by 6.10 metres in diameter and housed a nuclear family (Sturtevant 2001).

The Otoe and the Missouria lived in villages made up of 40 to 70 earthlodges, each one housing several related families. The Kansa had a large variety of dwellings including three permanent types of lodges and two mobile types. These include the rectangular wigwam (~18.3 by 7.6 metres) covered with bark, skins or mats; the earthlodge; a circular structure similar to the earthlodge but covered with bark or mats instead of earth; a tipi; and a tipi variant. Some of these structures were large enough to house up to 30 or 40 people (Sturtevant 2001).

Plains dwellings, although they have several different forms, organize interior space very consistently. The entrance is most often facing east, there is a central hearth, an altar or sacred space opposite the door, beds arranged around the perimeter, storage near the door, mats and/or robes covering the floor, and a lateral division of space based on sex. Some of the dwellings had physical barriers to create privacy around the sleeping areas, but not all of them did. While there were not always physical barriers to denote public versus private spaces, there were social barriers. Oetelaar (2000) noted that privacy was different in a tipi. If someone was carrying out a task in the periphery, or the outer edges, people knew to leave them alone and, if people were carrying out tasks closer to the centre of the tipi, near the hearth, they were in the public space of the tipi and it was acceptable to engage with them (Oetelaar 2000).

4.6.3 Plains Space Needs Per Person

Kehoe (1985) looked at hundreds of tipi ring sites throughout north-central Montana and southern Alberta. From an archaeological perspective, without knowing exact age, the average size of an isolated tipi ring was 5.27 metres in diameter. With sites of two or three rings, the average diameter was 4.84 metres. Sites with four or more rings had a large variety, with diameters ranging from 3 to 8.8 metres, but the overall average was 4.8 metres. These numbers are from sites found on the Blackfoot Reserve and are of varying ages. During this research he also extracted data from several ethnographic accounts and determined that before 1730, for the Blackfoot, the average floor diameter of one lodge was three metres, or 29 m^2 in area, and it housed six to eight people (Kehoe 1985). This is equal to 3.6 m^2 to 4.8 m^2 of floor space per person.



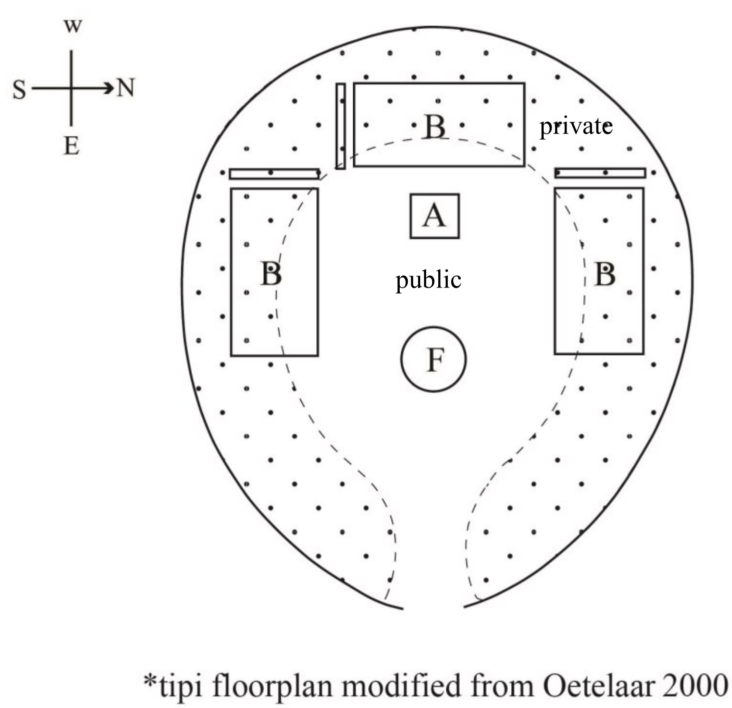
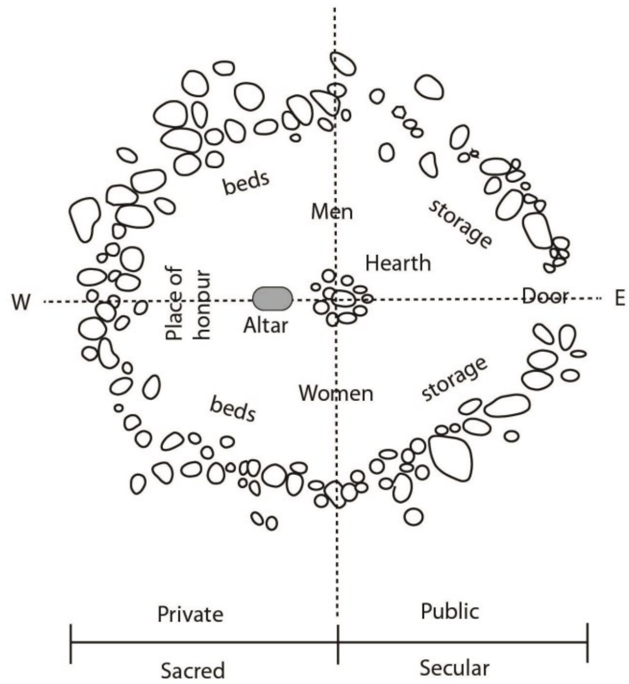
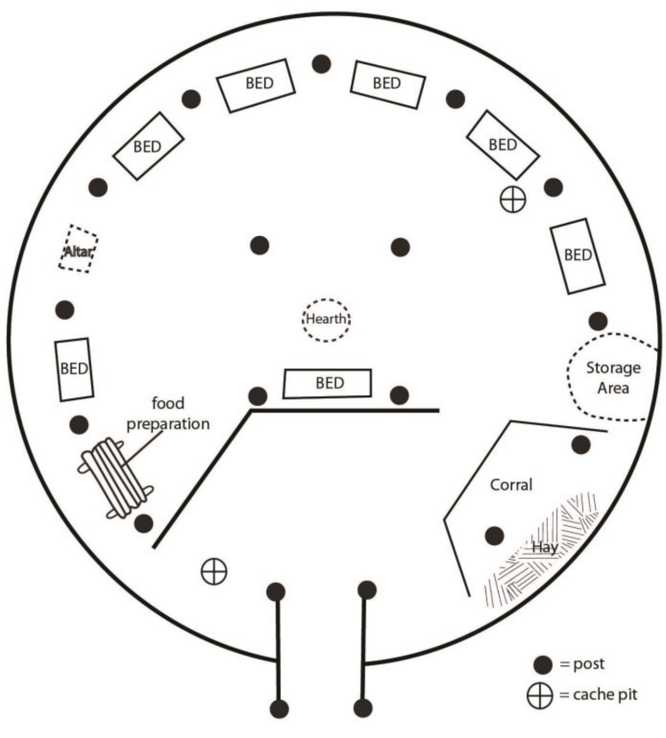


Figure 4.4. Plains dwellings (tipi) and organization of space, as illustrated in Laubin and Laubin (1964) and Oetelaar (2000).



Tipi floorplan. *Not to scale. From Peck and Vickers (2006)



Hidatsa earthlodge. *Not to scale. From Wilson 1934.

Figure 4.5. Plains dwellings (tipi and earthlodge) and organization of space, as illustrated in Peck and Vickers (2006) and Wilson (1934).

Quigg (1981) also summarized excavation data for several tipi ring sites in southern Alberta. On the Suffield Military Reserve, for five tipi ring sites, the diameter of the rings ranged from 4.0 to 9.8 metres. In a larger sample of 40 sites with a sample of 49 excavated rings, the diameter had a range of two to nine metres, with the most commonly occurring sizes (90%) being between three and six metres, most commonly five metres in diameter. Of these rings that could be dated, the average ring diameter during the Middle Prehistoric Period was 5.13 m (sample of 11 rings) and the average diameter during the Late Prehistoric Period was 4.63 m (sample of 20 rings). The Historic period had a sample of 5 rings with diameters ranging from 3.9 m to 5.5 m (Quigg 1981).

The diameter of a typical earthlodge during the Historic period was 5.5 to 6 metres, or 23.6 to 29 m^2 in area, but this also gives room to accommodate horses. In one account that is given, Wolf-Chief recalls at the age of 14 living in an earthlodge with a total of nine people including himself, his father and his two wives, his half-brother, his sister and her husband, and his half-brother's sister and grandmother (Wilson 1934). If Wolf-Chief's family lived in a "typical" earthlodge, there would have been anywhere between 2.6 m^2 to 3.2 m^2 of space available per person in his family's dwelling.

Wedel (1979) looked at several ethnographic accounts of central plains earthlodge dwellings, specifically those of the Pawnee and the Wichita, and calculated an average space per person value of 5 m^2.

When considering all of the ethnographic accounts discussed above, table 4.7 indicates an average space needs per person of 4.05 m^2 for Plains groups.

Group	Avg. Family or Household Size	# of families	Dwelling Type	Season	Area of dwelling (sq. m)	Avg. Space per Person (sq. m)	Source
Plains	*8.9		tipi	year round	19.63	2.2	Quigg 1981
Plains, Blackfoot	6 to 8	1	tipi	year round	29	3.6 to 4.8	Kehoe 1960
Plains, Cree	10 to 12		tipi	year round	12-20 buffalo hides		Mandelbaum 1979
Plains, Hidatsa	9	2	earthlodge	year round	23.6 to 29	2.6 to 3.2	Wilson 1934
Plains, Kansa	30 to 40		circular lodge	year round	65.6 to 262.7	2.2 to 6.6	Sturtevant 2001
Plains, Pawnee	12 to 18		earthlodge	year round	65.6	3.6 to 5.5	Sturtevant 2001
Plains, Pawnee	50		earthlodge	year round	262.7	5.3	Sturtevant 2001
Plains, Pawnee and Wichita			earthlodge	year round		5	Wedel 1979
					Average	**4.05**	
* this number is the average calculated from the group composition and size table							

Table 4.7. Plains space needs per person calculated from various ethnographic accounts.

4.7 Great Basin/Numic-Speaking Groups

The Great Basin has seen significant cultural change in the last 13,000 years (see chapter two), but the most recent groups, or the groups emerging in historic times, were Numic-speaking groups. These include the Shoshone, Paiute, and Ute. Prior to these groups entering the region, the dominant culture was Fremont. The Promontory Culture peoples occupied the area during the same time as the Fremont, and around the transition when Fremont were becoming less prevalent and Numic-speaking groups were becoming more prevalent.

4.7.1 Great Basin Social Structure and Group Sizes

The most extensive ethnographic work on the groups of the Great Basin was carried out by Julian Steward. He worked with several Shoshone, Paiute, and Ute groups (Steward 1938; 1941). Among these groups there was variation in group arrangement and size, but the group hierarchies noted above in table 4.1 were present.

The Shoshone groups were composed of composite bands, the members of which could intermarry within the band, as long as they were unrelated. Marriages were often arranged, with preference for a group of brothers to marry a group of sisters, forming a sibling core (Eggan 1980). The Shoshone practiced cross-cousin or pseudo cross-cousin marriage, and polygyny and polyandry (fraternal) could be practiced but usually only occurred among wealthier individuals.

Kinship was bilateral (Eggan 1980; Steward 1941). Residence practices were commonly matrilocal residence immediately following marriage but, after that, permanent residence depended on available resources (Eggan 1980; Steward 1941). The basic social unit of the Shoshone was the family. Sometimes families were on their own at a camp and sometimes several families would reside together to form a local band. The local bands could be comprised of as few as two families to as many as 20 at larger encampments (Steward 1938). Eggan (1980) noted that the winter camp was often made up of three to five related families.

The western localized northern Paiute were divided into composite land-owning bands and had large populations. Most villages, located in resource-rich areas, were able to support approximately 200 people. In contrast, the independent Northern Paiute villages were much smaller. The basic social unit was the family, with local bands being made up of several families, usually totalling 10 to 15 people. These families were nuclear at their base, but included one or more additional single family members or friends (Fowler 2012). These groups were highly mobile and changed residence often (Steward 1938). Paiute kinship was bilateral and the only restrictions were how closely the man and woman were related to each other. Matrilocal residence after marriage was common as a bride service (Fowler 2012). Usually intermarriage occurred between different family groups when larger groups gathered during the winter or fishing season. It was desirable for more than one marriage to be arranged between two families so that brothers and sisters would marry sisters and brothers (Steward and Wheeler-Voegelin 1974).

Like the Paiute and Shoshone, the basic social unit of the Ute was the family. This included a nuclear family and possibly other relatives such as grandparents. A residential unit could be comprised of several families; and bands, in turn, were made up of several residential units, usually under the lead of an elder male. Bands were exogamous and residence was always matrilocal (Janetski and Adem 2009). Bands gathered at certain times of the year to hold festivities, but often people were dispersed in smaller groups to hunt and gather (Janetski and Adem 2009).

The overall trend that Steward (1938) noted among Great Basin groups is that the family was an independent economic unit, but families would join together for communal hunts or during winter to form composite bands. Smaller villages consisted mostly of families that were related, often through sibling or parent-to-child bonds (Steward 1938). These family clusters based on kinship were equally important to the family unit and their sizes were often dependent on resource availability (Eggan 1980). Table 4.8 shows Great Basin group size data compiled from Binford's 2001 data. The overall average household size (HHSZ) for groups in the Great Basin was 4.75 individuals and the average family size was 4.05 individuals. The average size of Group 1 was 13.04 which is close to the universal hunter-gatherer size of Group 1. However, the numbers for Groups 2 and 3 are considerably lower than the universal hunter-gatherer group size averages outlined in table 4.1. This difference would indicate that the Great Basin groups were smaller in general, at least since Numic-speaking peoples emerged in the area. This situation could be a factor of less resource availability in the Great Basin, such that larger populations could not be supported.

4.7.2 Great Basin Dwellings and Use of Space

The Shoshone, Paiute and Ute dwellings were typically dome-shaped or conical houses made of a pole framework and covered in matting in the winter and semicircular bush windbreaks in the summer. These dwellings could be fairly impermanent, especially in the summer when people were highly mobile (Fowler 2012). Usually one family (nuclear or extended) would have lived in a small conical dwelling (Steward and Wheeler-Voegelin 1974). Because the Paiute were so mobile, their shelters were often very temporary and constructed by

Group	Location	GRPPAT	Household Size	Family Size	Group 1/ Dispersed Group	Group 2/ Aggregated Group	Group 3/ Periodic Aggregation	Total Population	Source
Paiute, Kaibab - Southern	Arizona	1	5.66		10.1	21.2	70	425	Binford 2001
Paiute, Deep Spring	California	1	4.6			23		23	Binford 2001
Paiute, Honey Lake	California	1						385	Binford 2001
Paiute, Mono Lake	California	1	3.82		9.6	25		170	Binford 2001
Paiute, North Fork	California	1	4.27	4.93		29		385	Binford 2001
Paiute, Owens Valley	California	2	4.9	3	13	64	300	2100	Binford 2001
Paiute, Antarianunts - Southern	Colorado	1						234	Binford 2001
Paiute, Cattail	Nevada	1	4.4		18	46	130	481	Binford 2001
Paiute, Fish Lake	Nevada	1	4.38	3.67	10.5	27	101	100	Binford 2001
Paiute, Pyramid Lake	Nevada	1	4.4			50	320	485	Binford 2001
Paiute, Suprise Valley	Nevada	1			12.9	28.4	100	367	Binford 2001
Paiute, Bear Creek	Oregon	1			16	40		60	Binford 2001
Paiute, Harney Valley	Oregon	1			11			200	Binford 2001
Shoshone, Kawaiisu	California	1	4.27		15	31	45	500	Binford 2001
Shoshone, Koso Mountain	California	1			13.5	35		222	Binford 2001
Shoshone, Panamint	California	1	4.01		7.5	22.5		500	Binford 2001
Shoshone, Saline Valley	California	1			9	30	65	65	Binford 2001
Shoshone, Bohogue—Northern	Idaho	1			12	60		380	Binford 2001
Shoshone, Salmon-eater	Idaho	1			11.2	34	119	400	Binford 2001
Shoshone, Sheep-eater	Idaho	1			18.3		300	550	Binford 2001
Shoshone, Antelope Valley	Nevada	1	4.27	4.37	12.3	20	110	78	Binford 2001
Shoshone, Kawich Mountain	Nevada	1			9.5	19.5	42	105	Binford 2001
Shoshone, Little Smoky	Nevada	1	6.85		16		96	96	Binford 2001
Shoshone, Rainroad Valley	Nevada	1	4.19		11	32	70	250	Binford 2001
Shoshone, Reese River	Nevada	1			10	30	132	390	Binford 2001
Shoshone, Ruby Valley	Nevada	1			21	48	63	450	Binford 2001
Shoshone, Spring Valley	Nevada	1	4.53		11	24	180	378	Binford 2001
Shoshone, White Knife	Nevada	1	4.2	5	11.4	23	180	500	Binford 2001
Shoshone, Gosiute	Utah	1			10	33	150	435	Binford 2001
Shoshone, Grouse Creek	Utah	1	4.17	4.38	16	38	78	200	Binford 2001
Shoshone, Hukunduka	Utah	1	4.33			24	138	1000	Binford 2001
Shoshone, Wind River	Wyoming	1			16	50	200	1500	Binford 2001
Ute, Timanogas	Utah	1			17.5	50	160	480	Binford 2001
Ute, Uintah	Utah	1	7.77	3.06	16	43	169	1750	Binford 2001
Ute, Uncompahgre	Utah	1	5.96		17	45	150	1100	Binford 2001
Ute, Wimonantci	Utah	1				37	102	405	Binford 2001
Washo	Nevada	1	4		9	29		1877	Binford 2001
Average			**4.75**	**4.05**	**13.04**	**34.74**	**137.00**	**514.00**	

GRPPAT: 1 = groups that are mobile and move the entire group from camp to camp as they go about the subsistence round; 2= groups that move into and out of a central location that is maintained for more than one year or are completely sedentary (Binford 2001)

Table 4.8. Great Basin/Numic group sizes compiled from various ethnographic accounts.

forming a simple dome or tipi shape from willow or other available wood, and then covering it with grass, tules, cattails, sagebrush, willow, or pine boughs (Wheat 1967).

Nevada Shoshone residence was temporary; therefore they had very simple houses. These included gabled, conical or domed houses and windbreaks, rockshelters, and caves (Steward 1941). Gabled houses had two vertical support posts and a ridgepole which supported sloping roof poles to form an elliptical or circular structure. The conical lodge consisted of interlocking poles arranged in a circular pattern and covered with bark, brush, earth or grass. Domed houses were constructed by digging willows into the ground, then bending them over and tying them together to form a dome which was then covered with grass, brush, or mats (Steward 1941).

Steward (1933) recorded dwelling size for several different archaeological sites in the Great Basin of western Utah. He did not associate these dwellings with any particular culture, but they were mostly mounds or forms of pithouses, and he did note that there was a "strong puebloan affiliation" (Steward 1933:30). The average size of the mound dwellings was approximately 13.45 m^2. Steward noticed two main shapes of dwellings: circular dwellings and rectangular or square structures with adobe wall. One feature that he did mention was that most of these dwellings had a central fireplace under the roof opening, which also served as the door. This is great archaeological data, but unfortunately it is unknown how many people would have lived in one dwelling.

The Shoshone, Paiute, and Ute had very simple dwellings, the most dominant type being a conical lodge covered with bark, grass, mats or other plant material. None of the ethnographic accounts above give details about the interior layout of the space. The dwellings used prior to Numic-speaking groups emerging were more complex, and included several forms of pithouses and mud and adobe structures. These structures had central fireplaces and were entered through a door in the rooftop (Steward 1933).

4.7.3 Great Basin Space Needs Per Person

There is little to no information on both the size of a dwelling and how many people would have occupied it for historic hunter-gatherer groups in the Great Basin. The average household and family sizes are known for the Shoshone, Paiute and Ute. We know that their dwellings were modest in size, so the number of square metres allotted per person was likely low. This number is also difficult to calculate for summer dwellings, which were windbreaks and so did not have clearly defined boundaries. Unfortunately, it is unknown what the space needs per person for these groups likely would have been.

4.8 Apacheans

The Apacheans are part of the Athapaskan language group, and are sometimes referred to as the Southern Athapaskans. The two major Apachean groups are the Apache and Navajo. These groups migrated to what is now the southwestern United States sometime between the thirteenth and sixteenth centuries (Beierle 2012).

4.8.1 Apachean Social Structure and Group Sizes

Thomas Rocek (1995) carried out ethnographic work among the Navajo, and Grenville Goodwin (1942) among the Western Apache. The Navajo are organized into four social units; the household, residence group, middle level (which Rocek refers to as an "outfit"), and community or clan organization. The household consists of one family unit; several family units living together form a residence group. These residence groups are based on kinship, spatial relationships, and patterns of cooperation. The "outfits" that make up the middle level are formed when residence groups combined to cooperate for certain purposes. The outfits can be small, with as few as four residence groups, or very large, with 50-200 people residing in one area. The outfits have greater spatial dispersion and a broader range of relationships between its members than the residence groups. The communities or clans are organized matrilineally and they serve as larger social networks that people could use for support or draw marriage partners from (Rocek 1995). Both Kent's (1984) and Rocek's (1995) ethnographies indicated that residence was predominantly matrilocal and marriage was exogamous. The basic social unit of the Navajo was the nuclear family, whose members lived together in one hogan (Adams and Skoggard 2004).

The Western Apache were grouped into families, family units, local groups, and matrilineal clans (Goodwin 1942). A family is defined as a conjugal pair and their children, and family units were commonly made up of four or five families that are linked by blood or clan. Local groups consisted of several matrilineal-matrilocal extended families and could vary in size from 35 to 200 individuals (Greenfield and Beierle 2002). Residence was matrilocal and each family unit had one nuclear clan. The nuclear clan was usually determined by which clan most of the married women originated from (Goodwin 1942). The Western Apache used different terms for cross-cousins and parallel-cousins and marriage was not encouraged between blood relatives. When choosing marriage partners, clan and blood exogamy was the most important factor; however, extended clan kinship did not affect marriage selection (Goodwin 1942).

The Eastern Apache were not organized into clans but did have named bands, each with their own territory. The bands were divided into local groups. The basic social unit was the extended family, which consisted of a couple, their children, and their married daughters and their families. These families lived close together, but each nuclear family had their own dwelling. The Eastern Apache commonly lived in wickiups (Beierle 2012).

The Navajo and Western Apache are organized into clans but the rest of the Apachean groups are not (Eastern Apache, Mescalero, Chiricahua and Lipan). However, all Apachean groups are organized by kinship into families, family units, and local groups, and all practice matrilocal residence (Goodwin 1942). As is the case with the Athapaskans, the Apache and Navajo most often practiced bilateral descent and almost all of them practiced mother-in-law avoidance and arranged marriages (Perry 1991, 1993). Mother-in-law avoidance was serious for the Apache. McAllister (1955:130) noted that for the Kiowa or Plains Apache, "A man would never touch his mother-in-law, look at her, talk to her, call her name, or be alone with her in a tipi." Respect for parents-in-law was another common theme between the Athapaskans and the Apache. For the Chiricahua, Opler (1941:164) stated that "the camp of the young people is so arranged that the place of the parents-in-law cannot be seen; it might be behind some brush with the door facing the other way." These practices of mother-in-law avoidance and respect for parents-in-law no doubt had an effect on how space was organized among these groups.

Table 4.9 shows Apachean group size data. The overall household size (HHSZ) for Apachean groups was 7.81 individuals. The overall family size could not be calculated from available sources. The sizes of Group 1 and Group 2 are much higher than the universal values in table 4.1, while Group 3 is only a bit higher. This difference could be as a result of the Apachean social organization of matrilineal clans or, perhaps, because of an overall lack of available data.

Group	Location	GRPPAT	Household Size	Family Size	Group 1/ Dispersed Group	Group 2/ Aggregated Group	Group 3/ Periodic Aggregation	Total Population	Source
Apache, Chiricahua	Texas	1			34	95	200	1425	Binford 2001
Apache, Kiowa	Texas	1	7.81			291		1908	Binford 2001
Apache, Lipan	Texas	1			25	75	166	500	Binford 2001
Apache, Western						35 to 200			Greenfield and Beierle 2002
Average			**7.81**		**29.50**	**154.00**	**183.00**	**1277.00**	

GRPPAT: 1 = groups that are mobile and move the entire group from camp to camp as they go about the subsistence round; 2= groups that move into and out of a central location that is maintained for more than one year or are completely sedentary (Binford 2001)

Table 4.9. Apachean group sizes compiled from various ethnographic accounts.

4.8.2 Apachean Dwellings and Use of Space

The most common dwellings used by the Apacheans are the hogan and the ramada. A hogan, which translates to mean "home place" or "dwelling area," is a circular, one-room structure traditionally made from logs, juniper bark and earth (Jett and Spencer 1981). The Navajos view the hogan as a space for both sacred and secular activities, and conceptually divide the hogan into male (south half) and female (north half) space. Traditionally, the conceptual division of space and the circular shape of the dwelling were important for ceremonies that took place in the hogan (Kent 1982; Jett and Spencer 1981). The layout of the hogan is quite similar to the Plains tipi. The door commonly faces east, and the seat of honour is placed opposite the door, at the very rear of the structure. The hearth is centrally located and public activities (sitting, eating, cooking, workspace) tend to take place in this central area, while more private activities (sleeping, storage) occur in the perimeter of the structure (Jett and Spencer 1981). The ramada is a rectangular structure most commonly used in the summertime and, unlike the hogan, is not viewed as a sacred space or conceptually divided into certain areas. Each family unit in Kent's (1984) ethnography had a hogan, used in the winter, and a ramada, used in the summertime. The hogan and the ramada vary in shape (hogans are generally circular and ramadas are rectangular) and somewhat in size.

Another type of Apache dwelling is called the wickiup. Longacre and Ayres (1968) provide an example from 1965 of a wickiup housing a single family. A wickiup was constructed from a pole framework and covered, in the summer, with thatch or grass. During historic times, at Geronimo's camp in 1886 in Arizona, it was observed that the wickiups were made with bent over ocotillo branches, either still in the ground or supported by rocks, and then covered with blankets, canvas or other textiles (Seymour 2008, 2013). In the winter, they may have been covered with hides. They were often dome-shaped (Beierle 2012). There were several distinct activity areas in a wickiup. The sleeping area was in the rear, and was well defined and even partitioned off a bit by logs; pine needles were often laid down on the floor. There was a large hearth in the centre of the structure, storage near the doorway, and a food processing area just south of the hearth. Even though this structure was not circular, the general arrangement of space is very similar to that of a hogan or tipi (Longacre and Ayres 1968).

4.8.3 Apachean Space Needs per Person

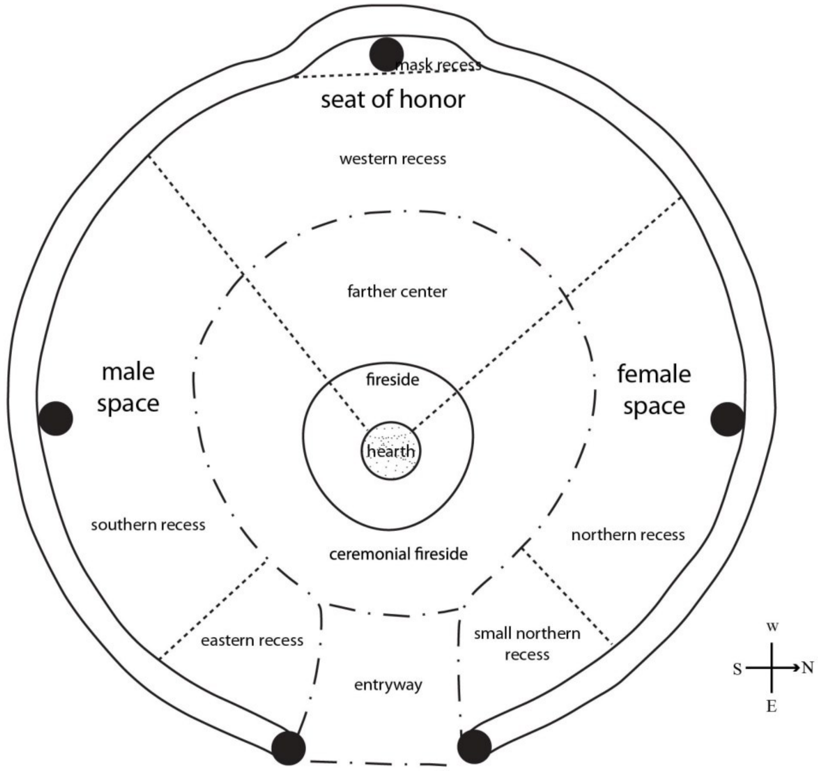
In Kent's (1984) and Rocek's (1995) ethnographies, one hogan typically housed one nuclear family which, on average, consisted of five people. In Kent's observation of the Many Sheep hogan (Navajo), there were a total of 13 people in the family, but not every member was present all the time. Most often, there were only five or six people using the 19.62 m^2 dwelling, which allowed for a total of 3.3 to 3.9 m^2 of space per person. Based on the size of the dwellings and the population of the family unit in Kent's (1984) ethnography the Navajo averages ranged from 2-4 m^2 per person, significantly less than that of the Dene (Athapaskan).

The wickiup observed by Longacre and Ayres (1968) measured ~3 m E-W by 2 m N-S for a total area of 6 m^2 and housed four people (1.5 m^2 per person).

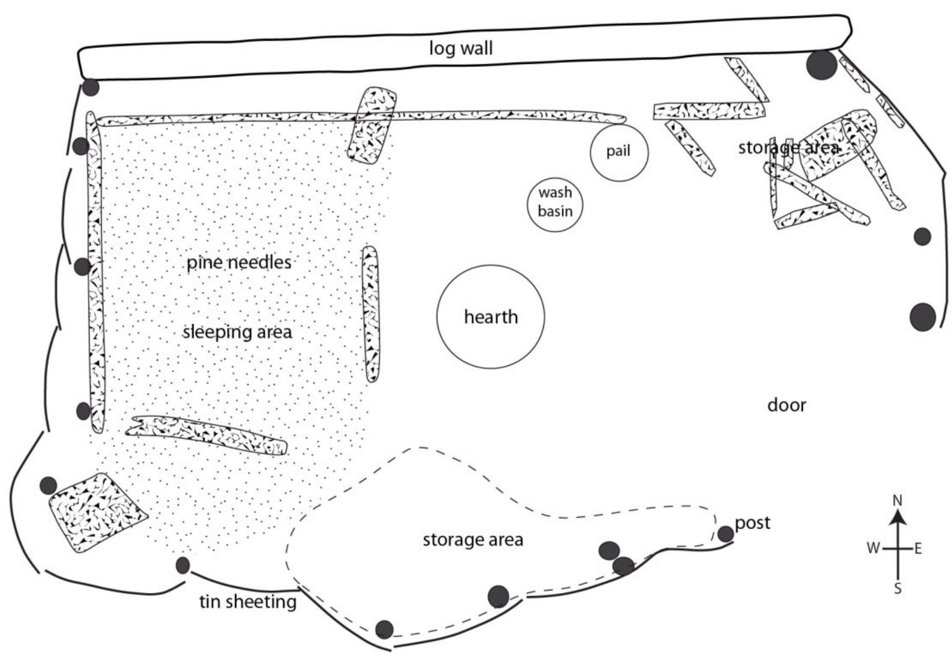
Considering the data above, the average space needs per person of Apachean groups is calculated to be 2.4 m^2 (Table 4.10).

Group	Avg. Family or Household Size	# of families	Dwelling Type	Area of dwelling (sq. m)	Avg. Space per Person (sq. m)	Source
Apachean, Apache	4	1	wickiup	6	1.5	Longacre and Ayres 1968
Apachean, Navajo	5	1	hogan	19.62	3.3	Kent 1984
				Average	**2.4**	

Table 4.10. Apachean space needs per person calculated from various ethnographic accounts.



*hogan floorplan modified from Jett and Spencer 1981



*wickiup floorplan modified from Longacre and Ayres, 1968; size ~3m by 2m

Figure 4.6. Apachean dwellings (hogan and wickiup) and organization of space, as illustrated in Jett and Spencer (1981) and Longacre and Ayres (1968)

4.9 Kinship, Sociopolitical Organization, and How They Relate to Dwellings

Kinship practices play an important role in group composition and household sizes. The family unit or local group, or band, were the main social units of the western North American hunter-gatherer groups. Local bands are most often, if not always, formed through kinship ties, usually through either parent-child or sibling bonds. Transformation of these groups happens through practices of descent (bilateral, matrilineal or patrilineal), exogamous or endogamous marriage preferences, and other factors such as polygyny, matrilocal or patrilocal residence, or fissioning or fusing of groups. The presence of clans or moieties can also affect group composition. All of these kinship factors affect group composition and size. In addition to kinship, a group's territory, available resources and subsistence practices also impact group sizes and composition. Whether a group is nomadic, semi-sedentary or sedentary affects group size greatly, as well as determining whether people will live in villages or temporary camps. This in turn determines what type of built dwelling they will have: something permanent or portable. These are the things that will show up in the archaeological record in ways that can reveal group size and, once an approximate group size is known, allow informed interpretations of group composition from ethnographic records. Architecture also allows us to determine how complex a group's sociopolitical organization may have been (Kent 1993).

Susan Kent (1993) developed a system of categorization for societies that relates sociopolitical organization to the use of space. She argued that the use of space and architecture is a direct reflection of how complex a society is. The categories for complexity range from 1 to 5, one being the simplest and five being the most complex. Category 1 societies have little sociopolitical stratification and less segmented camps. The example that Kent used for this category is the Subarctic Canadian Hare Athapaskan group. They traditionally lived in very simple tents, and in more recent time in one-room log cabins; activity areas are not specialized economically or socially. They have very simple political organization, with bilateral kinship bonds being the main force that structures the society, and leadership roles shifting between the most experienced individual(s) in certain situations. Category 2 societies have more pronounced gender differences and divisions of labour and can range from nomadic to sedentary. These societies, in general, have a recognized chief and structure of the society is based on lineage and clans or other patrilocal/matrilocal associations. The examples Kent (1993) gave for category 2 societies are the Navajo, Plains Blackfoot, Omaha, and Mandan. In general, their dwellings are still very basic, and often not partitioned but are divided, at least conceptually, into men's and women's spaces. Category 3 societies have increased sociopolitical stratification, and noted hierarchies and social ranking. There is gender-specific economic specialization and these groups are often semi-sedentary to completely sedentary. The examples that Kent (1993) presented for this category are the Pawnee and the Iroquois. These groups are both horticulturalists and, the Iroquois in particular, have more complex dwellings. Category 4 societies have hereditary chiefs, distinct classes and full time economic and sociopolitical specialization. Category 5 societies are the most politically stratified, hierarchical and specialized. In general, as a society becomes more segmented, its use of space becomes more segmented and there is an increase in functionally discrete spaces and activity areas (Kent 1993).

Using Kent's model, the dwellings for each western North American group described above seem to correlate well with their sociopolitical organization and kinship practices. The Numic-speaking groups of the Great Basin had both the most basic sociopolitical organization and the most basic dwellings. They were highly nomadic and organized into very small family groups that used very simple windbreaks or small, one-room expedient structures made of poles and brush or grass for shelter (Fowler 2012; Wheat 1967). They could be considered a Category 1 group. The subarctic Athapaskans, a primarily nomadic group, also had very simple dwellings and social organization. They were organized into small groups, tied together by kinship bonds, and lived in one room conical lodges or cabins with no physical division of space (Hearne 2007; Janes 1983). They would also fall into Category 1, or sometimes maybe Category 2. The Plains groups vary in complexity. In general, the more nomadic groups had simpler dwellings, often a conical lodge (tipi), but there is division of space based on gender (Oetelaar 2000). The groups that practiced horticulture and were semi-sedentary had more complex sociopolitical organization and more permanent dwellings (e.g. earthlodges). The Plains groups would fit into Category 2 or 3, depending on the group. The subarctic Algonquians were nomadic and had simpler dwellings and social organization (Brown and Beierle 2000). The Algonquians could also fit into Category 2. Those Apacheans dwelling in hogans and ramadas are similar in complexity to the more sedentary Algonquian and Plains groups. The hogan has a similar form to a conical lodge or earthlodge (Kent 1984). The Apacheans would fit best with Category 2.

4.9.1 Common Pattern of Western North American hunter-gatherer dwellings

Despite the differences among cultural groups and their dwellings, there are a lot of general similarities in the way western North American hunter-gatherer groups organized space. When comparing the dwelling diagrams, it is easy to notice a basic pattern in the organization of space, despite the shape or size of the dwelling. Each dwelling has a central hearth, most often just one doorway (usually facing east), storage space next to the door, public space upon entrance, where communal activities such as cooking and eating took place, and sleeping areas arranged around the perimeter of the dwelling. If there is a sacred space, it is located at the back of the dwelling, usually opposite the entrance. In dwellings that have divisions of space, there is often a men's half and a women's half. Most of these groups also laid down coverings on the floor such as willow, pine or spruce boughs, pine needles, and mats or hides. As discussed in Chapter 3, Lewis Henry Morgan (1881) also observed patterns and similarities in American Aboriginal house architecture and use of space. He noted that many groups had joint tenement houses with central fires, stalls or assigned places for sleeping, and some type of covering on the floor whether it was reeds, spruce hemlock, blankets, skins, grass, or mats (Morgan 1881). This pattern is something to consider when analyzing use of space in Cave 1, and also relates to the space syntax analysis of the dwellings, explained below.

4.10 Space Syntax Analysis of Western North American Hunter-Gatherer Dwellings

As discussed in Chapter 3, space syntax analysis is a tool researchers can use to look at the social effects of built structures. Some societies put more effort into complex, structured order, and others less. Often, the design of a built structure can give researchers clues as to how a society functioned. In the case of hunter-gatherer dwellings, Dawson (2002) applied space syntax analysis to three different Inuit groups in the Canadian Arctic. What he found was that the social structure of each group was in fact reflected in the layout of their snow houses. Space syntax analysis has been applied below to the dwellings of Athapaskan, Algonquian, Plains and Apachean groups. In chapter five, space syntax is also applied to Promontory Cave 1. The data obtained here can be used to compare space in built dwellings to space in the cave.

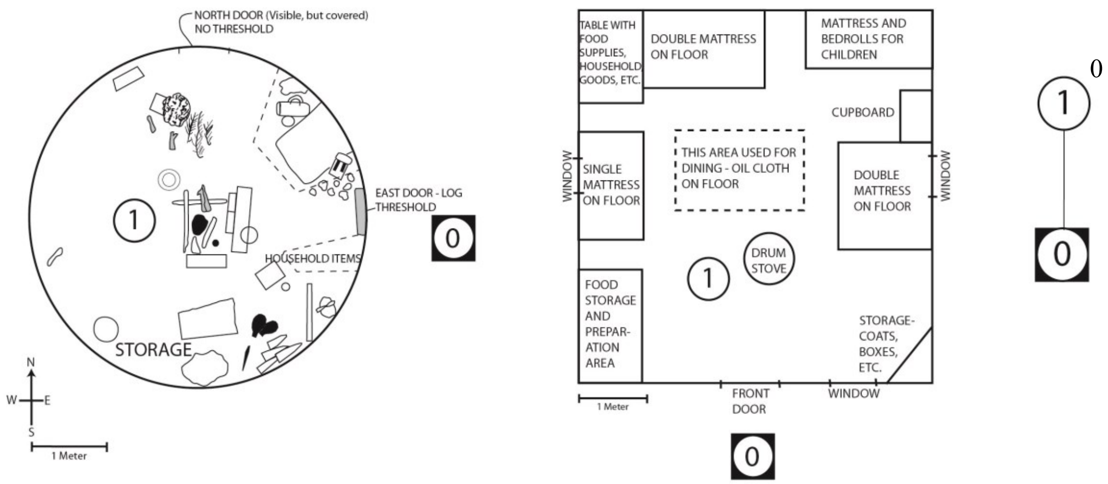
The figures below illustrate the respective dwellings of each group and their associated justified graphs. A space syntax program called AGRAPH was used to analyze the measurements of scale, and to calculate the real relative asymmetry (RRA) and integration of each dwelling. Higher real relative asymmetry values indicate greater asymmetry, which means some spaces require longer trips to reach, or all spaces are not equal in depth. As Dawson points out, “this has the effect of creating greater control over space” (2002:475). Integration values can also be used to determine how public or private a space is. Higher values indicate that a space is shallower, more public, and easier to access. Lower values indicate that space is more private, and has limited access points. The figures below show the real relative asymmetry values of each space in each dwelling.

Most of the dwellings analyzed below are very basic in form. The majority of them only have one node when considering physical barriers only. This means there are no physical divisions of space inside the dwelling. When social norms are considered, another node can be added that divides public and private space based on behaviour. In this case, private spaces are private because interaction does not occur between the two spaces. Still, having only two nodes indicates a very basic structure, and in turn, a simpler form of sociopolitical organization. The Athapaskan conical lodge and cabin, the Algonquian conical lodge, the Plains tipi and earthlodge, and the Apachean hogan and wickiup all exhibit this very basic form with only one or two nodes. The values in these cases indicate that there is not a lot of control over space in these dwellings as far as access and privacy, and that these groups have simpler sociopolitical organization, which is supported by their inclusion in Category 1 and 2 societies in Kent’s model discussed above.

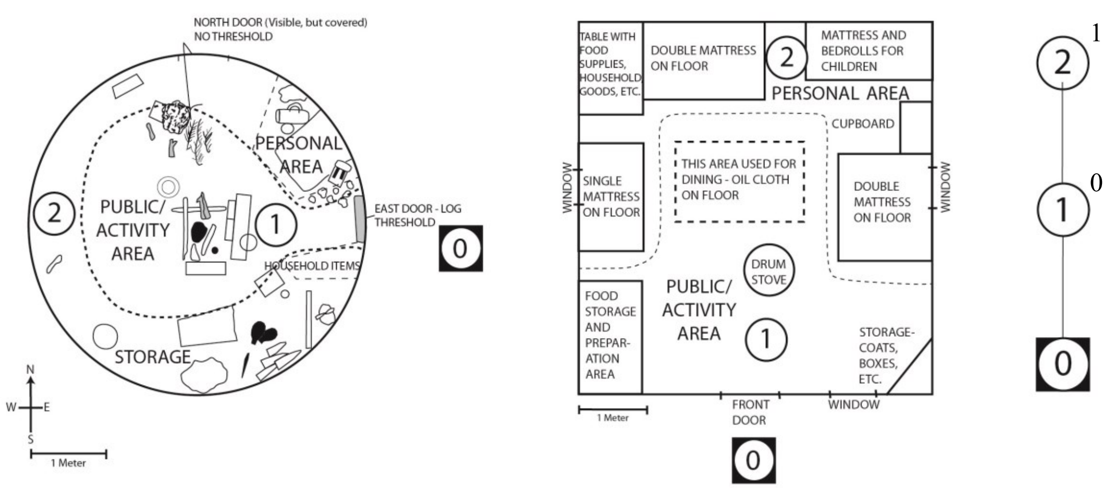
More complex dwellings are encountered among the Algonquian, with the Mistassini Cree winter house. This structure houses many families and has more physical barriers. Like Dawson’s (2002) experience with the Inuit houses, the space syntax of these dwellings correlates with the social organization of their inhabitants. In the Mistassini Cree winter house the private family spaces in the back of the dwelling have a lower RRA value, indicating that they are more private than the family spaces in the front. This difference in integration values provides more control over space in the structure and, as seen in Dawson's (2002) Inuit example, these more private spaces in the back may have been assigned to families with higher status or seniority.

Dwelling	Scale	Integration		Real Relative Assymetry/Integration
	# Nodes	# Rings	# Communal Spaces	Average RRA/Integration
Athapaskan, conical lodge, physical barriers	1	0	1	0
Athapaskan, cabin, physical barriers	1	0	1	0
Athapaskan, conical lodge, physical and social barriers	2	0	1	0.33
Athapaskan, cabin, physical and social barriers	2	0	1	0.33
Algonquian, conical lodge	2	0	1	0.33
Algonquian, winter house	5	1	1	3.77
Plains, tipi	2	0	1	0.33
Plains, earthlodge	2	0	1	0.33
Apachean, hogan	2	0	1	0.33
Apachean, wickiup	1	0	1	0

Table 4.11. Measurements of spatial configuration from floor plans of Athapaskan, Algonquian, Plains and Apachean dwellings, using AGRAPH.

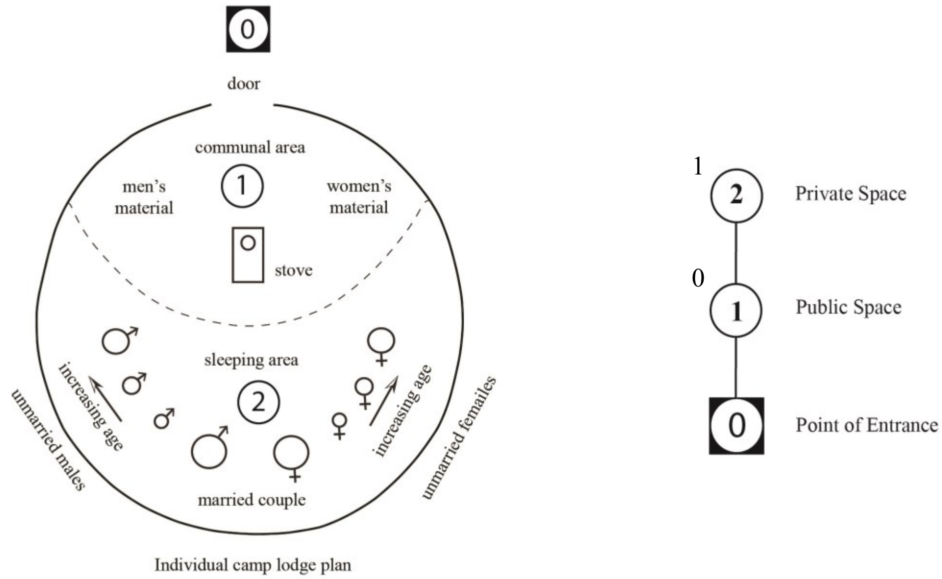


Space syntax analysis on Athapaskan conical lodges and cabins based on physical barriers.
(Floorplans from Janes 1983)

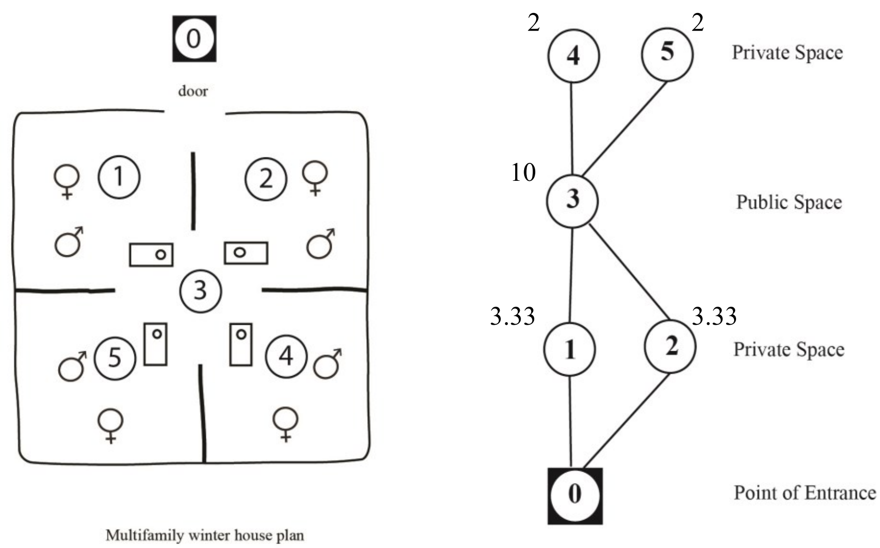


Space syntax analysis on Athapaskan conical lodges and cabins based on physical and social barriers.
(Floorplans from Janes 1983)

Figure 4.7. Space syntax analysis applied to Athapaskan dwellings and associated j-graphs, based on both physical and social barriers (RRA values beside nodes).

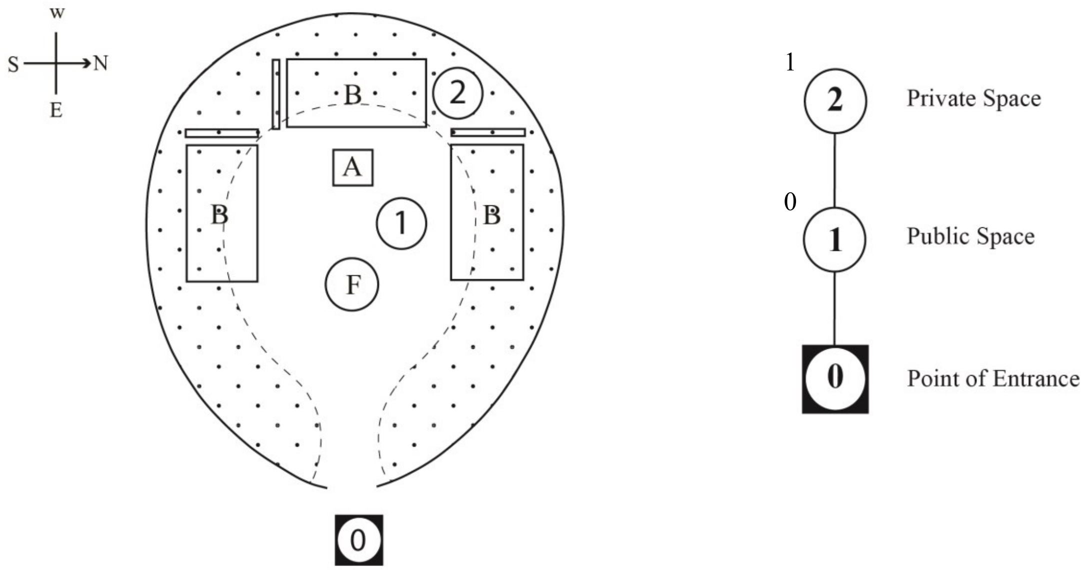


*Mistassini Cree floorplan modified from Nabokov and Easton 1989

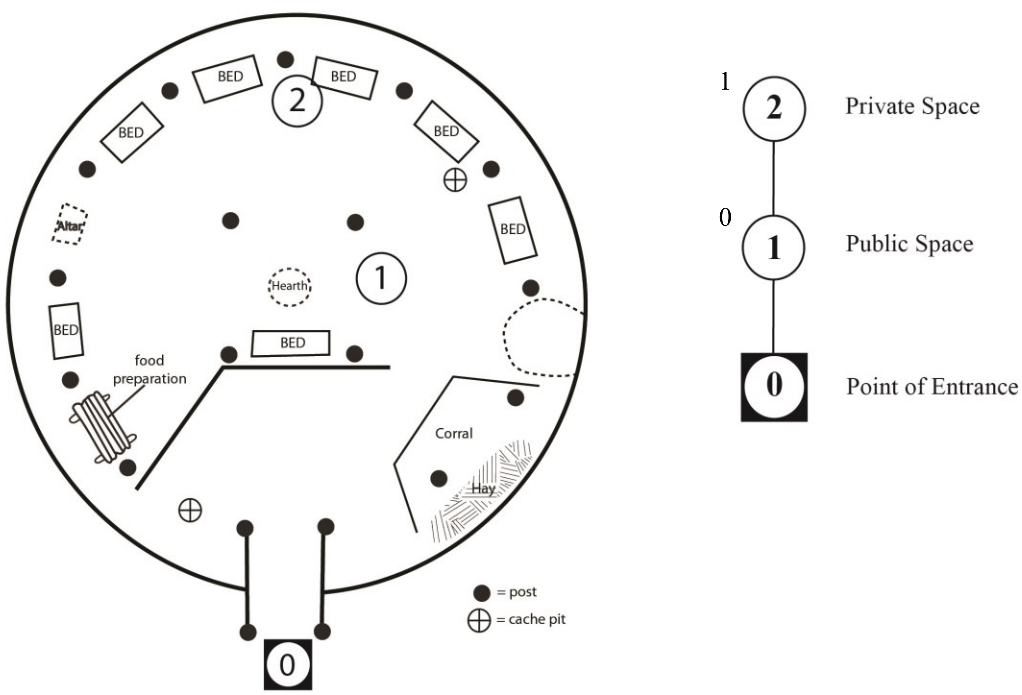


*Mistassini Cree floorplan modified from Nabokov and Easton 1989

Figure 4.8. Space syntax analysis applied to Algonquian dwellings and associated j-graphs; conical lodge and winter house (RRA values beside nodes).

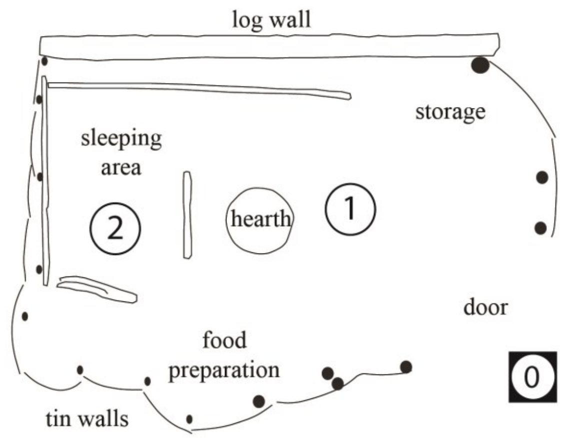


*tipi floorplan modified from Oetelaar 2000.

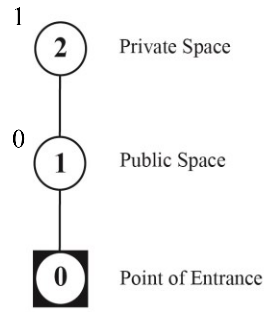


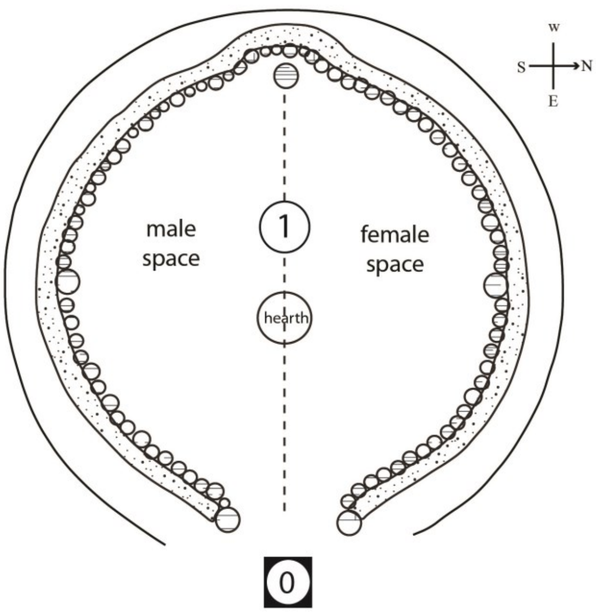
*Hidatsa earthlodge from Wilson 1934. *Not to scale.

Figure 4.9. Space syntax analysis applied to Plains dwellings and associated j-graphs; tipi and earthlodge (RRA values beside nodes).



*wikiup floorplan modified from Nabokov and Easton 1989





*hogan floorplan modified from Nabokov and Easton 1989 and Kent 1982

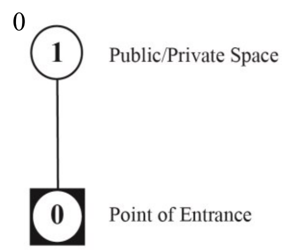


Figure 4.10. Space syntax analysis applied to Apachean dwellings and associated j-graphs; wickiup and hogan (RRA values beside nodes).

4.11 Space Needs per Person of Hunter-Gatherer Groups

In an archaeological context, population size of a site is difficult to predict. One method that has been explored is population based on the floor area of dwellings. The first attempt at developing a worldwide constant was by Naroll (1962). Based on cross-cultural analysis of 18 societies spread throughout the world, Naroll (1962) suggested that population could be estimated based on space needs of 10 m^2 per person. Several scholars revisited what became known as "Naroll's Constant" and subsequently reworked the results (Brown 1987). LeBlanc (1971) used Naroll's calculation and applied it to three additional case studies in Samoa, Iran and Peru. LeBlanc (1971) had concerns that "Naroll's Constant" would not account for variability between these three cultures and, when he included social and storage spaces in his area calculations, he noticed considerable variability. However, when living area alone was considered, the average floor area per person in all three studies was in the range of 10 m^2.

Wiessner (1974) criticized Naroll's approach, suggesting that his model does not account for variations in settlement types or cultural variation in interpersonal living spaces and that the model does not work for groups who carry out household tasks outside of their dwellings. Rather than using Naroll's formula, Wiessner (1974) used Nordbeck's law of allometric growth to estimate population by area. This formula was applied to eight !Kung Bushmen camps. The results indicated that for populations of ten, space needs per person were 5.9 m^2, but by the time the population of the group reached 25, space needs increased to 10.2 m^2 per person (Wiessner 1974). Casselberry (1974) focused on population estimates based on floor area, specifically for multifamily dwellings, using refinements of Naroll's formula. The result he obtained is similar to Wiessner's result for populations of ten; estimates of population of multifamily household dwellings can be calculated using a constant of 6 m^2 per person (Casselberry 1974).

Brown (1987) revisited this cross-cultural "constant" and looked at the strengths and weaknesses from each of the previous studies discussed above. To test these, and develop his own formula, he obtained data for 38 of the 60 cultures in the Human Relations Area Files Probability Sample. He developed and tested several different models and in the end settled on a sample mean of 6.1 m^2 per person as a cross-cultural worldwide constant for estimation of population from floor area. The space needs per person values obtained above for Western North American hunter-gatherer groups have a range from as low as 2.4 m^2 for the Apacheans to 6.31 m^2 for the subarctic Athapaskans (see Tables 4.3, 4.5, 4.7, 4.10 above and Table 4.12 below). When the values for all of the groups are averaged the result is 4.24 m^2 of space per person. This value is lower than Naroll's constant, but close to the value obtained by Brown (1987).

Group	Avg. Space Needs Per Person (square metres)
Athapaskans	6.31
Algonquians	4.21
Plains	4.05
Apachean	2.4
Average	**4.24**

Table 4.12. Average space needs per person of Western North American hunter-gatherer groups.

4.12 Chapter Summary

This chapter explored several aspects of five broad Western North American hunter-gatherer regions in and around Promontory Cave as a basis for analyzing space in the cave and speculating about the group that occupied it. Hunter-gatherer groups are consistently organized into discrete social units worldwide. These units are grouped into hierarchies such as the family, microband, and macroband and each of these hierarchies has strikingly consistent sizes worldwide. Larger groups, like microbands or macrobands, are often formed based on kinship ties. A common pattern seen in group formation is either groups based on parent to child or sibling bonds or on matrilineal clans or moieties. This consistency in group size, hierarchies, and formation patterns based on kinship can provide insights into the group that occupied Cave 1.

Group size, composition, and sociopolitical organization are often reflected in a society's architecture. Built dwellings and organization of space can inform archaeologists about the group that lived there, beyond material culture. The size of the dwellings can help determine group size based on space needs per person and division of space, or complexity of the structure can inform us about sociopolitical organization or social structure. Space needs per person of Athapaskans, Algonquians, Plains groups, Great Basin groups, and Apacheans were calculated based on various ethnographic accounts. These values will provide a solid foundation for applying space needs per person values to Cave 1, a topic explored in chapter five. In addition to group size, space syntax analysis and the basic layout of built dwellings of these groups provides insight as to how space in the cave may have been used, and how space syntax analysis of the cave compares to other groups in the surrounding regions. Even though the cave is not a built dwelling, it is likely space was used in a very similar fashion. Much like the layout of traditional dwellings were impressed upon European style cabins, observed in Janes' (1983) and Yellowhorn's (2015) ethnographic work, this basic layout could be also be applied to natural environments, such as Cave 1. Lastly, analysis undertaken in this chapter will allow reasonable predictions about possible group composition, social structure, and sociopolitical organization of the Promontory group.

CHAPTER 5

SPACE IN PROMONTORY CAVE 1, UTAH: METHODS, RESULTS AND INTERPRETATION

"…we want them to be respectful of the cave itself because it's a place for the ancestors of a great people" – Kumeroa Chournos, landowner of Promontory Cave 1 [video by Conor Snoek and Sally Rice, May 2013]

The preceding chapters have laid out background, methodologies and data that can be applied to Promontory Cave 1 to gain more insight into how people used this space. This chapter will look at different aspects of space in the cave to determine the approximate number of people that may have lived in this space, possibilities for how they organized space in this dwelling, what impact sound had on the inhabitants, and what this analysis can tell us about the Promontory Culture people who made this cave their home.

5.1 Sound

As discussed in chapter three, archaeoacoustics is a newer concept in archaeology. It considers how sound in a space would have influenced people's behaviour or actions. Cave environments are often known to be dynamic soundscapes, sometimes with intense sounds and echoes. While exploring the space in Cave 1, it is important to consider what effect sound may have had on the people inhabiting the cave. For instance, if there were many people in the cave at one time, the sound may have been very intense, and perhaps played a factor in where certain activities occurred, such as where people would have slept, or played games or music. As illustrated in chapter three, rock art placement and form sometimes have a tightly bound relationship with sound (Scarre 2006; Waller 2002a; Waller 2002b). There are panels of rock art in Promontory Cave 1, and one goal of this thesis was to see if sound had anything to do with their placement. Another thing to consider with sound is how it travels through the cave. Like the domed effect of some buildings (St. Paul's Cathedral whispering gallery), there may be special acoustic properties in which the sound in certain locations travels through the cave to some other noted location (Scarre 2006).

Sound was explored in the cave using a hand-held voice recorder along with voices, hand claps and a cellphone alarm. Eight locations throughout the cave were marked as "targets" and "sources." Each of these locations alternated as the "target," where the sound was recorded, and the other locations were the "sources," that is, where the sound was coming from (clap, alarm and voice). The sound recordings were analyzed in a free program called Praat. Praat was developed by Paul Boersma and David Weenink of the Institute of Phonetics Sciences of the University of Amsterdam and is traditionally used in the field of linguistics. One function that Praat has is measuring the intensity of sound in decibels. Since I was interested in determining how "loud" this space would be, I focused on analyzing the intensity of sound at each clap, voice, and alarm recording. This intensity is measured in decibels (dB) and is shown in Table 5.1. For the sake of comparison, typical decibel values for a whisper is 20 dB, rainfall is 50 dB, typical speech is 60 dB, busy city traffic is 85 dB, a Walkman or tractor is 100 dB, a jackhammer is 125 dB and a gunshot or fireworks is 140 dB (Berger et al. 2015). According to Canadian Occupational Health and Safety standards, anything over 87 dB is too loud to be exposed to for long periods of time. At 120 dB there should be no exposure; otherwise it can result in serious hearing damage (Government of Canada, Minister of Justice 2015).

Target		Source 1	2	3	4	5	6	7	8
1	Clap		70.79 dB	72.03 dB	65.77 dB	62.71 dB	58.29 dB	72.81 dB	71.88 dB
	Voice		52.55 dB	57.86 dB	57.95 dB	53.75 dB	50.22 dB	55.53 dB	57.54 dB
	Alarm		49.9 dB	44.72 dB	41.01 dB	41.80 dB	33.11 dB	40.11 dB	42.07 dB
2	Clap	68.93 dB		71.67 dB	73.11 dB	65.32 dB	58.78 dB	71.65 dB	75.96 dB
	Voice	56.10 dB		60.66 dB	58.78 dB	53.34 dB	50.08 dB	59.38 dB	63.04 dB
	Alarm	39.71 dB		36.28 dB	39.04 dB	32.75 dB	29.54 dB	37.71 dB	47.55 dB
3	Clap	69.52 dB	67.82 dB		72.26 dB	70.26 dB	61.93 dB	66.08 dB	75.7 dB
	Voice	54.41 dB	56.14 dB		57.51 dB	54.43 dB	51.95 dB	56.17 dB	59.69 dB
	Alarm	32.87 dB	35.53 dB		36.34 dB	36.60 dB	32.87 dB	37.73 dB	46.78 dB
4	Clap	60.66 dB	65.90 dB	66.40 dB		70.37 dB	61.93 dB	75.13 dB	76.84 dB
	Voice	56.53 dB	58.87 dB	58.40 dB		57.97 dB	54.01 dB	60.78 dB	62.65 dB
	Alarm	32.91 dB	37.01 dB	37.77 dB		42.48 dB	33.23 dB	43.09 dB	46.94 dB
5	Clap	64.24 dB	61.06 dB	56.23 dB	70.22 dB		71.42 dB	69.45 dB	69.83 dB
	Voice	50.58 dB	54.37 dB	52.09 dB	59.78 dB		61.39 dB	59.06 dB	58.98 dB
	Alarm	31.80 dB	34.00 dB	35.08 dB	35.80 dB		40.58 dB	40.38 dB	37.11 dB
6	Clap	55.82 dB	56.17 dB	66.34 dB	58.93 dB	74.95 dB		68.00 dB	63.15 dB
	Voice	49.26 dB	53.05 dB	52.56 dB	53.32 dB	61.57 dB		57.91 dB	54.59 dB
	Alarm	29.32 dB	32.70 dB	30.03 dB	31.83 dB	38.66 dB		37.78 dB	34.01 dB
7	Clap	64.20 dB	69.08 dB	71.59 dB	69.49 dB	71.29 dB	69.69 dB		73.68 dB
	Voice	58.52 dB	58.93 dB	62.82 dB	60.76 dB	63.69 dB	62.16 dB		61.74 dB
	Alarm	37.84 dB	36.12 dB	42.15 dB	38.97 dB	38.50 dB	38.08 dB		42.75 dB
8	Clap	69.53 dB	72.52 dB	73.91 dB	73.92 dB	69.54 dB	66.94 dB	73.16 dB	
	Voice	59.06 dB	65.87 dB	63.47 dB	63.92 dB	56.91 dB	56.22 dB	62.56 dB	
	Alarm	39.86 dB	41.74 dB	40.11 dB	44.24 dB	38.33 dB	35.93 dB	43.63 dB	

Table 5.1. Measurement of sound intensity (decibels) from each source to each target in Cave 1 with the highest and lowest values of the alarm highlighted (see also Figures 5.1 to 5.8).

From the values in table 5.1, sound maps were made for each target in ArcGIS 10.2 by generating a predicted surface using the "inverse distance weighted" interpolation technique based on the values recorded at each of the eight locations. Interpolation methods have been used in other studies to construct sound maps (Aletta and Kang 2015). The values used to construct the sound maps are the measurements in decibels of the alarm. The alarm would have been the most consistent sound throughout all of the recordings, since it was on an electronic device set at the same volume for all recordings. Alternatively, the intensity of the clap and the voice could vary each time, depending on the strength of the clap or how loud the speaker spoke.

Since a value was needed at each target in order for the interpolation to work, the targets were all assigned a constant of 40.62 decibels (dB). This value was assigned based on comparisons between the voice recordings and the alarm recordings. Voice recording measurements were available for target to target recordings, but alarm recordings were not. The value for typical speech is around 60 dB, which is close to most of the values for the target to target voice recordings (Berger et al. 2015). The difference between each of the voice and alarm values from each source was calculated and averaged. The alarm, on average, was 19.38 dB less intense than the voice. This average was subtracted from the value for typical speech and used as a constant for the alarm, since recordings were not available for target to target for the alarm. Figures 5.1 to 5.8 below show the resulting sound maps for each target.

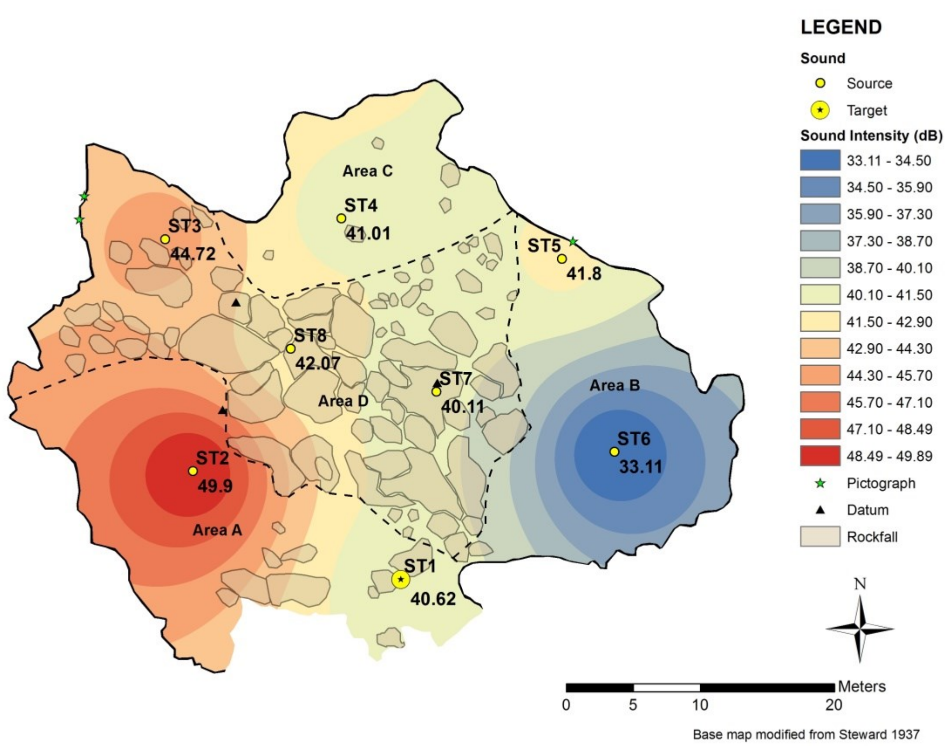


Figure 5.1. Sound Target 1 sound map.

Sound Target 1 is located near the mouth of the cave in Area A. This area has the best line of sight to the southwest portion of the cave and up onto the rockfall. It is separated from Area B by the rockfall and is quite a bit higher. The most intense sound recordings could be heard from Sound Target 2, also in Area A. As the sound source got closer to the back of the cave, the sound became less intense, a result which is not surprising considering the source would be farther away from the target and separated by rockfall (Figure 5.1). Interestingly, the least intense sound was recorded from Sound Target 6 in Area B. Even though that area is separated by the rockfall, it is relatively close to the target so one might expect it to be louder. However, it is significantly lower, suggesting that sound does not carry well from Area B to the front of the cave. This was true for not only the alarm but also the clap and the voice recordings.

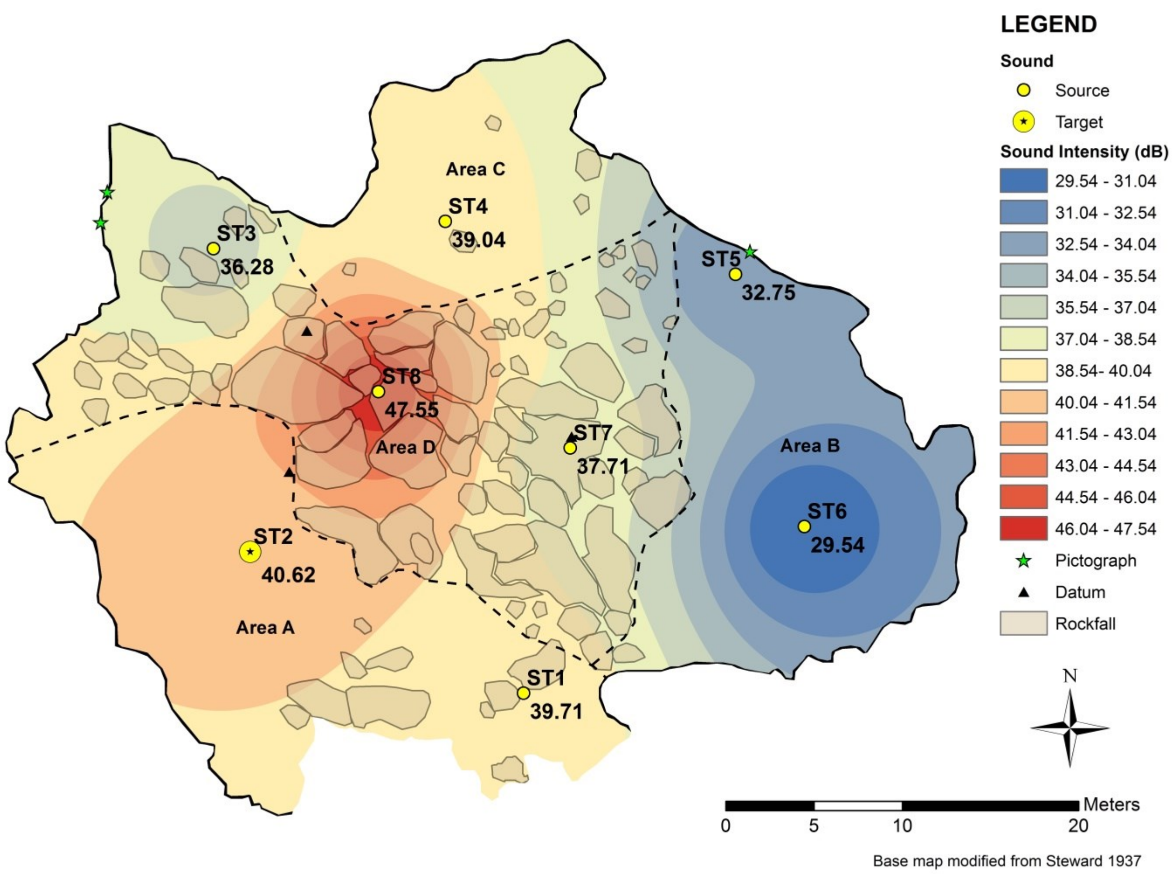


Figure 5.2. Sound Target 2 sound map.

Sound Target 2 is located in the southwest portion of the cave, also in Area A. The results of these recordings show the most intense sound coming from the rockfall area immediately above the target (also the closest sound source), with the values then becoming less intense with distance. Like Sound Target 1, the sound coming from Area B was recorded as the least intense for all of the sound sources (clap, voice, alarm) (Figure 5.2).

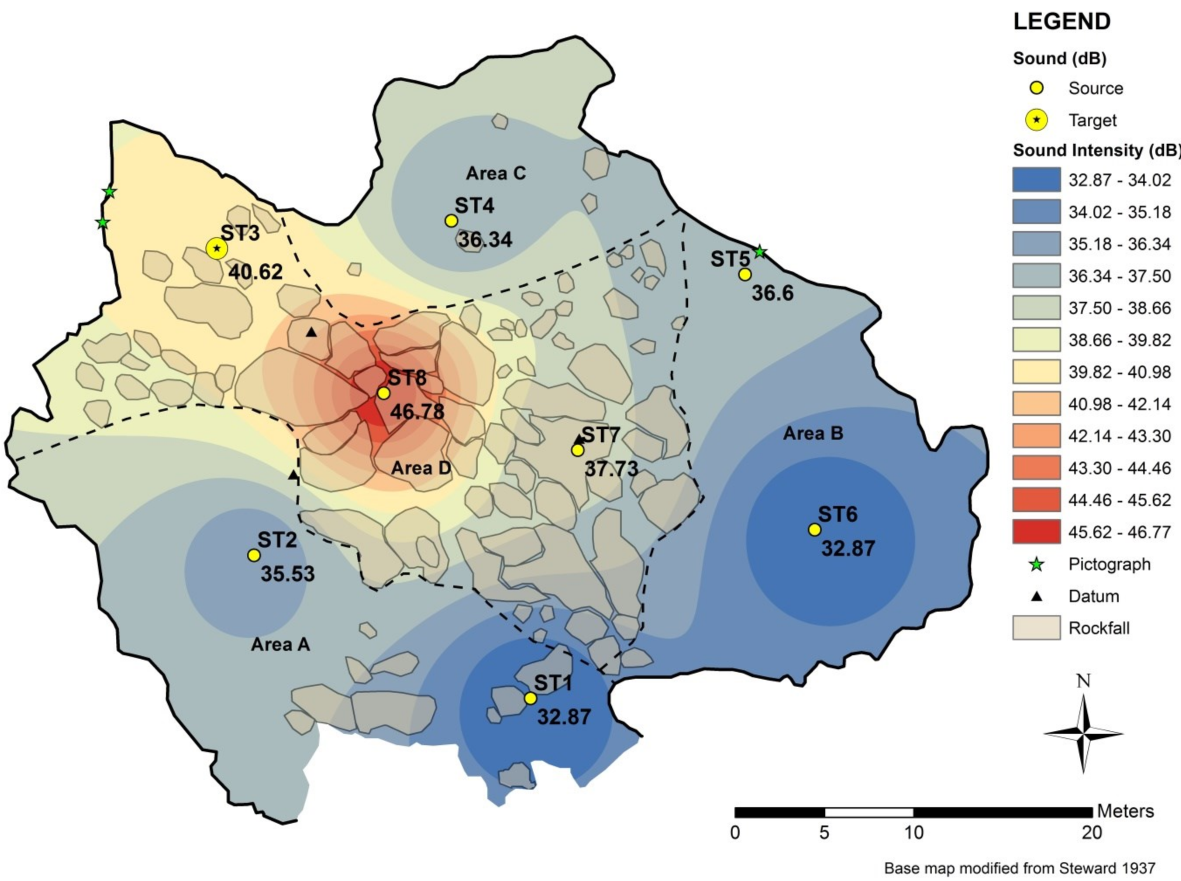


Figure 5.3. Sound Target 3 sound map.

Sound target 3 is located in the back, west side of the cave, in Area D. This location is below one of the sets of pictographs and is separated from the rest of the cave by rockfall. The most intense sound is from Sound Target 8, on the rockfall above and east of Sound Target 3.

The rest of the sound recordings have significantly lower intensity, suggesting that sound does not carry well into this back area (Figure 5.3).

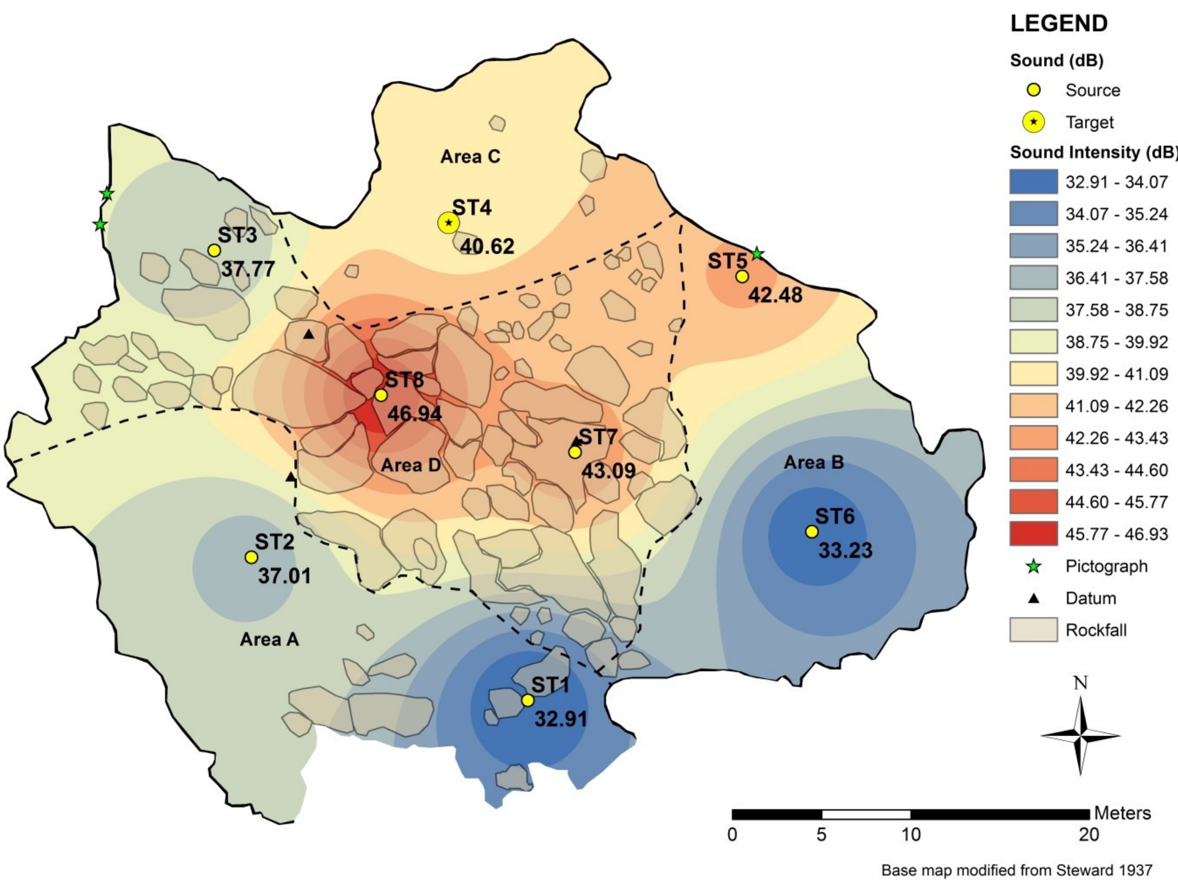


Figure 5.4. Sound Target 4 sound map.

Sound target 4 is located in the back, northern part of the cave. This area is separated from Areas A and B by the rockfall. Sound from Sound Target 5, Sound Target 7 and Sound Target 8 is the most intense, not surprisingly, since these sources are the closest. Sounds from Sound Target 1 and Sound Target 6 are the least intense (and the furthest away) (Figure 5.4).

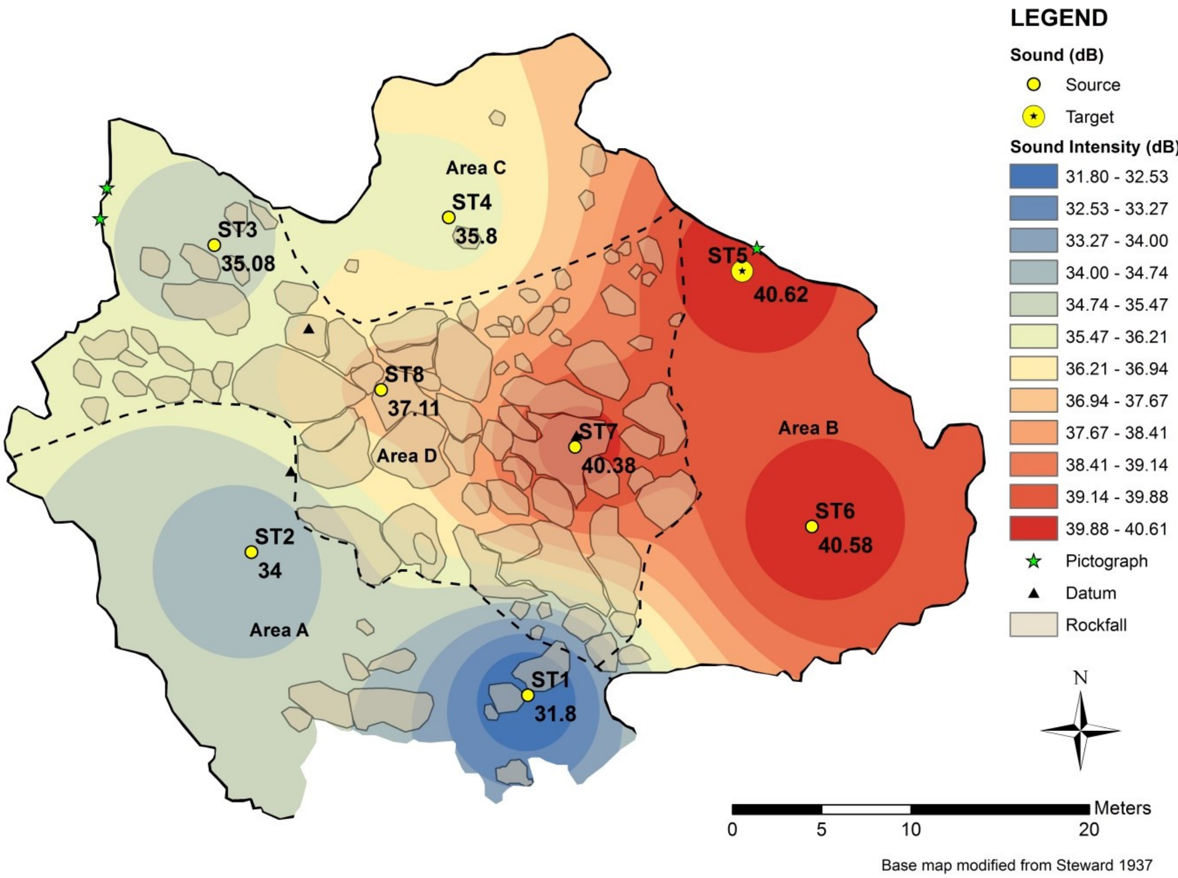


Figure 5.5. Sound Target 5 sound map.

Sound Target 5 is located under the other set of pictographs on the northeast side of the cave, in the back. Sound Target 5 is located in Area B, with Sound Target 6, and is separated from the west part of the cave and the front by the rockfall. Sound is most intense and well heard from Sound Target 6 and Sound Target 7, which are both close by. Sound intensity becomes less as the distance increases. The least intense sound is from Sound Target 1 at the mouth of the cave (Figure 5.5).

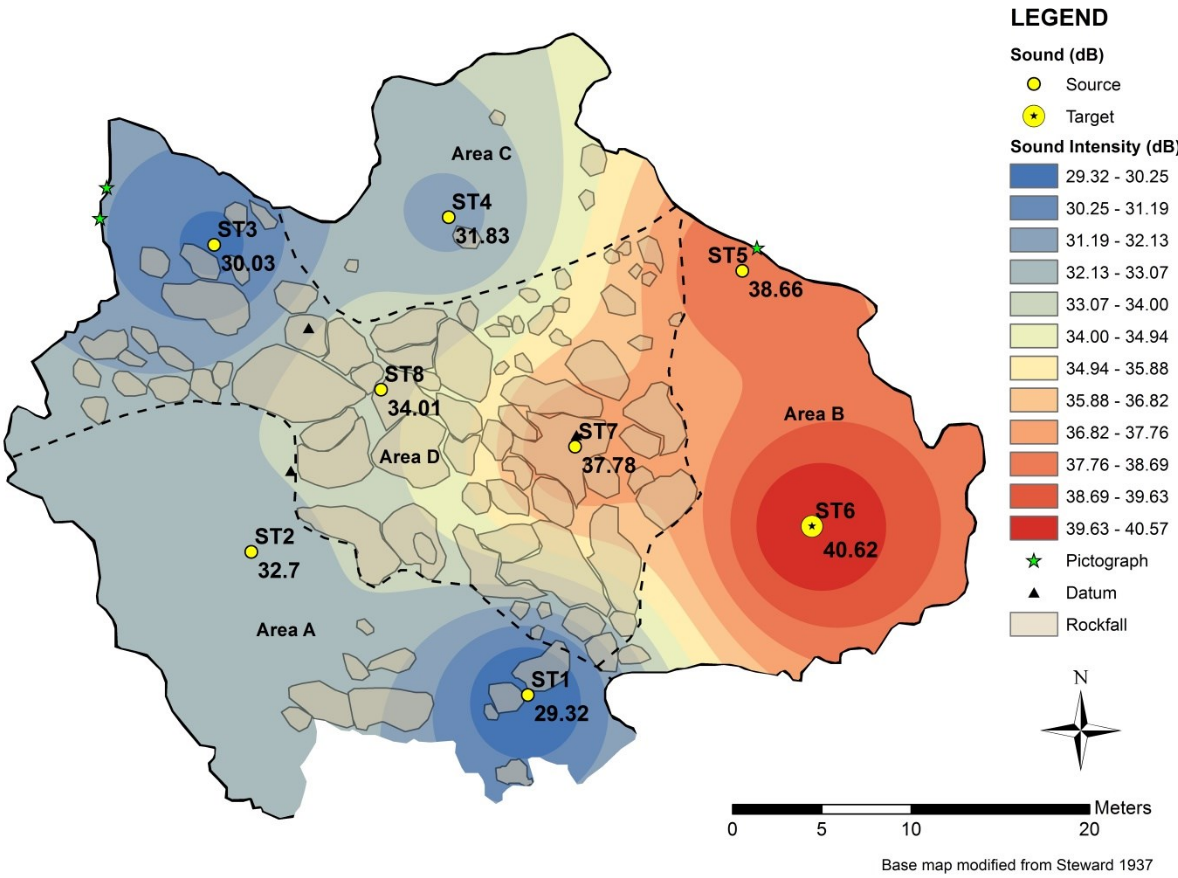


Figure 5.6. Sound Target 6 sound map.

Sound target 6 is located in the east part of the cave in Area B. Sound is most intense from Sound Target 5 and Sound Target 7 and becomes less intense as distance increases. However, the least intense sound source was from Sound Target 1 just to the west of target 6, in Area A (Figure 5.6). This is unexpected because it is one of the closest sound sources. The low value suggests that sound does not carry well from Area A to Area B, possibly because of the rockfall and elevation separation.

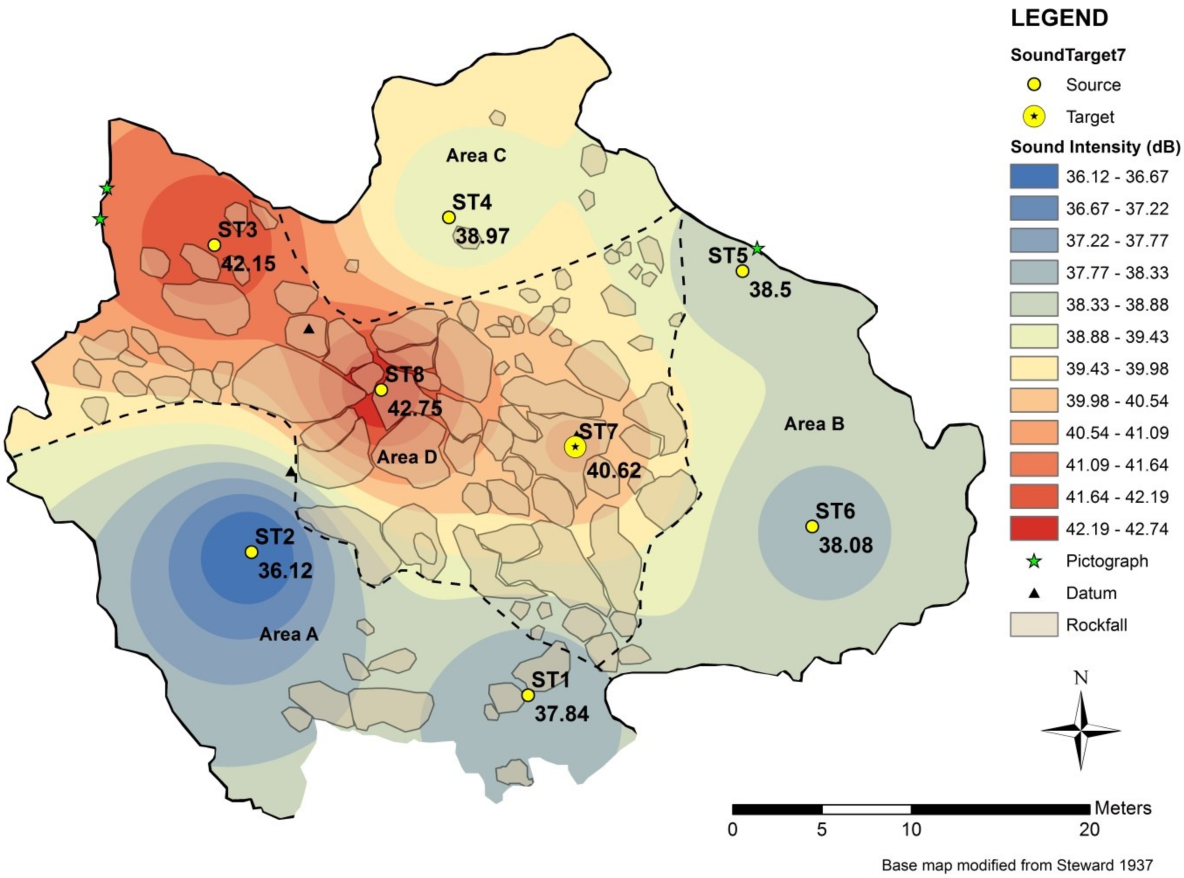


Figure 5.7. Sound Target 7 sound map.

Sound target 7 is located in Area D, on top of the rockfall in the central portion of the cave. This location is elevated above the other targets (except for Sound Target 8) and is below what would be close to the highest part of the roof. Sound is most intense from Sound Target 8 and Sound Target 3 to the west. The lower areas surrounding the rockfall have less intense sound, but are all relatively close in value. The least intense measurement is from Sound Target 2 in Area A (Figure 5.7).

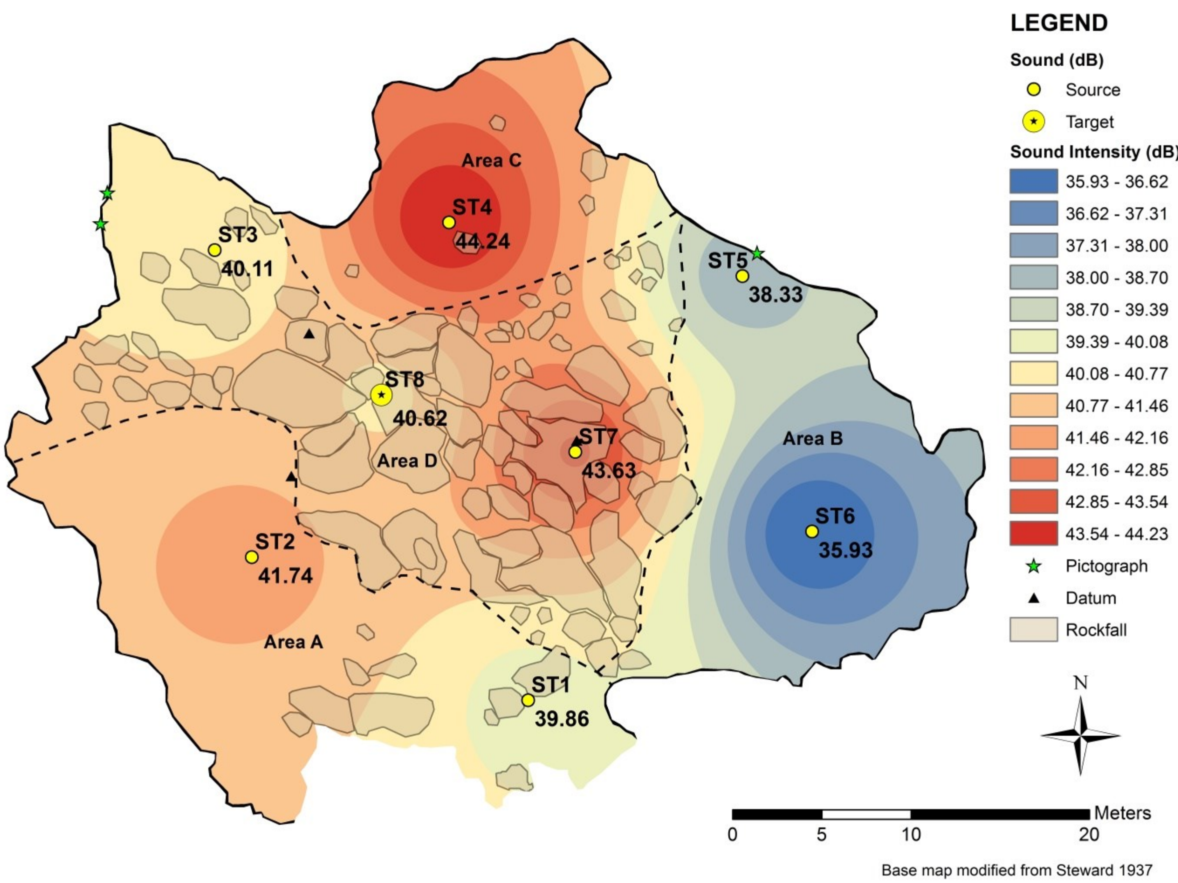


Figure 5.8. Sound Target 8 sound map.

Sound target 8 is also located in Area D on top of the rockfall, but further west. It is also higher in elevation than the surrounding sound sources. Sound is most intense from Sound Targets 4, 7 and 2, and least intense from Sound Target 6 (Figure 5.8). Again, this is suggesting that sound does not carry well from Area B to the rest of the cave.

Generally, sound in the cave was actually quite dead or dull. There were no echoes heard from any of the locations and the sound did not carry well through the cave. The alarm was difficult to hear on some recordings but, in general, the voices, and what they were saying, could be heard in all of the recordings. However, this is when all other activity and speaking in the rest of the cave was halted. If there were many people carrying out everyday activities and conversations, the voices would likely not be heard from all sources. Another thing to note is that birds could be heard chirping in the background in a lot of the recordings. This is something that I personally did not take note of while I was there, so it was interesting to hear it on the recordings afterwards. Overall, the cave seems to have ideal sound characteristics when considering several families or dozens of people living in it – the sound is dull, does not echo or carry through the cave, and is not too intense when there are many people in it. In fact, Cave 1 is rather quiet. There is also an apparent separation between Area B and the rest of the cave in terms of sound. Sound does not carry well from this area to the rest of the cave and vice versa. This is interesting when considering possible spatial organization of the cave. Area B, in terms of sound, is its own distinctive space.

It was not apparent from this study that sound had anything to do with the placement of the rock art. The sound by the rock art panels was not particularly distinct or intense. The placement is likely due to other factors, such as ease of access to a portion of the cave wall that had a large, flat panel. However, their placement may also be because of organization of space and good views from one panel to the other, as well as to the outside. I also did not note sound carrying in any special way to or from the rock art panels, so sound was likely not a factor in the placement of the rock art.

5.2 Fire

Steward (1937) noted evidence of fire during his excavations in Trench A at the front of the cave. He described this area as containing the "main fireplace" used during the entire Promontory occupation (Steward 1937:9). Interestingly, there is black staining on the roof above this trench area and in several other spots throughout the cave. It was suspected that this staining may be from fires in the cave, but bat guano can also leave shiny black staining on cave roofs (David McGee, personal communication 2013).

In order to determine if this black staining was from bat guano or from fires, four samples were collected for testing. One sample, BD1, was collected from staining on the west side of the cave in the Trench A area. The others were collected from the east side of the cave. BD4 was from staining on the roof near the east pictograph, and BD2 and BD3 were collected from the area over top of Trench B (Figure 5.9). Black staining was also observed on the roof in the central portion of Area B, but a sample was not collected there due to difficulty reaching the roof. The samples were submitted to the Analytical and Instrumentation Lab of the Department of Chemistry at the University of Alberta for testing. The results are shown in table 5.2 below. If the black staining was from bat guano, the chemical makeup of the sample would contain higher amounts of nitrogen. If the staining was a result of fires, carbon would be more dominant. As can be seen in the table, all four samples had a significantly greater amount of carbon compared to other elements, confirming the suspicions that this staining was caused by smoke from fires.

The distribution of black staining is interesting when considering space use and activity areas, but it is not known when the staining was deposited. In Areas A and B, the staining occurs over the main areas of activity revealed by excavations by Steward and the Institute of Prairie Archaeology and Brigham Young University. However, in Area C, there is roof staining but not a lot of cultural deposition. The landowner, George Chournos, has also noted that Boy Scouts had camped in the cave in recent decades and had fires in the back of the cave. Despite these challenges, the black staining does provide clues as to where hearths were located in the past and can be correlated with excavation data.

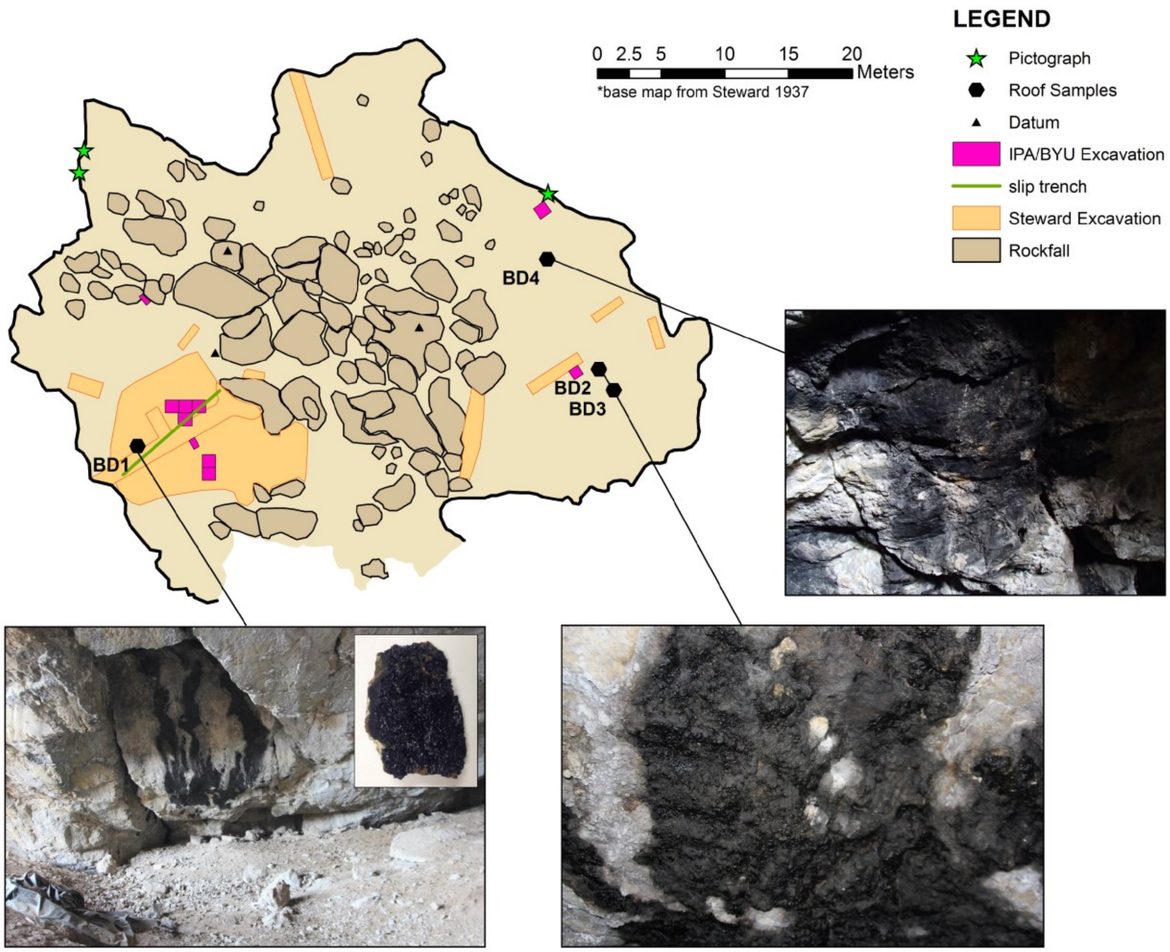


Figure 5.9. Map and photos showing black staining on the roof of Cave 1 and locations where samples were collected for testing.

Department of Chemistry, University of Alberta						
Sample	**File**	**Weight (mg)**	**%N**	**%C**	**%H**	**%S**
LAKEVOLD BD1	NOV04C036	2.766	2.665083	23.33379	3.052773	3.069947
LAKEVOLD BD1	NOV04C037	2.7687	2.816383	24.51903	3.157081	2.824196
LAKEVOLD BD2	NOV04C038	2.4012	0.820751	13.19851	1.074557	0.615738
LAKEVOLD BD2	NOV04C039	2.3842	0.78164	13.023	1.031252	0.616162
LAKEVOLD BD3	NOV04C041	2.8965	1.042231	13.92476	1.528733	0.871784
LAKEVOLD BD3	NOV04C042	2.5387	1.119423	14.3824	1.678977	0.779573
LAKEVOLD BD4	NOV04C043	2.6099	0.552803	11.13345	1.573412	0.790208
LAKEVOLD BD4	NOV04C044	2.3472	0.550491	11.11081	1.565325	0.766357

Table 5.2. Results of testing from the black roof stain samples from Cave 1; note the relatively high percentage of carbon in each sample.

5.3 Routes in the Cave

Another observation that was made while excavations were being carried out in the cave is the presence of "smooth spots" on some of the rocks. These spots are very polished, shiny, smooth and rounded, and located on the edges of some of the rocks or, in some cases, on the top. There was speculation as to how these smooth spots would have been created and if they relate to human occupation of the cave. Figure 5.10 shows the location of these smooth spots and plates 5.1 to 5.4 show close up photographs of some of these spots.

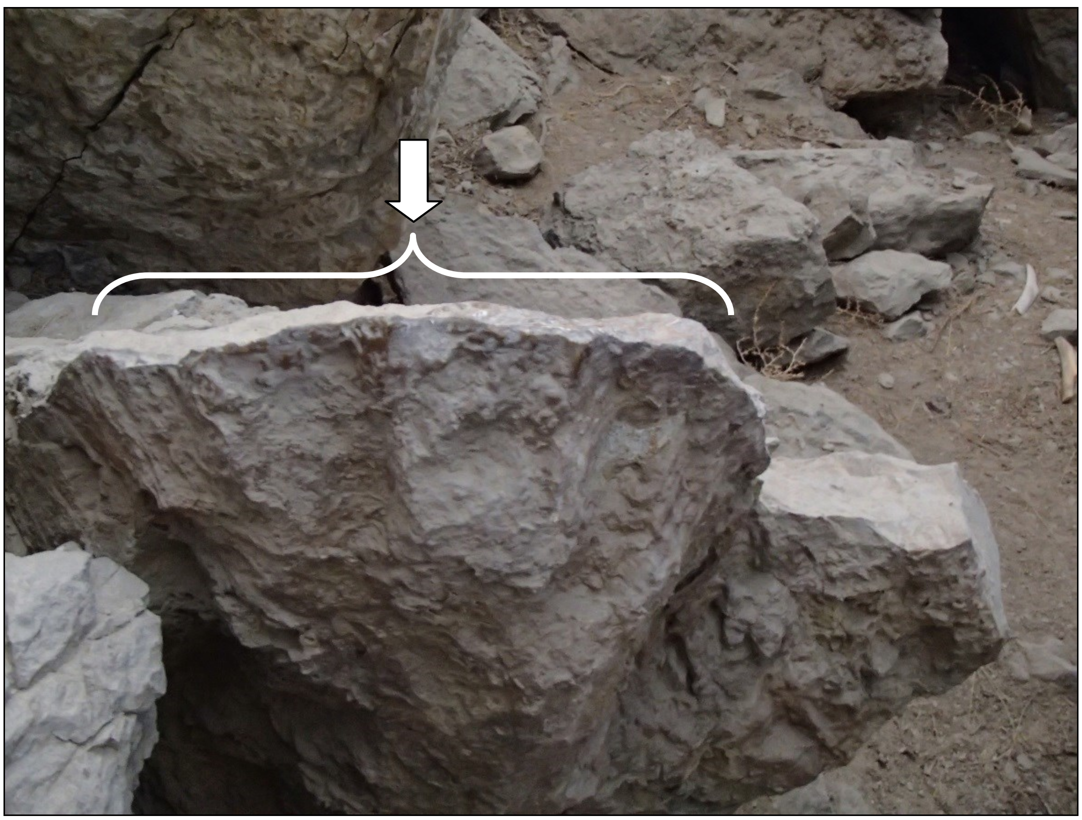


Plate 5.1. Smooth spot at location SS13 on the east side of the cave at entrance to Area B.

Plate 5.2. Smooth spot at locations SS15 and SS16 on the east side of the cave. This is the main access to Area B and is the step people would have used over and over again.

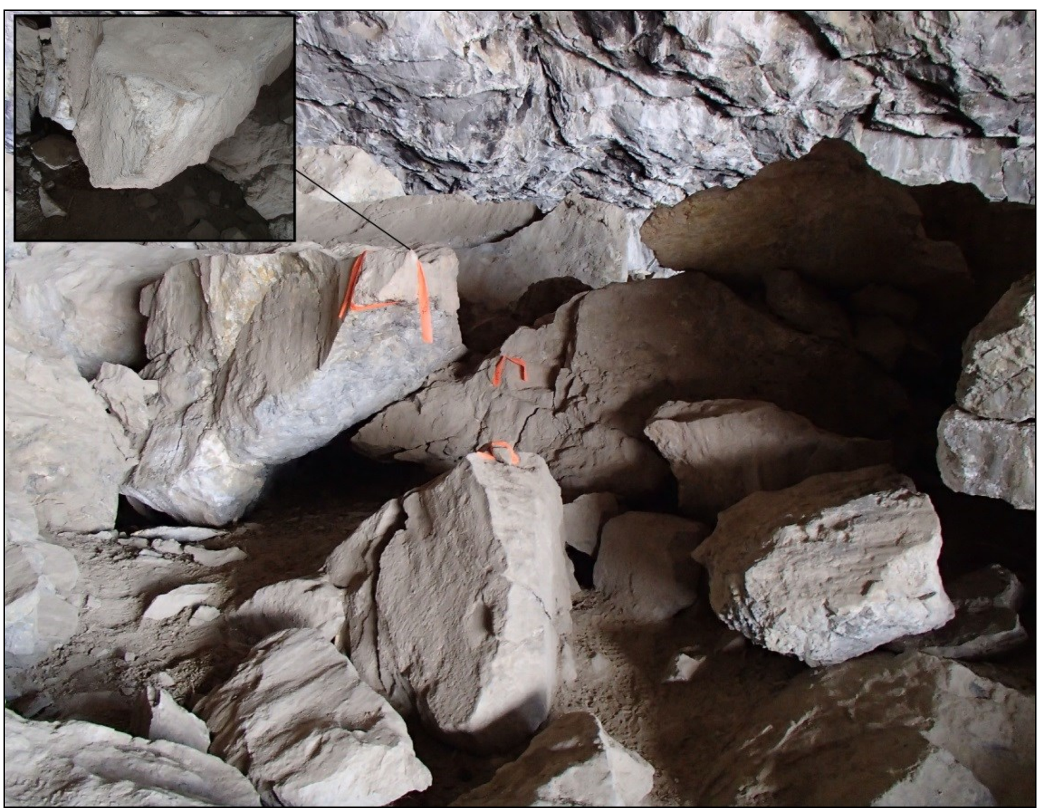


Plate 5.3. Smooth spots SS2, SS3, and SS4 in central rockfall area, with close up of SS2.

Plate 5.4. Smooth spot SS10; this pattern of smoothing is different than the areas used for access. It may be the result of other activities, such as rubbing hides or other material back and forth over the rock.

The locations where these smooth rocks were noticed immediately is from points labeled 11 to 16 (Figure 5.10) on the east side of the cave. This location is where access to the east side (Area B) of the cave is gained. It requires stepping down an opening between the rockfall and the wall of the cave. There are natural steps and handholds on the way down and up and it was observed that most of us used the same rocks for stepping and grabbing repeatedly. These were also the locations where the rocks were smoothed out and polished. It is not hard to imagine that the Promontory people would have used the same route in and out of Area B. With the recurrent rubbing of the rock from feet, moccasins and hands, smoothing of the rock likely occurred. This area had the most obvious smoothing and polishing. The cave was surveyed for other areas where the rocks had been smoothed to see if insights could be gained into how people traveled through the cave. Seventeen locations were recorded in total (Figure 5.10).

Least cost path analysis was carried out to see what the paths of least resistance would be for getting from one area of the cave to another. The floor data that was collected during the 3D scan was separated from the rest of the data using a program called ZBrush. The data was cleaned up and exported to a x,y,z file. These data were brought into ArcGIS and georeferenced to line up with the arbitrary datum that was used for the rest of the spatial data in the cave (the excavation location, datums, roof samples, smooth spots, etc.). From here, a surface was created using the Inverse Distance Weighted (IDW) interpolation tool. Through a series of several more steps, including creating a cost distance raster from each location, least cost paths were calculated from several locations in the cave. Figure 5.10 shows the result of the least cost path analysis.

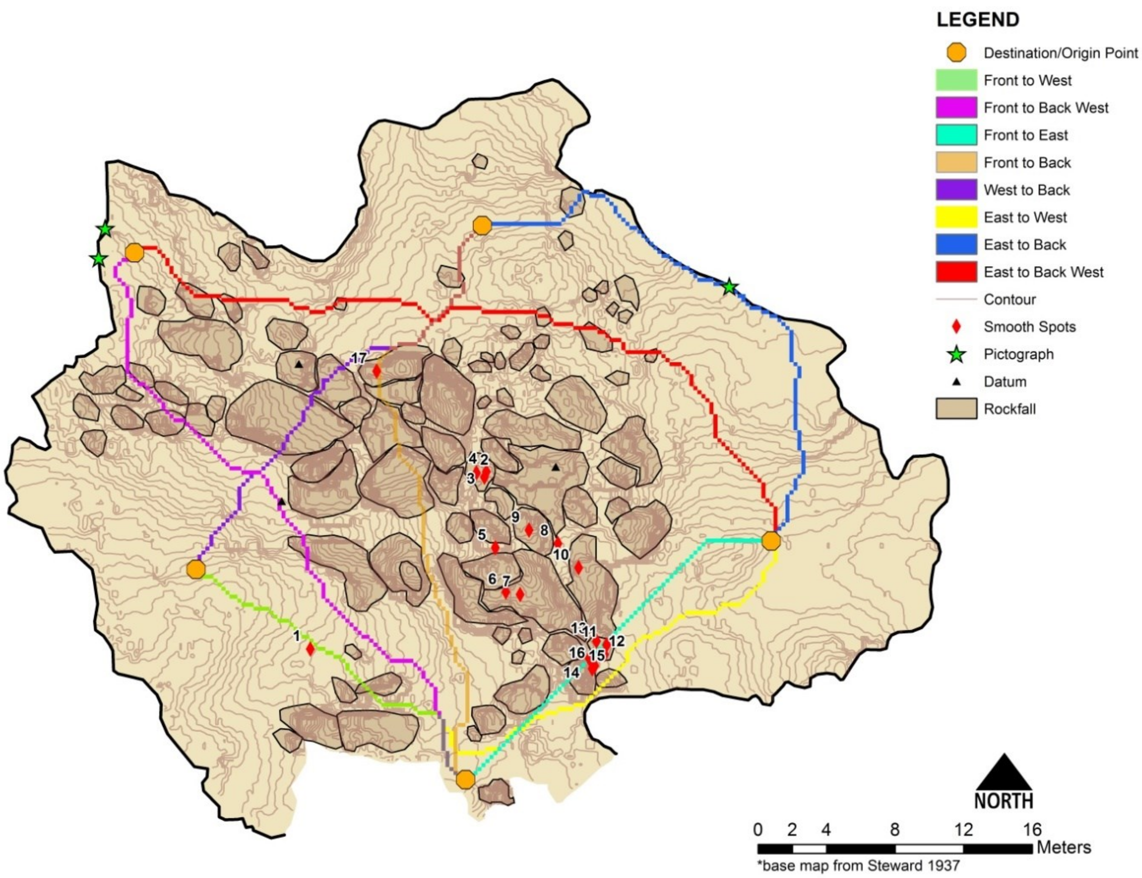


Figure 5.10. Locations of smooth spots and least cost paths from several different locations in Cave 1. Each line represents the most efficient route from one point to another.

Not surprisingly, the smooth spots recorded on the east side are crossed when the route is calculated from the front of the cave to Area B to the east. This is the route that we used while working in the cave. The smooth spot labeled as 17 is crossed when analysis was done from the front of the cave to the back. This was the approximate route that we also used while working in the cave. Smooth spots 2 to 10 are not crossed by the least cost path analysis. This area of rockfall is a bit more difficult to cross and required more climbing, which means that, in the computer model, these rocks would "cost more" to cross. Therefore, most of the routes calculated in GIS go around the rockfall as much as possible. However, while working in the cave, when we chose to traverse the rockfall instead of going around, we traveled through the area indicated by these smooth spots. The area labeled with 2, 3 and 4, in particular, was a good area to step up to access the top of the large rock on which the datum is located. It is difficult to say what the smooth spots labeled 5 to 10 represent, as it was not an area we traveled through a lot and it is not crossed by the least cost path analysis, but maybe it was used more during the Promontory occupation. Children may have used these areas for playing games, running around and hiding. Alternatively, there may be another explanation for some of these smooth spots such as natural wearing down from cave drip. Or, perhaps the edges of these rocks were used for other activities such as hide processing. Some of these spots would possibly make for good softeners by running the hide back and forth over the edge of the rock. The smooth edges at SS10, shown in Plate 5.4, are a possible example of an area that hides could have been run across. The location of this rock is not one that would have been used much for access, and the angle and shape of it doesn't make it very easy to step on. This suggests that the smoothing may be a result of other activities, or caused by a natural process occurring in the cave. This idea might be explored further in the future.

5.4 3D Laser Scanning and Model

In 2013 point cloud data for Cave 1 was collected by M2 Technical Services Inc. using a Leica 3D scanner. Approximately 1.1 million x, y, z points were recorded from three different scan stations. This scan data provided a very accurate map and reconstruction of the cave that allowed some spatial analysis to be carried out more accurately. It also illustrates the shape and size of the cave more effectively than manual maps and photographs, especially the dominant cathedral ceiling.

One of the most important aspects of this scan was to get an accurate measurement of the floor area and a measurement of the areas in the cave that are relatively flat and aren't impeded by low roof heights, shown in Figure 5.11 as livable space. These flat areas with a high enough roof are likely the areas that people would have regularly occupied, versus trying to carry out activities on the jagged rockfall. The 3D scan of the cave allowed the floor area of these locations to be calculated. The floor area of the entire cave was calculated to be 1301 m^2, but as illustrated and discussed above, a large portion of the cave is obstructed by rockfall. People may have walked on the rockfall to get from area to area, or used some of the larger rocks to sit on while visiting or carrying out other tasks, but it is not an area suitable for most activities that take place in a typical dwelling. This is also evidenced by the fact that few to no artifacts were found in this portion of the cave. In addition to the rockfall area, habitation of large portions of the outer perimeter of the cave would be limited by low roof heights.

Using the 3D scan to eliminate these areas deemed unsuitable, the "livable" area of the cave was calculated by Scott Ure of Brigham Young University to be 449 m^2 (Figure 5.11). Area A, at the mouth of the cave, has a "livable" area of approximately 155 m^2, Area B on the east side of the cave has a "livable" area of 193 m^2 and Area C at the back of the cave has a "livable" area of 101 m^2. However, the total area that may have actually been occupied is further refined in section 5.6, with the areas of actual cultural deposition taken into consideration.

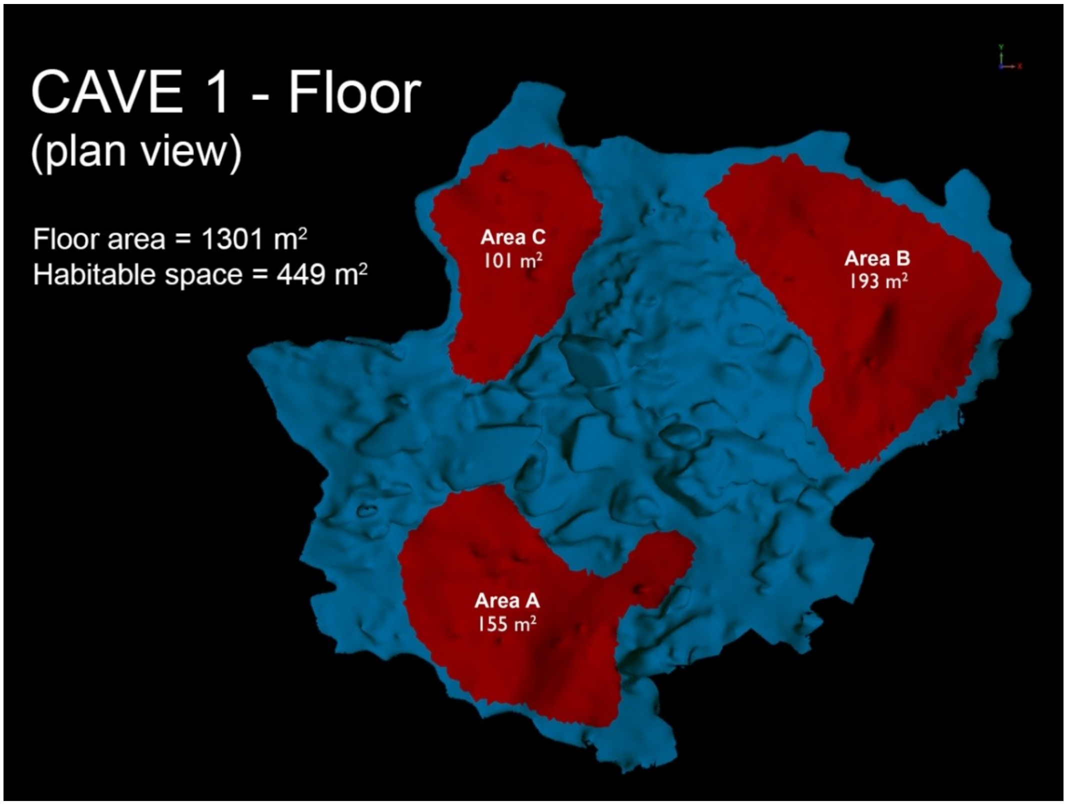


Figure 5.11. Areas of flat, livable space in Cave 1 as calculated from the 2013 3D scan data (figure courtesy of Scott Ure, Brigham Young University).

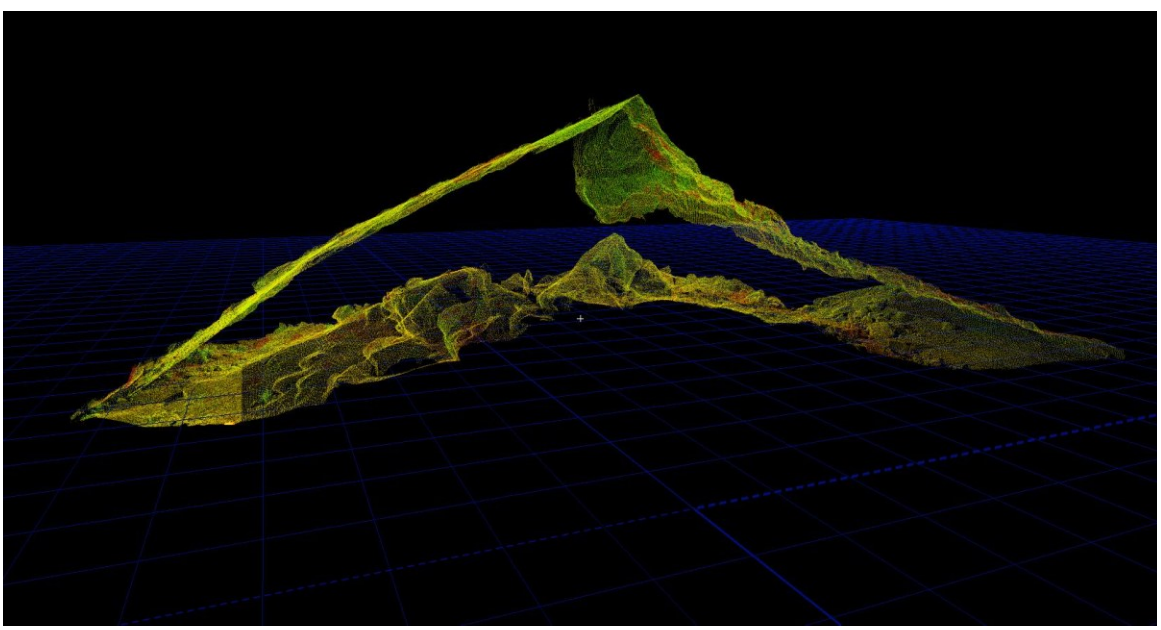


Figure 5.12. 3D scan cross section of Cave 1 showing the shape of the cave and the high cathedral-like ceiling.

5.5 Promontory Cave 1 Group Size

Combining the area data calculated by Scott Ure from the 3D scan (discussed in section 5.4) with the average space needs per person values obtained in chapter four allows the approximate number of people that could have occupied the cave to be calculated. Area C at the back of the cave has very few artifacts; this may indicate that it was not used as a living space. This will be taken into account in these calculations, in which some calculations will include this area and some will exclude it.

Chapter four explored space needs per person of several different Western North American hunter-gatherer groups; these values are based primarily on ethnographic accounts but also some archaeological data. The values obtained for each group varied somewhat, but the overall average space needs per person of Western North American hunter-gatherer groups was calculated to be 4.24 m^2. Combining this figure with the livable area value calculated above can give an approximation of how many people may have occupied the cave at one time. With a total livable area of 449 m^2 and a space needs per person value of 4.24 m^2, the maximum number of people occupying Cave 1 is 106. However, in common group sizes and hierarchies seen among hunter-gather groups worldwide, this number falls between an aggregated group or tribe (Binford's Group 2), and a group that periodically aggregates (Binford's Group 3) (Table 4.1). Given that the archaeological evidence shows a group inhabiting this cave relatively permanently for one to two generations it seems unlikely that it would be a periodic aggregation. This means it is more likely that the actual number of people inhabiting the cave at one time would be smaller than 106, leaning towards the aggregated group, tribe, or regional band whose average worldwide number is 54 people (Table 4.1).

As mentioned above, Area C at the back of the cave has very few artifacts, suggesting that it wasn't used as a dwelling area, at least not like Areas A and B were. If that area is excluded from the calculation, as well as portions of Area B that do not have cultural deposits, then the livable area value drops to 239 m^2. The portions of the cave that contained cultural material were mapped by Jennifer Hallson during the 2014 field season which has allowed the definitively inhabited area to be refined even further than with just the 3D scan (Figure 5.14). With an average space needs per person value of 4.24 m^2 and a livable area of 239 m^2, this would take the maximum number of people down to 56.4, which brings the value, almost exactly, to the worldwide aggregated group value of 54.

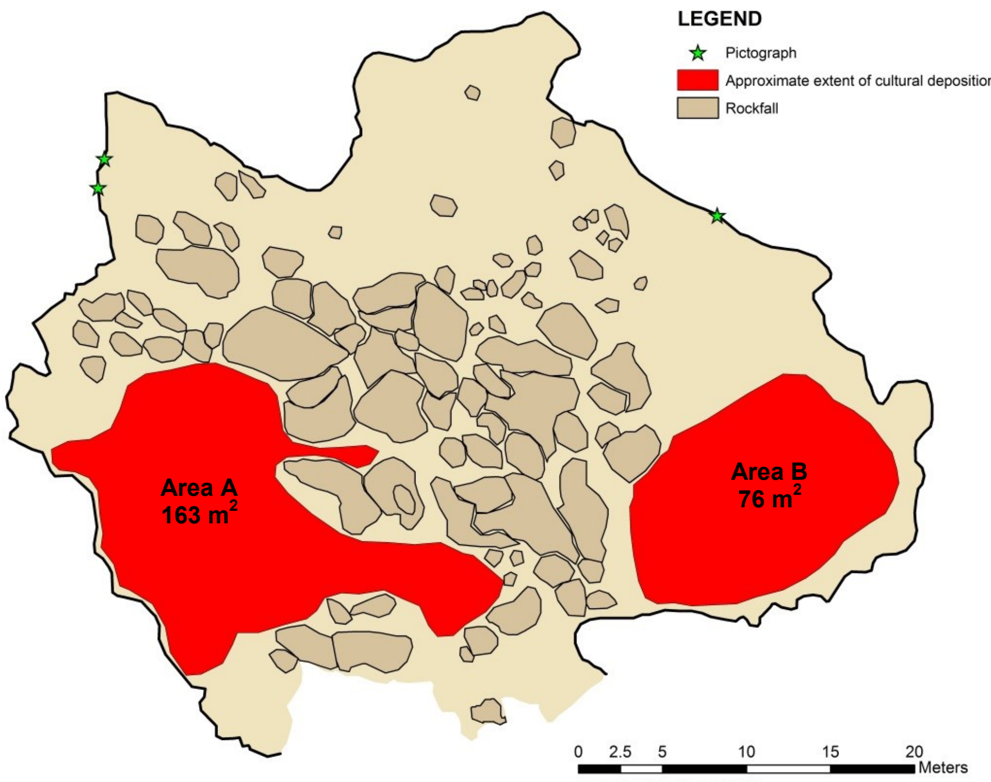


Figure 5.13. Areas of Promontory Culture deposition or the "livable area" (mapped by Jennifer Hallson).

Another factor to consider is that the material culture is quite possibly from ancestral Athapaskans (Steward 1937; Ives 2014). If we consider Athapaskans only, the space needs per person value is a bit higher at an average of 6.31 m^2. Space needs per person values used by Casselberry (1974) and Brown (1987) are also approximately 6 m^2 so, while I am using this value because it is close to Athapaskan averages, it is also relevant for other hunter-gatherer groups. With 239 m^2 of definitively inhabited space and the Athapaskan space needs per person value, the maximum number of people inhabiting the cave would lower to 37.9 (Table 5.3).

	Space Needs Per Person (square metres)	Livable Area in Cave 1 (square metres)	Group Size (Livable Area/Space Needs)
Western North American Hunter Gatherers	4.24	*449	106
Western North American Hunter Gatherers	4.24	**239	56.4
Athapaskans	6.31	**239	37.9
*Livable area calculated from 3D scan where occupation of cave is not limited by rockfall or low roof heights **Livable area based on actual extent of Promontory cultural material			

Table 5.3. Promontory Cave 1 Group Size Calculations

It is important to remember that the numbers above represent the maximal extent of the inhabited area in the cave, and that calculations based on that maximal extent of the occupied area reflect the maximum size of the group occupying the cave. These maximal values fall in the microband or small macroband size range, but the initial group occupying the Cave may not have been this large and would be more difficult to detect archaeologically. Because many facets of the Promontory record suggest that this was an intrusive occupation, smaller scouting parties or task groups may have been the first Promontory cave inhabitants. Logically, an initial residential group could also have been smaller and then grown through the 20 to 50 year occupation. Hallson's (2017) accumulation studies have shown the entire amount of cultural material in the cave could not have been produced exclusively by small groups (a single family, hunting party or small residential group), but such groups could very well could have been some of the earliest occupants. From the accumulation perspective, Hallson (2017) has shown the various group sizes and durations that have modal values of approximately 20 to 25 people and ten years of cumulative seasonal occupation will yield the amount of artifacts we see in key categories like moccasins, hide processing implements and weaponry. Correlatively, consistent longer term occupation by more than 50 people would soon produce too much material to fit the Cave 1 circumstances (Hallson 2017). So, the group may have started out smaller, at the size of a dispersed group, band or Binford's Group 1, which is commonly made up of 15 people (table 4.2). It might through time have grown into a group of 25 to 30 and then, finally, may have reached the maximum size of 35 to 50 people calculated here. At this point, the Cave 1 inhabitants would have threatened to outgrow the cave and would either have needed to split into smaller groups or move elsewhere.

There are indications of changing group size through time in the excavation data. Radiocarbon dates (Figure 2.8) indicate that the front midden portion of Area A seems to have come into use during the midrange of dates for the Promontory Culture in Cave 1, when the depression is first filled in. Later occupation then occurs above it. The dates for Area B also suggest that it was not used intensively until a bit later than the initial onset of occupation (Figure 2.7). If Area B wasn't used heavily initially, and only portions of Area A were in use, the total cave area utilized by the group may have been lower, perhaps around 120 to 150 m^2. This extent of occupation would result in a group size of 20 to 30 people, consistent with Hallson's (2017) estimates. Because later radiocarbon dates are widespread over Areas A and B, it is possible that the maximal extent of occupation took place later in the Promontory Culture record, and therefore that inhabiting population was at or near the comfortable human capacity for Cave 1.

5.6 Promontory Cave 1 Group Composition

In addition to group size, ethnographic data can also tell us something about group composition. Given that the maximum group size (56 people based on livable space and the average space needs per person of Western North American hunter-gatherer groups) matches the universal averages closely, it is also likely that the group composition followed universal patterns of hunter-gatherer groups. Throughout chapter four, where possible, family and household size and composition were noted among Western North American hunter gatherer groups. The average family size is commonly four to five: a man, his wife, and two or three children. The household is often larger because it was made up of the nuclear family along with several relatives such as grandparents or single siblings, which brings the number up to about 8 to 9 people per household. Or, one household could be made up of two or more families (chapter 4; sections 4.5 to 4.9). These common patterns of family and household makeup can be applied to Promontory Cave 1.

The Promontory Cave moccasins also indicate something about group composition. Billinger and Ives (2015) used the moccasins Steward collected from Caves 1 and 2 (about 250 moccasins) as well as the 40 whole and fragmentary moccasins recovered from 2011-2014 in order to study the relationship of moccasin size to foot size and stature. They were able to calculate stature from foot size, obtaining results that were quite consistent with ethnographic data in which both foot length and stature had been recorded. After calculating the stature for each moccasin they were then able to predict the age for individual moccasins, based on anthropometric data from Franz Boas and other research. These results were accurate for children and subadults, and for large adult males, with a gray area in determining young adult males from adult women. The results they obtained indicate that, of the 207 individuals represented by the moccasins with complete lengths, 12 of these were definitively adult males (with a stature of over 165 cm), 25 were a combination of adult females and adolescent males and the other 170 were subadults (individuals under the age of 12). These data suggest that the Promontory population included a large number of children, from which one might infer that they were a growing group (Billinger and Ives 2015). Billinger and Ives (2015:84) also note that "the demographic structure of the population arriving in the caves was relatively constant throughout the Promontory occupation."

If the group in Cave 1 was made up of approximately 50 to 60 people, several models of group composition for the Promontory Cave 1 inhabitants can be explored using the common patterns for family and household composition observed in the ethnographic data. The first model of group composition is the "single family household model." This model is based on a nuclear family (a conjugal pair plus their children) combined with adult relatives such as grandparents or unmarried siblings. Each family plus their adult relatives would equal one household. Table 5.4 shows the average household size for each group and the overall average household size for Western North American hunter-gatherer groups. Using the average household size of 7.81, the number of households in a group of 56 people would be about seven. This means the group composition could look something like: seven adult males (the fathers of the nuclear families), seven adult females (the mothers of the nuclear families), plus their children which could range in number from 14 to 21 (using the average of 2 to 3 children per family), but could be higher or lower. The remaining individuals (21 to 28 people) would likely be a combination of elderly adult males or females or young (subadult) males or females that are unmarried siblings of either the mother or father. Because each household would likely have a higher number of adults, this model of group composition would be made up of a larger number of adults than children.

If this same single family household model is applied to Athapaskan groups, the ratio of group composition would remain the same, with more adults, but the numbers would be lower. With a group size of 35 to 40, and an average Athapaskan household size of 9.36 (table 5.4), the number of households in the cave would be closer to four. The group composition might then look something like: four adult males (the fathers of the nuclear families), four adult females (the mothers of the nuclear families), plus their children which could range in number from 8 to 12 children (using the average of 2 to 3 children per family), but could be higher or lower. The remaining individuals (17 to 21 people) would likely be a combination of elderly adult males or females or young (subadult) males or females that are unmarried siblings of either the mother or father. Again, there would be a higher number of adults than children.

Group	Average HHSZ
Athapaskan	9.36
Algonquian	7.34
Plains	8.9
Great Basin	4.75
Apachean	7.81
Average	**7.63**

Table 5.4. Average household sizes (HHSZ) of Western North American hunter-gatherer groups.

The second model of group composition is the "multi-family household model" and is based on two or more families in one household. Each family would be made up of a man, his wife and their children. This composition would look quite different than the first model. In a group of 50 to 60 people, representing approximately seven households (based on the average household size for Western North American hunter-gatherer groups, table 5.4), the composition might look something like: 14 adult males, 14 adult females and anywhere from 28 to 42 children, plus perhaps additional adults representing grandparents or unmarried siblings or relatives. These numbers are based on two families per household, but there could be more families in each household. This type of group composition would consist of quite a few more children. The drawback with this model is that the numbers do not leave a lot of room for the presence of other relatives (grandparents, unmarried siblings, etc.), who would, no doubt, be present.

If the multi-family household model is applied only to Athapaskans, the group composition for a group of 35 to 40 people in four households might look like: eight adult males, eight adult females and anywhere from 16 to 24 children. Again, these numbers are based on two families per household.

The moccasin data indicated that the Promontory group may have been growing: 8.2% of the population were small children (under five years old), 37.2% were children five to nine years old, and 36.7% were 10 or 11 years old. This works out to 82.1% of the population being under the age of 12 (Billinger and Ives 2015). If this is the case, the average number of children per family would have to be much higher than two to three. Also, when we calculate 82% of 37 or 56, the number of children is substantial. In a population of 37 (for Athapaskans), the number of children would be 30, meaning there would only be seven people over the age of 12, which is highly unlikely. In a group of 56 people (Western North American hunter-gatherers), 46 would be children, leaving 10 individuals who are over the age of 12, also unlikely. This would also mean that the average number of children per conjugal pair (10 adults, equaling 5 conjugal pairs) would be nine, significantly higher than the universal average of two or three children per conjugal pair for Western North American hunter-gatherer groups.

One explanation for this would be a factor that Billinger and Ives (2015) mention, bias in moccasin discard. Adult males would be much more likely to discard their moccasins in locations outside the cave while on hunting or scouting trips, and it is possible adult women also discarded moccasins away from the caves. This would result in an underrepresentation of adults in the moccasin counts, especially men. It remains entirely possible that both factors operated: the population in the cave did have more children than average, but discard bias had significant effects too. It is also important to consider that the average family sizes calculated in chapter four are largely based on ethnographic accounts, a time when these groups may have lived a different lifestyle than prior to European contact, and had been previously affected by severe epidemics. It may have been that people in these groups commonly had more children in the past. One more factor to consider is the possibility of the practice of polygyny, in which one man would have more than one wife. This practice would also increase the possible number of children versus adult males significantly.

The ethnographic data explored in chapter four shows several accounts of polygyny, including Plains groups such as the Arapaho, the Hidatsa and the Mandan (Conaty and Beierle 1999; Sturtevant 2001), the Shoshone of the Great Basin (Eggan 1980; Steward 1941) and several Athapaskan groups. Sharp (2001) noted that polygyny was practiced among the Chipewyans, an Athapaskan group, and it caused family sizes to range greatly within this group. A single family could occupy one dwelling, or a husband with several wives and their children might occupy several dwellings. Ridington (1968) demonstrated in his work that the Beaver Athapaskan groups also practiced polygyny, and Dyen and Aberle (1974) determined through their work on Proto-Athapaskan kinship that polygyny was practiced by the earliest Athapaskan populations.

Polygyny was not uncommon in the Western North American hunter-gatherer group data and there is a possibility that the Promontory Cave 1 group followed this practice. It certainly would account for the large number of children's moccasins versus adults. If the group in the cave was practicing polygyny, the size of each family or household could range quite a bit. The group composition would consist of a man, his wives and their children. If each wife had the universal average of two or three children, the number of children in the group would be high. However, the overall group composition would likely still be made up of several households.

As mentioned in section 4.4.1 in chapter four, another way of looking at group composition among some Dene groups was a local group made up of a group of brothers married to a group of sisters. In this case the children of the founding sibling core would be siblings as well, which would force local group exogamy (Ives 1990; 1998). In other cases, the local group was idealized as a group of brothers and sisters married to a group of brothers and sisters. In these cases, first generation cross-cousins were able to marry, allowing group endogamy. It was noted that variability could occur in these group compositions (Ives 1990; 1998).

Given that the moccasin data indicates a high number of children were present in the cave, the second model of group composition (multi-family households) is more likely, in which two or more families made up one household. The high number of children also leaves the door open for the possibility of the practice of polygyny. One thing that is common in each of these group composition models is the likelihood that several households made up the core group living in the cave. Based on common practices of most groups, it is also more than likely that this core group was tied together through kinship.

5.7 Dwelling Models

Even though the cave is not a traditional dwelling type, it would not be unusual for people to organize space in the cave much the same way as a traditional built dwelling. The way they carried out activities, and social norms, would dictate a certain organization. The basic model of dwelling organization among Western North American hunter-gatherer groups was laid out in chapter four. This model (Figure 5.14) is characterized by a central hearth, most often just one doorway (usually facing east), storage space next to the door, public space upon entrance where communal activities such as cooking and eating took place, and sleeping areas arranged around the perimeter of the dwelling. If there is a sacred space, it is located at the back of the dwelling, usually opposite the entrance. In dwellings that have divisions of space, there is often a men's half and a women's half. Most of these groups also laid down coverings on the floor: willow, pine or spruce boughs, mats, or hides. This basic model can be applied to Promontory Cave 1 quite nicely.

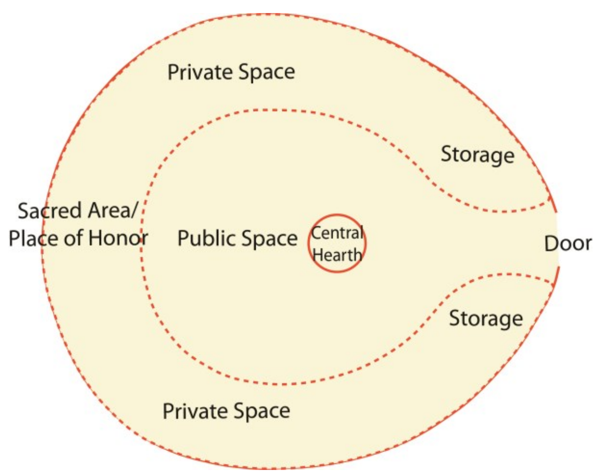


Figure 5.14 Basic Dwelling Model of Western North American Hunter-Gatherer Groups.

Based on the basic model of built dwellings and the areas of cultural material deposition (Figure 5.13), two models of space use in the cave are presented below. These are identified as the "One-Dwelling Model" (Figure 5.15) and the "Two-Dwelling Model" (Figure 5.16).

One-Dwelling Model

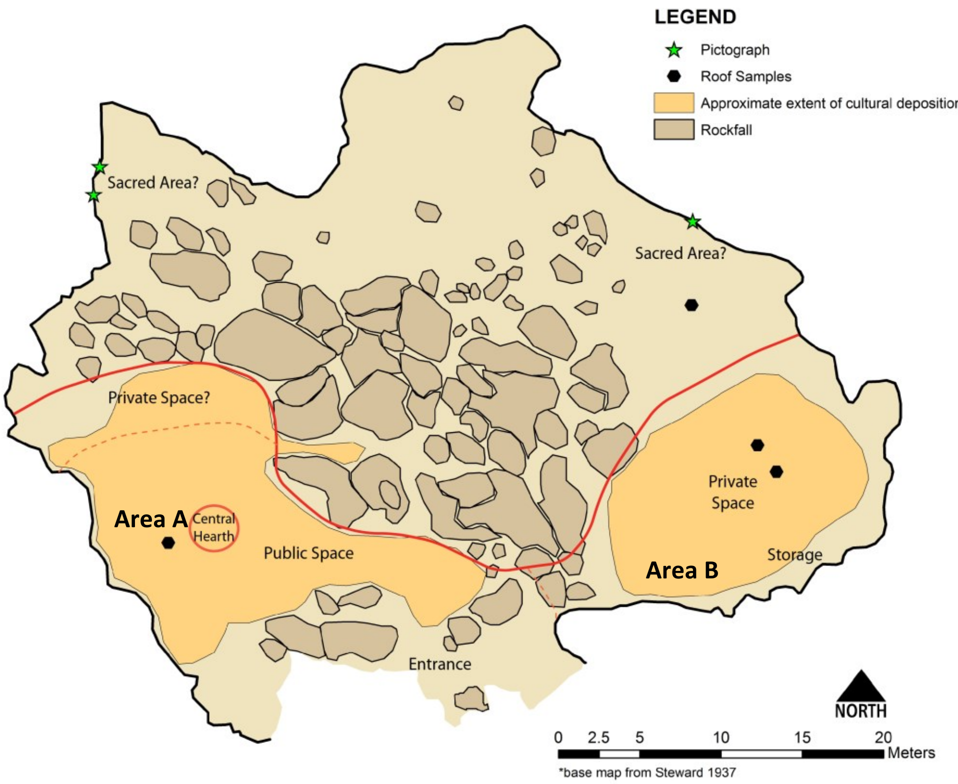


Figure 5.15. The "One-Dwelling Model": Possible layout if Area A and Area B (the areas with cultural deposition) were occupied as one large dwelling.

Figure 5.15 shows the possible layout of the cave if it was occupied as one dwelling. This analysis focuses only on the areas that contain Promontory Culture material – Area A and Area B. Steward's excavation data, as well as data from the most recent excavations, has revealed that deposits of cultural material are denser and more diverse in Area A (Hallson 2017; Steward 1937). Excavations at F3 have also been interpreted as a midden because the deposits are more than two metres deep (significantly deeper than deposits in the rest of the cave) and the material within it is somewhat mixed. The large amount of material in this midden suggests that Area A was heavily used, and for many activities that are considered public, such as cooking and eating. Steward (1937) also mentioned a large central hearth in this part of the cave. These excavation data support the idea that Area A could be considered public space, while Area B, which had lower artifact density and diversity, would be private space. Area A could have been utilized as the main activity area where larger groups of people gathered, food was prepared and cooked, and socializing took place. This would leave Area B as a more private space, used for sleeping and perhaps storage. One problem with this model is that there is roof staining from fires in Area B, so it is possible that this area was also used as public space at times. However, given how dark the cave gets, it is also plausible that fires could have been used to provide light in this area.

Two-Dwelling Model

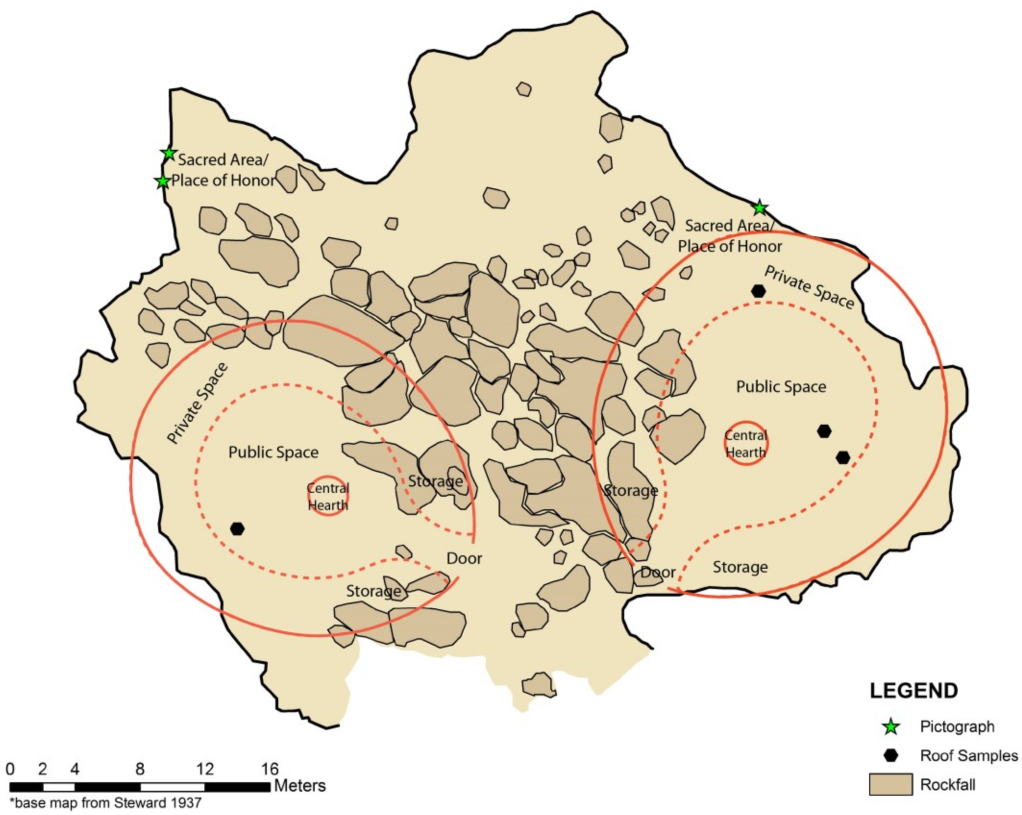


Figure 5.16. The Two-Dwelling Model: Basic Western North American hunter-gatherer dwelling model overlain on each Area A and Area B in Cave 1 to show possible organization of space.

Focusing again on Areas A and B (the areas with cultural material deposition), the Two-Dwelling Model treats these two areas as separate dwellings. Figure 5.16 shows the basic model of Western North American hunter-gatherer groups imposed on top of each Area A and Area B. The model fits over each side quite nicely, and the excavation data and roof staining mesh well with this model. Most notably, both of these areas can be accessed directly from the outside and are separated quite distinctly by the central rockfall, meaning that they both have somewhat distinct "doorways." Both areas have been excavated and the types of artifacts that come from each are similar; however, the density and diversity of artifacts from Area A are higher (Hallson 2017). However, the artifacts found in Area B are still representative of a variety of activities (including potentially gaming, as evidenced by the presence of cane dice). Additionally, black staining on the roof in Area A and Area B provides evidence of fire, as well as Steward's (1937) mention of a large, central hearth in Area A. Fire in both of these areas suggest that each area may have had their own central hearth, a feature that is more often than not associated with public activities.

The location of the central hearth that Steward (1937) mentioned was located in his Trench A area. He said that "here and there is evidence of fire, and at one point is the main fireplace, which, however, lacks special form….is 2 feet deep and evidently was used during the whole period of occupation" (Steward 1937:9). In the Two-Dwelling model, the hearth in Area A is located about six metres east of the black staining on the roof, and close to Steward's Trench A, which did have evidence of fire. In the One-Dwelling model, the hearth is only about two to three metres east of the black staining, also in the Trench A area. While these are just models, the expected location of the central hearth is relatively close to this black staining in both. It is also expected that the hearth could be located anywhere in this central area within these models, so it could have been located even a bit closer to the staining. Even it if was not right under the area of staining, with just a few metres of drift, it is possible that the smoke would have hit the roof at that location. This also applies to Area B, in which the expected hearth location in the model is only about five to six metres west of the black staining. Again, there is flexibility in the actual location of the hearth, but some drift from the smoke could also result in the roof staining being located where it is.

There is one point of access into Area B; a small opening in the rockfall on the edge of the east side of the cave. Evidence that this opening was used regularly is made apparent by the smoothing of the rocks in areas where people would have stepped or climbed up and down (see section 5.3 above). Area A has two points of access, one on the far western portion of the cave opening and one in the central part of the mouth of the cave (the area between these two openings is blocked by a few large boulders). The mouth of the cave is south-facing, meaning the "doorway" is facing south, but in this natural environment occupants would not have been able to choose which way the "door" was facing. A south-facing cave entrance is actually quite favourable, as it would allow for the maximum amount of sunlight to enter the cave, providing light and warmth.

The next aspect of the model is the location of public space upon entrance, where communal activities took place. Excavation data in the cave certainly show public activities taking place in the central portions of these two areas. The location of storage and sleeping areas in the cave is unknown, as there are still large parts of it that have not been excavated, but it is not unreasonable to think that these also follow the norm of storage spaces located close to the doorway and sleeping areas around the perimeter. It is possible that the nooks and crannies in the cave were used for storage, but this idea has not been tested.

The last aspect of the layout is sacred spaces located at the back of the dwelling. While it is unknown if the rock art in the cave is associated with the Promontory Culture occupation, the placement of it at the back of the cave on each the northeast and west walls also fits well with the basic model of dwelling layouts. Even if the rock art was not created by the Promontory occupants, it may have still influenced them and how they organized space. Copeland and Rogers (1996) noted that the Navajo would sometimes put their rock art near, or on top of, existing Anasazi rock art. These locations were "treated in the same manner because they were already charged with power and sanctified by their association with the ancients" (Copeland and Rogers 1996:226). Likewise, even if the Promontory group did not create these rock art panels, they may have still viewed these areas as spiritually or ceremonially significant and organized their space accordingly. Given that very little material culture is found in the back portions of the cave, in contrast to the thousands of artifacts found closer to the front, the rock art may have deterred people from occupying the back portions of the cave.

5.8 Space Syntax Analysis

Space Syntax Analysis of Cave 1, like most of the dwellings analyzed in chapter four, indicates a very basic layout of space. There is lack of evidence for physical barriers having been constructed within the cave, a factor which means that the identified livable areas would likely have been occupied as large, open spaces. However, the rockfall in the centre provides a physical barrier between these identified livable areas, so there was some natural separation of space in the cave. Figure 5.17 below shows space syntax analysis applied to Cave 1.

The mouth of the cave is the only entrance and exit point. From here (0), two areas can be accessed separately, labeled as '1' (Area A) and '2' (Area B) in the space syntax figure. Based on material remains, these were the two areas that were most heavily occupied. These two areas are distinctly separated by the rockfall and, as evidenced by smoothing of the rocks (illustrated in section 5.3 above), the area labeled as ‘2’ (Area B) was accessed directly from the outside on the east side of the cave.

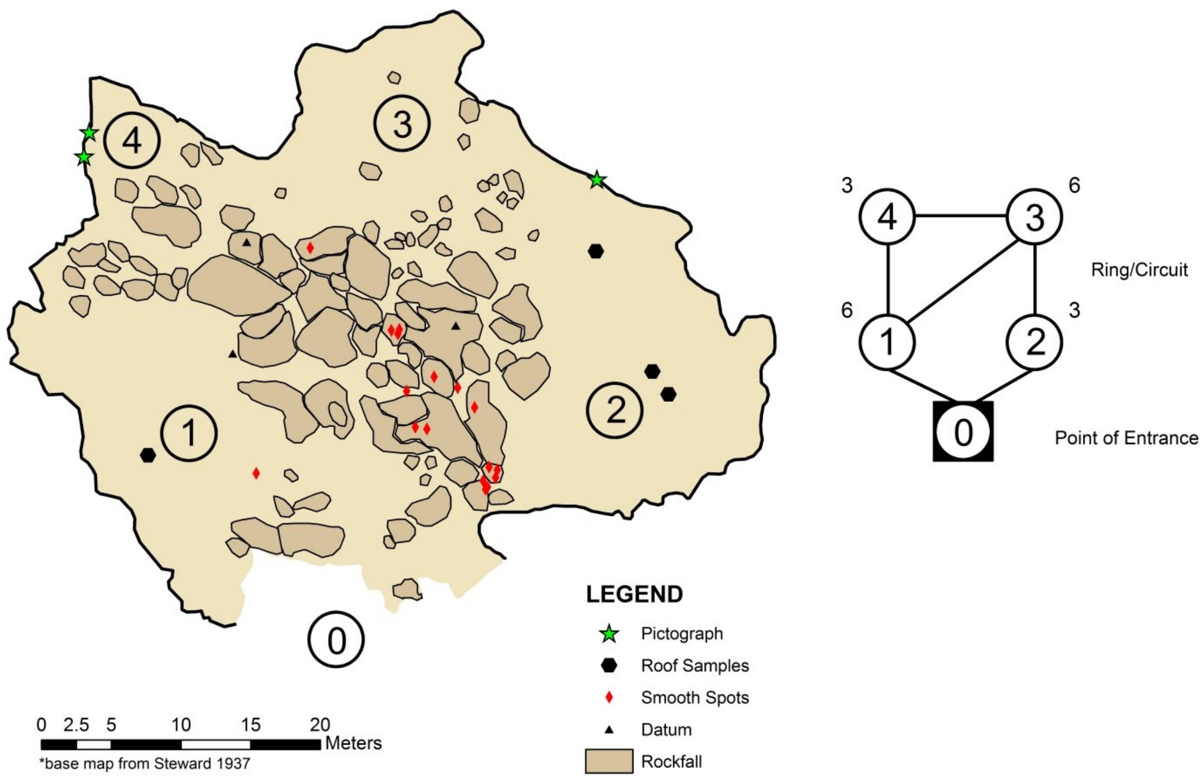


Figure 5.17. Space syntax analysis of Promontory Cave 1.

Even the sound between these two areas is compartmentalized, with sound not traveling well between area ‘1’ (Area A) and area ‘2’ (Area B) (section 5.1). The area in the back of the cave, labeled with a ‘3’ (Area C) in the space syntax map, can be accessed directly from area ‘2’, with few physical barriers between these two spaces. Area ‘3’ can be directly accessed from area ‘1’ as well, with a bit of climbing over the rockfall. Area ‘4’ (Area D) can be accessed from areas ‘1’ and ‘3’, also with some climbing. Areas ‘2’ and ‘4’ could be accessed by climbing over the rockfall but this route is a bit more of a challenge and likely would not be a commonly chosen route when going through areas '1' or '3' would provide much easier access. Because of this, that connection has been left out of the space syntax analysis.

The rockfall provides a challenge for space syntax analysis. There is evidence that people traversed it (the smooth spots and the fact that we often used it as a travel corridor) but it is unclear exactly how people would have used this space. It is "communal" or "public" space in the sense that it is accessible from all areas, but it is not really a gathering space for groups or families. Therefore, in the space syntax analysis, the rockfall area is treated like a hallway or corridor rather than a 'room'. There were very few artifacts found in this area and, due to the roughness of the terrain, it is not considered livable.

According to the space syntax analysis, areas '1' and '2' and areas '3' and '4' are parallel (the same depth). The most accessible or highly integrated spaces are '1' and '3'. These can both be accessed from three points. When integration is calculated in AGRAPH, the values are six for areas '1' and '3' and three for areas '2' and '4' (Figure 5.17). Archaeological excavation has shown that area '1' was the most heavily used area of the cave, with over two metres of cultural deposition. This high integration value suggests that this space was more public and easier to access. However, much less material was recovered in area '3', so while it is a highly integrated space in the space syntax analysis, it does not appear to have been used much during the Promontory occupation. The lower integration values for areas '2' and '4' suggest that these spaces were a bit more private. There are multiple ways to access the different areas of the cave, and no areas of the cave are inaccessible. This makes the cave highly integrated, and several "rings" are created.

The space syntax analysis of the cave does not match any of the built dwellings perfectly. However, the positioning of activity areas, hearths and rock art are very comparable to the basic layout that we see in most dwellings, and particularly that of a conical lodge or tipi. If we treat areas ‘1’ and ‘2’ as separate dwellings, we see the entrance at the front, a hearth in the centre, public space around the hearth, private space around the perimeter and, if the rock art was present at the time of occupation, a sacred space at the back, opposite the door. Because these two spaces are separated so distinctly by the rockfall and in terms of sound, and have separate entrances, I think it is reasonable to suggest that they were treated as separate dwellings.

If areas ‘1’ (A) and ‘2’ (B) are treated as separate dwellings, the space syntax analysis becomes very basic and identical to that of many of the built dwellings analyzed in chapter four, in which there is public space upon entrance and then private space at the back. However, as also discussed in chapter four, the private space is often not distinguished by a physical barrier but a social barrier instead. While Cave 1 does have physical separation because of the rockfall, it could essentially be thought of as one big open space, so social barriers more than likely played a part in the separation of space in the cave as well. If we do think of areas ‘1’ and ‘2’ as separate dwellings (Two-Dwelling model shown in section 5.7), the social aspect of occupying and entering or exiting these areas would be important, since they are both within the cave, and Area A is traversed somewhat when accessing Area B. If we think of the cave as one large dwelling (One-Dwelling model shown in section 5.7), these social barriers would be different than if they were two separate dwellings.

5.9 Space in Cave 1 and What It Can Tell Us

It has been determined in the above sections that the main areas of occupation in Cave 1 were Areas A and B, located closer to the front of the cave. These two areas were shown through excavation data to have the most Promontory cultural material deposition, while the areas in the back of the cave had very little to no artifacts present. Due to the lack of material culture in the back portion of the cave (Area C), it is unknown what this space was used for. It is separated from the rest of the cave by rockfall, but it is still easily accessible and areas of it are quite flat and could be suitable for some activities. One disadvantage of this area is a lack of light, but it would be somewhat suitable as a sleeping or storage area. As noted in section 5.7, the presence of the rock art on the back walls of the cave may have led people to avoid this area or treat is as sacred space, meaning they wouldn't have been carrying out normal, everyday activities in the back portion of the cave.

How the Promontory group would have used the central rockfall area (Area D) is also uncertain. There is evidence of people traversing the rockfall (see section 5.3), but there is not much evidence of material culture here. Several of the large boulders are placed nicely for sitting on (with a good view), so they may have been utilized as sitting areas or as an area for children to play games.

The front half of the cave is distinctly separated into two areas, identified throughout this research as Area A and Area B. These two areas are separated physically by rockfall. Sound also does not carry well between these two areas (section 5.1). This separation is interesting, as it allows for options of spatial organization in the cave. Two models were developed for how space may have been organized in the cave (section 5.8), the One-Dwelling model and the Two-Dwelling model. Spatial organization can tell us something about group composition and, in turn, group composition can tell us something about spatial organization. This is where the space syntax analysis comes into play.

The space syntax analysis in section 5.8 shows that Area A and Area B are parallel (same depth). Both of these spaces are considered “shallow”, meaning a person does not have to pass through a lot of other spaces in order to access them. Shallower spaces are considered more public, while deeper spaces tend to be more private. However, space syntax analysis also shows that Area A is more highly integrated (accessible from multiple points) than Area B, which suggests that Area A is “more public” than Area B.

The space syntax analysis for Cave 1 (section 5.9) was closest to the Mistassini Cree winter house, shown in chapter four. The Mistassini Cree dwelling was a square dwelling with a central hearth and public area surrounded by separate rooms for four different families. If Promontory Cave 1 was occupied during the winter, as is shown in seasonality studies, this comparison becomes relevant (Johannson 2013). The Mistassini Cree families grouped together in the winter to occupy one dwelling, a practice that the Promontory group may have also carried out. The layout of the Mistassini Cree winter house is a bit more difficult to compare to the cave but, if each family in the cave did have their own space, they could have been separated by the natural rockfall into Areas A and B. Social norms may have also dictated some separation.

The space syntax analysis supports both dwelling models presented in section 5.8. It suggests that both areas are public and accessible directly from the outside. However, it also differentiates between Area A and Area B in terms of integration, suggesting that Area A is more public than Area B.

The One-Dwelling model is plausible, given that there is much more material culture deposition in Area A, which may have served as the main public space, with Area B acting as a secondary, more private space. This model is also supported by Steward’s (1937) mention of a large central hearth in Area A, and by Hallson’s (2017) conclusion that the artifacts in this area were much more diverse, suggesting a larger range of activities taking place here. The midden accumulation also suggests that more activity occurred in this space. One challenge of this model is that if Areas A and B were treated as one dwelling, there would be little opportunity for separation of households, at least with physical barriers. This means the model of group composition would likely be one multi-family household.

Use of the cave as one dwelling has implications for the social organization or group composition. This interpretation would suggest that the group in the cave consisted of one multi-family household. If the group size was 50 to 60 (based on average Western North American hunter gatherer numbers) this would mean there could be up to seven households making up this group. As laid out in section 5.6, the composition might look something like: 14 adult males, 14 adult females and anywhere from 28 to 42 children. If the group was Athapaskan, the group size would lower to 35 to 40 people made up of four households, consisting of eight adult males, eight adult females and anywhere from 16 to 24 children.

The two-dwelling model shows two separate dwelling areas, each with a central hearth surrounded by public space, private space around the edges and a sacred space at the back. This model is supported by evidence such as black staining from fires on the roof in both areas, a build-up of cultural material in the central portions of each Area A and Area B and a sacred space at the back of each dwelling area. These areas are also distinctly separated by the rockfall and, sound does not carry well between these two areas, suggesting that in terms of the natural aspects of the cave, these spaces are quite distinct. If this model applies, each area may have been occupied by two or more households, supporting the multi-family household model of group composition.

The group composition for the two-dwelling model, in terms of numbers, would be the same as the one-dwelling model. However, instead of one multi-family household, there would be two multi-family households. Each household would be made up of three to four families, if the group size was 50 to 60 or, if we use Athapaskan numbers, each household would consist of two families (two in Area A and two in Area B).

The dwelling model that was used would have been determined by social norms and practices and marriage practices. For example, if mother-in-law avoidance was practiced, the two-dwelling model would accommodate that custom by providing separation between households. Further, if the occupants of Cave 1 practiced cross-cousin marriage as various Athapaskan, Algonquian and Numic groups did, then we would expect a somewhat more relaxed approach to the use of space, as affines and consanguines would be in frequent contact. If, however, cross-cousin marriage and endogamous marriages were prohibited, in the presence of strict mother-in-law proscriptions, then we would expect a more defined partitioning of social space.

If endogamous precepts in a Local Group Growth framework were being applied in Cave 1, then the existence of segregated Area A and B spaces could be purely a matter of demography and functional use of space, expanding into available space as the group became larger. However, if exogamy was required in a Local Group Alliance framework, in the presence of mother-in-law avoidance, then there would need to be social partitioning. All Apachean groups head in the direction of exogamy and mother-in-law avoidance (as do some Shoshone and Paiute), so the Area A and Area B distinction could accommodate these social factors.

It is difficult to definitively say which dwelling model was employed by the Promontory occupants. As discussed earlier, however, it is quite possible that the size and nature of the group living in the cave changed during the one to two human generation span in which the cave was occupied during Promontory Culture times. Therefore, the one and two dwelling models are not necessarily mutually exclusive. A smaller initial group may have started out by occupying only Area A, or Area A and B, as one dwelling, but then as the group grew, may have shifted to a two-dwelling model. The shift would have been driven in part by population growth but could also have been facilitated by emerging social factors like a new generation of marriages where in-law avoidance practices came significantly into play. The people in the cave would have had children, the children would have grown and married and then had their own children. Members of the group would have also passed away, or moved away from the group for marriage, or to break off into their own group. How this group changed through time would have been dependent on their marriage and residence practices (endogamous or exogamous, patrilocal or matrilocal residence) and kinship ties. Other factors could include success in terms of resource procurement, interpersonal group conflict, and exchange of materials and mates with other groups (Hamilton et al. 2007). The neighboring Fremont group at Chournos Springs may have also factored into changing group composition. Marriage exchange may have occurred between the two groups. This would have resulted in either Fremont people joining the Promontory group, or Promontory people leaving to join the Fremont group. Given the apparent prosperity of the Promontory group, the latter alternative seems unlikely, however.

One last aspect of space use in the cave that is apparent is the use of floor coverings. Floor coverings are a common theme seen throughout the ethnographic literature and there is no exception in Promontory Cave 1. In many accounts, willows, spruce boughs, mats and hides are common materials used for this purpose. A large part of the material culture recovered in the cave is vast amounts of juniper bark, as well as plenty of evidence of hides and robes. It is highly likely that the presence of these materials represents floor coverings. In excavations in Area A from 2011-2014 the stratigraphy revealed, over and over again, interspersed layers of material culture and juniper bark. This pattern may represent the practice of laying down fresh floor coverings regularly. It is possible, and even likely, that the juniper bark layers were subsequently also covered with hides or robes to provide even more comfortable sitting or sleeping areas. Steward (1937:9) also mentioned this, noting “juniper bark being brought in for beds, where it still appears in layers 4 to 6 inches thick.”

5.10 Chapter Summary

Some of the main goals of this thesis were to explore the way Promontory Culture peoples inhabited Cave 1 and what the group size and composition may have been. Exploring these ideas has been productive, and led to constructive data about space needs per person and how people may inhabit a natural dwelling much the same way as a built dwelling. This chapter has explored different aspects of the cave including sound, location of fires, routes through the cave, and the “livable” area and what implications that has for group size and models of spatial organization.

Overall, sound in the cave was proven to be “dead” or “dull.” The cave is an ideal space in terms of sound because the noise level would not have been too intense or overwhelming when many people were in the cave. We collected samples from black stains observed on the roof of Cave 1, and found through chemical testing that they were predominantly made up of carbon. This means they were likely deposited by smoke from fires, allowing us to infer hearth locations, with the further insight this has allowed for organization and layout of space in the cave. Smooth spots on rocks throughout the cave also provided clues into how the space was used. A 3D scan of the cave allowed contours and an accurate layout of the cave to be created which led to the construction of least cost path models in conjunction with the smooth spots that were observed.

Using a combination of techniques, including the calculation of area of the cave from accurate 3D scans, mapping areas of cultural deposition, and applying space needs per person data from ethnographic accounts has allowed for an informed calculation of maximum group size. The likely modal group size was calculated to be 50 to 60, close to the common number of worldwide hunter-gatherer aggregated groups. This range is calculated using space needs per person averages and the mapped livable area in Areas A and B of Cave 1. Specifically for Athapaskans, the modal group size was calculated to range from 35 to 40. If the entire livable space in the cave was not used, these group size numbers could be smaller. Changes in group size no doubt occurred as the group changed through time over the 20 to 50 year period that occupation occurred.

Since there were likely a large number of children living in the cave, as evidenced by moccasin data, families or households (versus a hunting group made up mostly of men) were probably what made up this group. Based on space syntax analysis, models of space use and group size and composition, the group in the cave was mostly likely made up of multi-family households. It was potentially a sibling core group, a theme common in many ethnographic accounts. The way these families organized space was probably similar to that of built dwellings and many of the same social behaviours or norms would have applied in this natural cave environment.

CHAPTER 6

DEFENSIBILITY OF PROMONTORY POINT SITES

"Since defensive systems take time and energy to construct and inhabit, people create them less because of the experience of violence than because of the expectation of violence." [Martindale and Supernant 2009:194]

To this point, I have been considering the internal dynamics of the Cave 1 occupation, but it is legitimate to ask, why were the cave locations chosen at all? When doing predictive modeling for archaeological site locations, the variables that archaeologists often take into consideration include access to basic resources like food, water, firewood and shelter. They also consider the landforms themselves, whether they are high and dry, what kind of slope the area has and if there is an aspect that allows for ideal amounts of sunlight and heat or shade (depending on the region and its climate). Often, areas with good access to food and water, that are easily accessible, are chosen as the areas ideal for settlement location. These locations provide people with their basic needs and are generally pleasant places to live. However, there are other factors to consider in addition to environmental variables. Social factors are also an important influence when choosing settlement location(s).

Environmentally, the caves do have their advantages. They remain a comfortable temperature at any time of year, staying warm in the winter and cool in the summer (Fiero 2009). They are a good source of shelter and do not require the acquisition of raw materials to construct. Overall, the caves make for comfortable dwellings, and Cave 1 especially is very spacious. However, anyone that has been to the Promontory Cave sites knows that the hikes into the caves are not easy, especially into Caves 1 and 3. Water is not necessarily readily accessible, except for when there is snow on the ground, and the slope leading up and down to Cave 1 is steep; it would be daunting to think of carrying the remains of a large mammal, just killed, into the cave.

However, we know that people did carry these animals in, as evidenced by the overwhelming presence of faunal elements of all kinds from bison and other large mammals.

As far as built dwellings are concerned, there are tipi rings associated with Fremont material and Fremont sites in Utah and western Wyoming, so tipis clearly could have been constructed if desired (Aikens 1967). Given the intrusive northern and Plains elements in the Promontory assemblage, one might expect that the Promontory group would use tipis. So, why did the inhabitants of Cave 1 choose to live in the cave, in an intensive fashion as never seen before, of all places on Promontory Point?

The Fremont site (Chournos Springs 42B01915) is located on the flats below, about four kilometers to the south, where the sheep herders and archaeological field crews of 2011, 2013 and 2014 chose to set up their camps. It is close to an abundant freshwater supply provided by springs flowing into the Great Salt Lake. There are plants growing down on the flats, and the ranchers can find their animals easily when they wander down to access the water. As far as settlement locations go, from an environmental perspective, these flats are ideal. So, why wouldn't the Promontory people choose a location with similar attributes? Why are all of the known Promontory sites on Promontory Point located in hard-to-reach caves?

There is no direct evidence of warfare occurring at these sites, but defensibility may have been a factor in choice of settlement location. If the inhabitants of the Promontory Caves were a migrating group, as hypothesized by Steward (1937) and Ives (2014), they may have had to take other factors into consideration, such as how to protect themselves if the resident inhabitants of Promontory Point were unwelcoming. This chapter will explore this idea by quantifying the defensibility of several known sites on Promontory Point. By quantifying and comparing defensibility of various sites on the point, I can provide some insights as to whether defensibility was a contributing factor when choosing the Promontory caves as settlement locations.

6.1 Evidence of Conflict and Turmoil A.D. 1250-1300

Several scholars have noted archaeological evidence for an increase in warfare in the 13th and 14th centuries in what is now the western United States. Arkush and Allen (2006) note resource stress as one of the major contributors to warfare in several case studies from across the world, including the American southwest. LeBlanc and Rice (2001:10) also notice a pattern of warfare in the American southwest: "Beginning in the late A.D. 1100s or early 1200s, there was a marked increase in the level of warfare in the Southwest, and by the early 1300s one finds strong evidence for its ubiquity and significance wherever one looks." Climate seemed to have played a major role in the increase in warfare. In the years preceding the mid-1100s, the southwest and Great Basin experienced a climate of increased moisture and cooler temperatures, ideal for farming. Population of groups in the region increased, but so did the carrying capacity since farming yields were plentiful (LeBlanc and Rice 2001). When the climate began to change to drier and warmer conditions (see chapter two), the carrying capacity of the region decreased, which led to resource scarcity, one of the factors believed to have contributed to increased conflict as people fought over resources (LeBlanc 1999; LeBlanc and Rice 2001).

There is considerable evidence of warfare in the southwest from A.D. 1250-1300 and earlier. By A.D. 1250-1400 all regions of the southwest were engaged in full warfare (Lambert 2002). In addition to the southwest, there is also archaeological evidence showing an increase in violence and warfare after A.D. 1200 on the Great Plains, with population movement both to the north and the south (Bamforth 1994; Lambert 2002). There were also a lot of migrants coming into the area, further increasing competition for resources. A change in settlement patterns to larger group sizes and built fortifications is also noted (Bamforth 1994). Benson et al. (2007) have shown a correlation between droughts in the early 11th, mid 12th and late 13th centuries that correspond with population declines among Fremont, Cahokian, Puebloan and Lovelock Cultures. The Central Mesa Verde region has evidence for increased violence and human trauma during this same general time period (Kohler et al. 2014). This increase in defensiveness and violence is attributed to low maize production due to the droughts and therefore competition for resources (Benson et al. 2007; Kohler et al. 2014; Schwindt et al. 2016).

In this same vein of thought, LeBlanc (1999) pinpoints A.D. 1250 as the time when levels of warfare became significant in the southwest, with conflict that lasted for 50-75 years. He noted that population migrations began to take place on a "massive scale" and settlement patterns changed. He argued that settlement patterns were one of the most telling signs of an increase in warfare, particularly site configurations, sites on defensible landforms, site distributions, and sites located for line-of-sight communication. Site configurations shifted towards defensive layouts, with palisades or fences being erected, and other constructions with defense as the main purpose. The shift of sites to defensible landforms is also a major factor that shows there was likely a major increase in warfare (this is the characteristic that applies most strongly to the sites on Promontory Point).

The most obvious defensible landform is a hilltop because of the advantages of height, view, and line-of-sight communication (LeBlanc 1999). The Early Period (~A.D. 800-900) shows three site locations being primarily chosen for defense: hilltops, cliff overhangs or caves, and trincheras (hilltop sites with residential terraces) (LeBlanc 1999). Defensible sites on hard-to-reach landforms provide challenges, such as gaining access to water, fuel and other necessities, and are sometimes unpleasant places to be, with exposure to sun and wind.

Therefore, it seems that social factors, such as defense, could be significant motivators in choosing these locations. LeBlanc (1999) also noted site distribution as a change that came with an increase in warfare. Sites with high intervisibility began to cluster, with large unoccupied spaces in between. Being close and able to see each other allowed people to signal for help (LeBlanc 1999). Lambert (2002) also noted changes in site distribution in the southwest around A.D. 1150, with shifts to defensible landforms, population aggregations and clustered settlements. Line of sight between these settlements was evident.

There is also evidence of warfare in Utah's Fremont area, appearing after A.D. 1150, mostly evidenced by an increase in defensibility of sites based on site location and configuration (Lambert 2002). Interestingly, this date (A.D. 1150) corresponds with Coltrain and Leavitt's (2002) date for abandonment of agriculture in the Great Salt Lake wetlands, a time of resource stress, discussed in chapter two.

Solometo (2006:42) identified topography as a "crucial part of defensive settlement strategies" in the southwest from A.D. 1150 to A.D. 1250. Sites were located in highly defensible areas such as canyon rims, canyon walls, and mesas. The main point of this was to control site access. In addition to natural topography, there were often architectural features built that made access even more difficult (Solometo 2006). Solometo identified four major fortified site types during this time period: lookouts, proximate refuges, isolated refuges and defensive habitations. Lookouts are characterized by low artifact density and are used primarily for communication and observation. Proximate refuges had 5-8 rooms, low artifact density, were in proximity to larger settlements and were used primarily as a refuge for a large community. Isolated refuges were smaller with just two rooms, one communal structure and one storage room. They had moderate artifact density and there were no other settlements nearby (hence, isolated). The main purpose was a refuge for a dispersed population. Defensive habitations were the largest, with 15-25 rooms in the settlement plus possible communal structures, high artifact density, and variability in surrounding settlements. These sites were used as year-round habitations, or used repeatedly (Solometo 2006). Solometo also mentioned another characteristic of site distribution that is interesting when compared to the three Promontory Culture cave sites that are discussed below:

> Living within or close to fortifications is common in the late period, but the size of the co-resident group increases to a minimum of 12-15 households, nearly five times the size of the average Chevelon habitation site. Given the low population density and short distances between communities, it is likely that occupants of defensive habitations and refuges located on the same canyon were allies, providing valuable strategic assistance in defensive and offensive endeavors. The cooperation of closely related communities, common in the ethnographic record, therefore is likely in this period [Solometo 2006:50].

Promontory Caves 1, 2, and 3 were occupied coevally, and it is possible, even likely, this type of cooperation took place. Steward (1940) noted up to twelve caves on Promontory Point, so there may have even been more sites involved.

Ahead of the turmoil in the deep southwest in the mid-late 1200s, there is evidence of Fremont peoples inhabiting the highly defensible Range Creek site in Utah. In an article in Science Magazine in December of 2007, Duncan Metcalfe, the head archaeologist on the project, speculated that climate change and a move to defensible, clustered settlements may have occurred in the Utah area as much as 100 to 150 years earlier than further to the south (Kloor

2007:1541). The Range Creek site shows great efforts to protect food supplies, with granaries constructed in extremely inaccessible locations. In addition to the inaccessibility of food supplies, dwellings were also moved high up into the cliffs, some as much as 300 metres above the valley floor. Material culture remains show that these were long-term occupations, not seasonal. Other sites in Utah, such as Nine Mile (A.D. 1050) and Five Finger Ridge (A.D. 1200-1300), show signs of defensive behaviour at the same time. Human remains from a Fremont village site in Central Utah, the Hysell site, provide evidence of violence from A.D. 960-1180 (Lambert 2002). Climate records show a twenty year drought around A.D. 1050; the same time these Utah sites show signs of defensibility and violence. This drought may have led to resource stress, and in turn, social turmoil and violence (Kloor 2007).

Lambert (2002:209) noted four lines of evidence for warfare at sites in North America. These include "settlement data, injuries in human skeletal remains, war weaponry, and iconography." Three of these factors are absent in the Promontory Cave records. Thus far, there have been no human remains found. While there are weapons present in the form of bows and arrows, spearpoints, and knives, there is no compelling evidence that these were used for anything other than hunting (supported by the vast amount of bison and other faunal remains) and there is no iconography indicative of conflict. Kohler et al. (2014:449) suggest that technological innovation can "influence character or intensity of warfare." They used the sinew-backed bow found in the Promontory Caves as an example of a new technology entering the Great Basin region sometime between A.D. 1200 and 1400 (this is the earliest archaeological example) (Steward 1937). These bows are more powerful and able to shoot heavier arrows over a longer distance with more speed. However, the settlement data may illustrate some concern for defense (explored further in the sections below). Lambert (2002:209) noted that defensive settlement behaviour might be shown by “a shift in village location from a valley floor with ready access to agricultural fields to a steep slope or inaccessible rock shelter requiring greater energy expenditure for day-to-day living.” This line of evidence is certainly compelling for Promontory Cave 1, and other Promontory sites in the immediate area, as they are all located on steep cliff faces and no doubt would have required the inhabitants to expend a lot of energy acquiring and hauling resources in.

This period was a time of change for many groups, with people moving around, with major shifts in subsistence practices, and fighting for territory and resources. While all groups were not directly involved in warfare or conflict, there was a great deal of turmoil in what is now the Western United States during this time period. This competition for resources and territory led to movement of sites to defensible locations and construction of defensible structures (Kloor 2007; Lambert 2002; LeBlanc 1999; Solometo 2006). While this warfare and violence is not directly observed on Promontory Point, it may have been influenced and affected by this turmoil.

6.2 Defensibility

There is no direct evidence to suggest that the group occupying Promontory Cave 1, or other groups on Promontory Point, were involved in conflict. However, the Promontory Culture peoples were a group relatively new to the area that seemed to be infringing on others’ territory, and their choice of settlement locations, at first glance at least, seems to suggest a concern for defensibility. With the presence of Fremont peoples in the region already, the Promontory groups would have been entering Fremont territory, a move which had potential to lead to conflict. Therefore, there may have been a certain level of ambiguity when entering this territory. As quoted at the beginning of the chapter, defensive systems are often created because of the “expectation of violence” (Martindale and Supernant 2009:194). Perhaps the inhabitants of the

Promontory sites found their situation to be ambiguous and anticipated that there could be resistance to their presence in the region. Even though there may not have been conflict or violence at all between these two groups, their initial interactions may have been tense and uncertain, and some level of caution would likely have been taken to avoid a worst case scenario of violence. The extensive evidence of gaming pieces and the presence of Fremont ceramics and basketry do suggest that the cave occupants took actions to mitigate this ambiguity (Yanicki and Ives 2015). Nevertheless, the choice of Promontory site locations in seemingly defensible locations may have been as a result of this ambiguity.

As Lambert (2002) noted, when the southwest became involved in turmoil, settlements moved from valley floors to steep slopes and inaccessible rockshelters. On Promontory Point, steep slopes and inaccessible rockshelters are certainly terms that could be used to describe Promontory Culture site locations. Since this is just speculation, the goal of this chapter is to find a quantitative way to measure site defensibility and compare the Promontory site locations to Fremont site locations on Promontory Point and Northwest Coast and Fraser Canyon sites.

6.2.1 Defensibility of Promontory Sites

Martindale and Supernant (2009) developed a defensibility quotient to calculate defensibility of archaeological sites on the Northwest Coast. They noted that architecture and site configuration were common themes that came up in the literature for evidence of conflict and warfare. This is also shown in some of the literature explored above in section 6.1. While signs of defensiveness are visible in the archaeological record, and often assumed to be defensive, Martindale and Supernant (2009) saw a need to quantify defensibility to obtain a definitive answer rather than rely on assumptions. They noted several examples where site constructions were more symbolic than actually defensive. To explore this they decided to focus on the biomechanical functionality of a site as a measure of defensibility. They created a defensibility index (DI) based on four main variables: visibility, elevation, accessibility and area (Martindale and Supernant 2009).

Visibility is important so that approaching enemies can be seen. For this equation a minimum distance of 100 m was applied, since anything less than that would not give people enough time to prepare for defense. The highest visibility values are assigned to sites that have unlimited visibility in all directions (Martindale and Supernant 2009). Visibility is calculated with the equation:

$$V = V_{100} \text{ (degrees of visibility in excess of 100 m)}/P \text{ (degrees of approach around site)}$$

Elevation differences can provide an advantage to defenders if they are on higher ground than the approaching enemy. Elevation is calculated using the equation:

$$E = E_v \text{ (degrees of elevation difference)}/90°$$

Accessibility considers how easily a site can be accessed. The easier it is to access, the lower its defensibility value is. Accessibility is calculated with the equation:

$$C = [360 - P \text{ (degrees of approach around site)}/360] + [P - T \text{ (degrees of access through thresholds)}/P]$$

Area is another factor considered. If a site is large in size, it is likely easier to approach and access, and therefore easier to attack. However, larger sites usually have larger populations, which means more people that can defend them (Martindale and Supernant 2009). Area is calculated using the equation:

$$A = \text{Site area}/1{,}000{,}000$$

Martindale and Supernant (2009:195) calculated area "as a ratio against the estimated largest site on the coast." For the Promontory Cave sites, area will not be considered. While the population size is an important factor, one of the main variables that area represents is the opportunity for approach and access to the site: the larger the site, the more opportunity for access. Since the cave access is limited by the size of the entrance and angles of approach, and the area of the site is contained within the rock walls, area is not a logical consideration for the calculation of site defensibility of the caves.

Each of these variables results in a coefficient from zero to one. A value of zero represents a space with no barriers to movement, and a value of one represents maximum defensiveness. To calculate the defensibility index (DI), these values are summed to reach a value between zero and four, zero being the least defensive and four the most defensive (Martindale and Supernant 2009). The equation used is:

$$\mathrm{DI} = [V_{100}/P] + [E_v/90] + [P - T/P] + [\text{area}/1{,}000{,}000] \text{ or } \mathrm{DI} = V + E + C + A$$

While decimal values can be reached in these calculations, Martindale and Supernant (2009) recognize that DI is a coarse calculation and, rather than provide exact values, the intention is to distinguish between sites that have very little defensive qualities and those that have more. Therefore, DI is used to classify sites into three categories of defensiveness: low, medium and high (Martindale and Supernant 2009).

To explore the idea of defensibility of known sites on Promontory Point, Martindale and Supernant's (2009) defensibility index is applied to Promontory Cave 1 (42B01), Promontory Cave 2 (42B02), Promontory Cave 3 (42B01916), and the Chournos Springs Site (42B01915)

(Table 6.1). As mentioned above, area has been taken out of the total sum of defensibility for this study, so the DI values in this case will range from zero to three. The modified equation is:

$$\mathrm{DI} = [V_{100}/P] + [E_v/90] + [P - T/P] \text{ or } \mathrm{DI} = V + E + C$$

Promontory Cave 1 is located on the west-central edge of Promontory Point and is carved into a large cliff face overlooking the Great Salt Lake. The mouth of the cave lies approximately 130 metres above the shore of the lake and has great views to the south-southwest. Promontory Cave 1 was occupied from A.D. 1240-1290, resulting in almost two metres of Promontory Culture deposition at some locations and implying intense occupation (Ives et al. 2014; Johansson 2013). Through her artifact accumulation analyses, Hallson (2017) suggested that there were episodic Cave 1 occupations of two to six months duration during this interval. We also know that men, women and children all occupied the cave, suggesting it had a large population (perhaps as many as 56 people) and was similar to a village or habitation site, as defined by Solometo above (Billinger and Ives 2014; Solometo 2006). Visibility from the site is excellent (Plate 6.1), which gives the inhabitants an advantage as far as seeing approaching enemies. The elevation change to access the site is an extremely high value; the cave is quite challenging to get to in terms of vertical loss and gain. This would make it more difficult for enemies to approach. The site access and approach lower the defensibility value a bit, since the mouth of the cave is technically approachable from most of the southern side (145 degrees of access), but it is quite difficult terrain for a lot of that area (Plate 6.2). The mouth of the cave is carved into a rockwall so approach, visibility and access is basically non-existent directly to or from the north, but the site can be accessed from above by going around and then down the path against the rock wall to the east (the downslope side). This route could be easily guarded by a few well-placed archers. The mouth of the cave itself could be also be defended very effectively by archers if attackers approached from below. Solometo's (2006) definition of defensive habitations as one of the four major fortified site types is a good fit for Cave 1 (see section 6.1). The defensibility index, calculated using Martindale and Supernant's (2009) algorithm, is 2.2 with approach from the downslope side and 2.22 if approach is from the upslope side (from a scale of 0-3).

Plate 6.1. View to the south from Cave 1; Chournos Springs site can be seen.

Plate 6.2. Entrance to Cave 1, side slope approach from below.

Promontory Cave 2 was also occupied by Promontory Culture peoples from A.D. 1250-1300. Cave 2 is downslope to the southwest of Cave 1, but is in fairly close proximity. It is closer to the shore of Great Salt Lake and about 85 metres above the lake level. Like Cave 1, this cave was carved into a rockwall and the only way into the site is through the mouth of the cave (Plate 6.4). The cave can be accessed by climbing up from the shoreline, or by climbing down from Cave 1. Caves 1 and 2, other than the steep climb, are fairly accessible to one another. The Promontory occupation is not as archaeologically dense in Cave 2, but these two sites were likely used in conjunction with one another during this time period. Many of the defensibility factors are very similar between caves 1 and 2. Visibility is excellent from Cave 2 (Plate 6.3), so approaching enemies can be seen. A rock ledge can be spotted immediately above the mouth of the cave. This ledge provides even greater visibility and may have been used as a lookout for either game or approaching people. The elevation change to get to the mouth of the cave is a significant factor in defensibility, since enemies would have a steep slope to climb. Again, the approach and access lower the DI a bit because it is technically accessible from the majority of the south and east sides (190 degrees). Site access and visibility is non-existent to the north and west because the rock wall is there. The defensibility index for Cave 2, calculated using Martindale and Supernant's (2009) algorithm, is 2.16 when approach is from the downslope side and 2.35 when approach is from the upslope side (from a scale of 0-3).

Plate 6.3. View to the south from Cave 2; Chournos Springs site can be seen.

Plate 6.4. Entrance to Cave 2, side slope approach from below.

Promontory Cave 3 lies to the northeast of caves 1 and 2, at a higher elevation. Like the other two caves, this cave was carved into a rock wall of the Promontory mountain range. This cave is highly visible from the southeast side of Promontory Point and is distinguished by a tall, triangular-shaped mouth. It also contains archaeological evidence of Promontory Culture inhabitants. Cave 3 can be accessed by hiking up to the flats immediately below the cave and traversing the steep slope up to the cave. Visibility from the cave is excellent to the south, southeast and southwest (Plate 6.5). The elevation change from the flats below up to the cave is 145 metres and is a very steep slope and challenging climb (Plate 6.6). This obstacle is a significant factor in the defensibility of the site. The degree of approach and access is about 105 degrees, but is all impeded by the steep slope. The rockwall makes approach and visibility to or from the north, northeast and northwest non-existent. The defensibility index, as calculated using Martindale and Supernant's (2009) algorithm, is 2.12 (from a scale of 0-3).

Figure 6.1. Defensibility Index calculations for Promontory Caves 1 (42B01) and 2 (42B02), if approach to the caves were from above (upslope).

Figure 6.2. Defensibility Index calculations for Promontory Caves 1 (42B01) and 2 (42B02), if approach to the caves were from below (downslope).

Plate 6.5. View to the south-southwest from Cave 3; Chournos Springs site can be seen.

Plate 6.6. View to the north-northeast of Cave 3, note the steep slope as the cave is approached.

Figure 6.3. Defensibility Index calculation for Promontory Cave 3 (42B01916).

The Chournos Springs Site differs from the previous three sites in that it is an open air site on the flats below and is associated with the Fremont culture. This site consists of hundreds of surface artifacts and several features (depressions) that may represent Fremont pithouses. Yanicki (2014) carried out excavations at this site in 2013 and several radiocarbon dates were obtained. The radiocarbon dates show that this area of the Chournos Springs site was occupied around A.D. 950, and then more intense occupation occurring around A.D. 1020 to 1030. A later occupation of the site occurred from A.D. 1160-1300, a time range that overlaps with the Promontory cave occupations (Yanicki 2014; Yanicki and Ives 2015). This site is easily accessed and has good views in all directions. Visibility from the site is excellent in all directions, so like the cave sites, the occupants would be able to see enemies approaching with enough lead time (Plate 6.7). There is very little elevation change across the site and leading up to the site, meaning that elevation is a very small factor in defensibility of the site. It offers no barrier to enemies or protection to the occupants of the site. The site is also completely accessible and approachable from all directions (when considering land and water) (Plate 6.8). This ease of access also lowers the defensibility of the site. The defensibility index, as calculated using Martindale and Supernant's (2009) algorithm, is 1.04 (from a scale of 0-3), which would indicate a low level of defensibility (Table 6.1; Figure 6.4). Even when all four variables from the original defensibility index equation are considered for Chournos Springs (visibility, elevation, accessibility *and* area), the DI value does not change significantly. The area of Chournos Springs site is approximately 20,000 m^2, which results in a value of 0.02 for area in the defensibility index equation, bringing the DI value to 1.06 instead of 1.04.

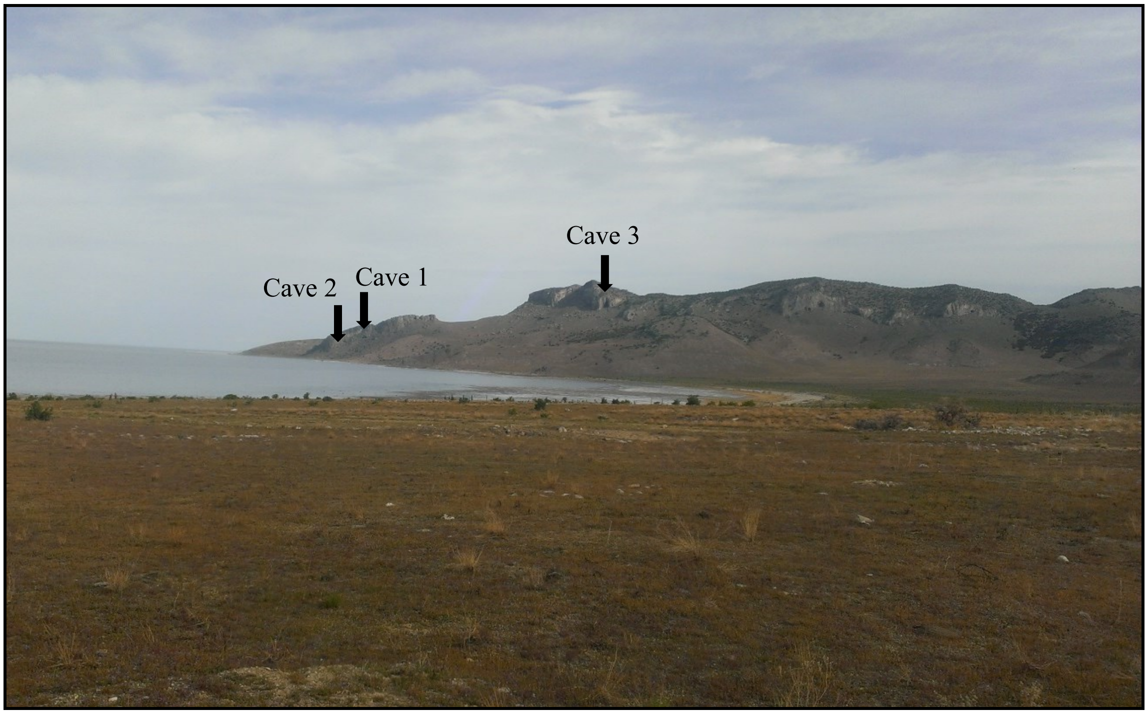


Plate 6.7. View to the northwest from Chournos Springs; Caves 1, 2, and 3 can be seen.

Plate 6.8. View west to the Chournos Springs site; note the wide open approach.

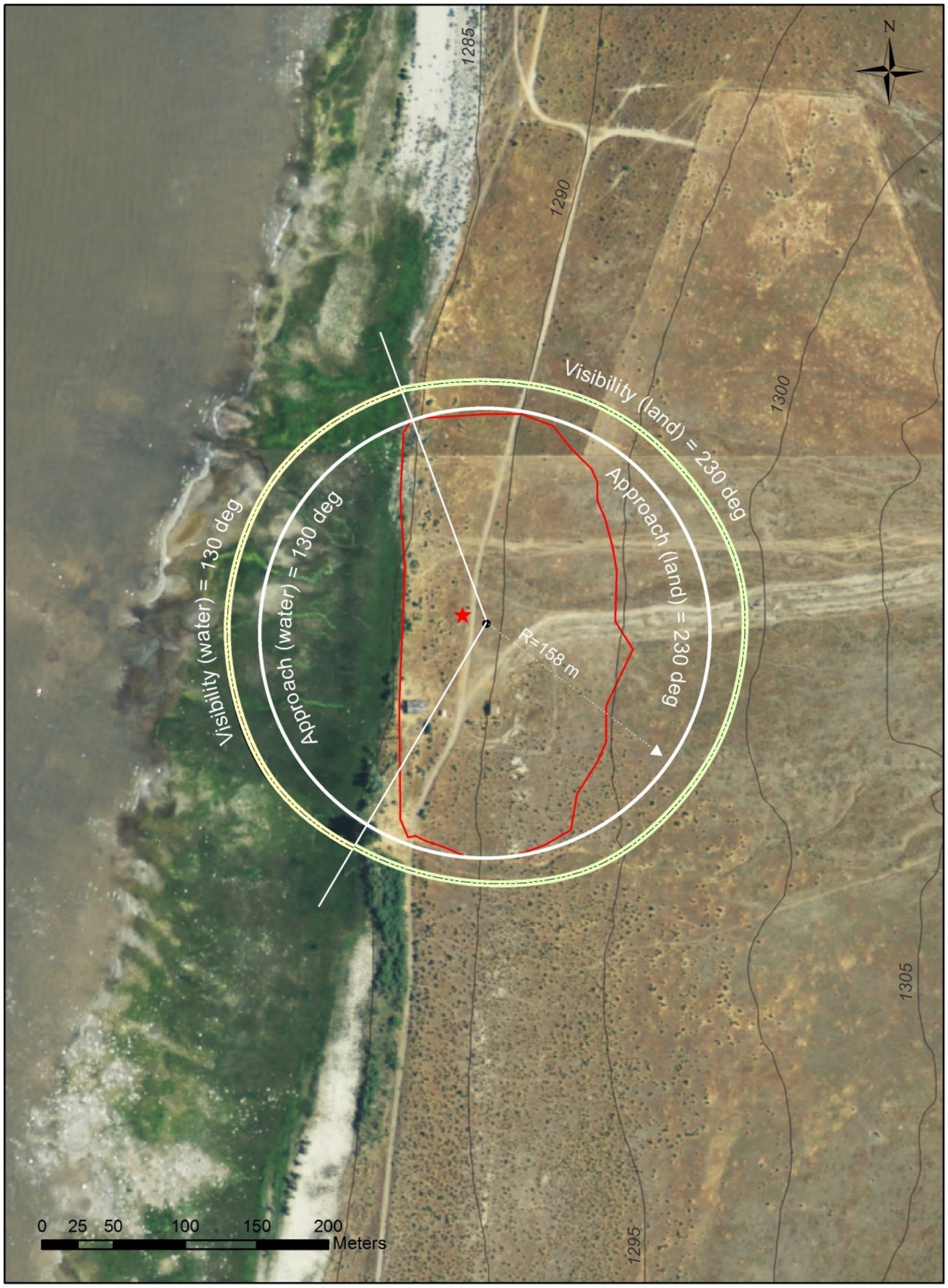


Figure 6.4. Defensibility Index calculation for Chournos Springs (42B01915).

Site Name	Designation	Possible Defensive Site Type (Solometo 2006)	Approach in Degrees: Land	Approach in Degrees: Water	Visibility in Degrees >100m (land)	Visibility in Degrees >100m (water)	Elevation changes (m)	Degree limited access	Degrees Access	Radius	(V) Visibility	EV angle	(E) Elevation	(C) Approach/ Access	DI Final (V+E+C)
Cave 1 (from below)	42B01	Defensive Habitation	145	0	145	0	130	1	145	20	1	81.25384	0.9028204	0.2986111	2.20
Cave 1 (from above)	42B01		20	0	20	0	50	1	20	20	1	68.19859	0.7577621	0.4722222	2.22
Cave 2 (from below)	42B02	Proximate Refuge or Defensive Habitation	190	0	190	0	85	1	190	10	1	83.29016	0.9254463	0.2361111	2.16
Cave 2 (from above)	42B02		30	0	30	0	60	1	30	10	1	80.53768	0.8948631	0.4583333	2.35
Cave 3	42B01916	Proximate or Isolated Refuge	145	0	145	0	105	1	145	30	1	74.0546	0.8228289	0.2986111	2.12
Chournos Springs	42B01915	Village/Habitation (not defensive)	230	130	230	130	10	1	360	158	1	3.621485	0.0402387	0	1.04

Table 6.1. Defensive Index Calculations for known sites on Promontory Point.

Overall, the Promontory cave sites have high DI values and the one Fremont site has a low DI value, suggesting that either the Promontory Culture peoples were considering defense as a factor when choosing their settlement locations, or defensibility was an added bonus of their chosen site locations.

6.2.2 Comparative Defensibility of the Promontory Point Sites

As mentioned above, the formula for calculating site defensibility was first developed for Northwest Coast sites and was applied by Martindale and Supernant (2009) to 27 sites (with a total of 31 defensibility calculations). Supernant (2014) also applied the equation to six sites in the Lower Fraser River Canyon, resulting in a total of eight defensibility calculations. In order to get a sense of how defensible the Promontory Cave sites are in comparison to other sites, the DI calculations for the Northwest Coast and the Lower Fraser River Canyon are considered (Table 6.2). To make the sites comparable, the Area (A) variable has been taken out of these calculations, since it was not included in the Promontory site calculations.

Comparison of these values provides a strong argument for the Promontory Cave sites being highly defensible. On the Northwest Coast, the sites with the highest DI indexes are Kitwanga (DI without area equals 2.07), a site that is a known defensible fort, and the redoubt portion at the site of *Xelhálh*, located at the "southernmost point of a defensive network in the Lower Fraser River Canyon region" (Martindale and Supernant 2009:201). The redoubt for *Xelhálh* has a DI (without the Area (A) variable) of 2.12. In addition to being in a defensible location, the inhabitants built rock walls and terraces on the bluff to enhance defense. In the Fraser River Canyon region, the site with the highest DI is the redoubt portion of DiRi-14, with a value of 2.12.

Site Name	Designation	Type	(V) Visibility	(E) Elevation	(C) Approac h/Access	DI = V+E+C
Northwest Coast Sites						
Kiix?in	DeSh-25	Village	0.25	0.017	0	**0.27**
T'ukw'aa	DfSj-23	Village with Defensive Site	0.22	0.031	0.07	**0.32**
Katz	DiRj-1	Village	0.31	0.042	0	**0.35**
Kiix?in	DeSh-1	Village	0.27	0.058	0.09	**0.42**
Beach Grove	DgRs-1	Village	0.25	0.001	0	**0.25**
Huu7ii	DfSh-7	Village	0.47	0.022	0	**0.49**
Beach Grove	DgRs-1	Village	0.25	0.001	0	**0.25**
McNichol Creek	GcTo-6	Village	0.5	0.038	0	**0.54**
Paul Mason	GdTc-16	Village	0.25	0.099	0.23	**0.58**
Boardwalk	GbTo-31	Village	0.53	0.015	0	**0.55**
False Narrows|Senewelets	DgRw-4	Village	0.56	0.002	0	**0.56**
Ts'ishaa	DfSi-16	Village	0.61	0.04	0	**0.65**
Shingle Point	DgRv-2	Village	0.64	0.005	0	**0.65**
T512-1 Dundas		Village	0.5	0.09	0.13	**0.72**
Dionisio Point	DgRv-3	Village	0.45	0.031	0.25	**0.73**
Scowlitz	DhRl-16	Village	0.71	0.024	0.03	**0.76**
Whalen Farm	DgRs-14	Village	0.5	0.002	0	**0.5**
Xelhalh Village	DiRi-15	Village	0.21	0.126	0.56	**0.9**
T512-3 Dundas Village	T512-3	Village	0.68	0.045	0.24	**0.97**
Ozette Village	45CA24	Village	0.58	0.004	0	**0.58**
Towner Bay	DeRu-36	Trench Embankment	0.75	0.01	0.47	**1.23**
Unmiak Island	AA-12246	Village	1	0.026	0.27	**1.3**
Finlayson Point	DcRu-23	Trench Embankment	0.78	0.018	0.49	**1.29**
Rebecca Spit	EaSh-6	Trench Embankment	0.92	0.064	0.49	**1.47**
Keatley Creek	EeRl-7	Village	1	0.22	0.25	**1.47**
T'ukw'aa Redoubt	DfSj-23	Village with Defensive Site	0.75	0.43	0.49	**1.67**
T512-1 Dundas Redoubt	T512-1	Village	1	0.334	0.38	**1.71**
Izembek Lagoon	XCB-121	Refuge	1	0.242	0.5	**1.74**
Execution Rock Fortress| Kiix?in	DeSh-2	Midden and Defensive Site	0.83	0.614	0.49	**1.93**
Ozette Redoubt	45CA24		1	0.458	0.49	**1.95**
Kitwanga Fort		Fort	1	0.334	0.74	**2.07**
Xelhalh Redoubt	DiRi-15	Village	0.71	0.644	0.77	**2.12**
Lower Fraser River Canyon Sites						
DiRi-14	DiRi-14	Village	0.21	0.126	0.556	**0.89**
DjRi-21	DjRi-21		0.35	0.207	0.473	**1.03**
DjRi-13	DjRi-13		0.7	0.229	0.477	**1.41**
DjRi-2 (south)	DjRi-2		1	0.374	0.375	**1.75**
DjRi-46	DjRi-46		1	0.31	0.446	**1.76**
DjRi-62	DjRi-62		1	0.155	0.67	**1.83**
DjRi-2 (north)	DjRi-2		1	0.334	0.5	**1.83**
DiRi-14 (redoubt)	DiRi-14	Redoubt	0.71	0.644	0.77	**2.12**

Table 6.2. Defensive Index calculations for select Northwest Coast and Lower Fraser River Canyon sites with exclusion of the variable Area (A) (Martindale and Supernant 2009; Supernant 2014).

Promontory Caves 1, 2 and 3 all have equal to or higher DI values than the most defensible sites on the Northwest Coast and in the Fraser River Canyon region (Tables 6.1 and 6.2). This illustrates that the Promontory Cave sites were highly defensible. Martindale and Supernant's (2009:202) observations on the Northwest Coast suggested that sites with a DI in "excess of 1.75, such as the fortress at Kitwanga, represent sites where defensiveness is a primary concern for the occupants." Sites with values less than one probably had little to no concern for defensibility. Given that all of the cave sites have defensibility indexes over 2 (with the exclusion of area), it would suggest that defense may have been a primary concern for the Promontory Cave occupants.

On the other end of the Promontory Point spectrum is the Chournos Springs site with a DI of 1.04, its overall value being brought up by the excellent visibility the site location provides. With a DI value of just slightly over 1, defensibility was likely not a primary concern for the Chournos Spring site inhabitants. This made the Chournos Springs residents highly vulnerable, a factor that may have motivated them to cultivate a friendly relationship with the Promontory Culture group(s).

Another site that is comparable to the Promontory Cave sites is Franktown Cave in Colorado. This site is a large rockshelter, carved into a cliff face with difficult access, and would likely be highly defensible. This site has evidence of human occupation spanning over 5000 years and a large amount of perishables were found, including a Promontory Culture moccasin (Gilmore 2005; Ives, personal communication).

6.2.3 Viewshed and Site Intervisibility

A common theme in the defensibility studies above is settlement patterns and visibility from chosen site locations. LeBlanc (1999) and Lambert (2002) noted settlements clustering with line of sight communication between these sites. Solometo (2006) also mentioned cooperation between sites located in the same areas, and Martindale and Supernant (2009) consider visibility an important factor in the quantification of defensibility. Smith and Cochrane (2011) and Supernant (2014) also explored the relationship between visibility and defense in their studies of sites on the Fijian islands and the Fraser River Canyon, respectively. Since visibility is an important factor in defensibility, I ran viewshed analysis in GIS (Geographic Information Systems) to look at the relationships between the Promontory sites in terms of visibility. The viewshed analysis was carried out using a 10 metre digital elevation model (DEM) obtained from the Utah Automated Geographic Reference Center (AGRC). The point observer features were the locations of the mouths of the caves, as close as possible, and the observer height was set to one metre.

The viewshed analysis from the mouth of Cave 1 (Figure 6.5; Table 6.3) shows excellent visibility to the south, southeast and southwest over the Great Salt Lake. Cave 2, or very close to Cave 2, is visible and the Chournos Springs site is clearly visible. Cave 3 is not visible from the mouth of Cave 1, but a small stretch of the flats below it are. Views to the north and east are restricted by the rock wall, but a short wander to the east of the mouth of the cave and up to the saddle and high cleft above the cliff face allows for exceptional 360 degree views around the point. Plates 6.9, 6.10 and 6.11 illustrate the remarkable views from this location. Not only does this spot provide great views to the observer, the observer can also remain hidden among the nooks and crannies of the rock cleft. This provides a big advantage in terms of lookout and early warning of other people approaching. Viewshed analysis from this point is illustrated in Figure 6.6. As can be seen in the viewshed analysis, this location opens up a whole world to the north that is not visible from the mouths of Caves 1, 2 and 3. Cave 3 can also be seen from this location and, of course, Chournos Springs to the south. However, the viewshed figure is not completely accurate; a lot of the areas directly north and south of this point are classified as "not visible" when in reality these areas are actually highly visible.

Plate 6.9. View southeast from saddle above Cave 1, rock cleft middle-right (Courtesy of Reid Graham).

Plate 6.10. View to the north from the saddle area above Cave 1 (42B01) (Courtesy of Reid Graham).

Plate 6.11. View to the south from the cleft directly above Cave 1 (42B01) (Courtesy of Reid Graham).

Plate 6.12. View of the rock cleft directly above Cave 1 (42B01) (Courtesy of Joseph Bryce, Brigham Young University).

The viewshed analysis from the mouth of Cave 2 (Figure 6.7; Table 6.3) shows that visibility is best to the southeast, overlooking the Great Salt Lake, over to the flats where the Chournos Springs site is located. Cave 1 is visible as well but Cave 3 is not. Views to the north and west are restricted because they are blocked by the cliff wall. This viewshed analysis provides a good idea of the visibility, but when visiting the cave in real life, the views to the southwest are better than this analysis indicates.

The viewshed analysis from Cave 3 (Figure 6.8; Table 6.3) shows that views to the south, southeast and southwest are very good, with some limitation to views in the valleys between mountain ridges. Caves 1 and 2 are not directly visible, but the Chournos Springs site is visible. Views to the north, northeast and northwest are restricted by the cliff wall.

Viewshed analysis from the Chournos Springs Site (Figure 6.9; Table 6.3) shows excellent visibility to the west, northwest and southwest over the Great Salt Lake. Views to the east and north are fairly good as well, with some limitations to views of the mountain gullies and valleys. This analysis shows more limited views directly to the east than is true in real life. Caves 1, 2 and 3 are all visible from the Chournos Springs site and there is no doubt that the people living here would have been able to see the people in the caves, especially with fires burning.

	Cave 1 (42B01)	**Cleft above Cave 1 (42B01)**	**Cave 2 (42B02)**	**Cave 3 (42B01916)**	**Chournos Springs (42B01915)**
Cave 1 (42B01)		Not Visible	Visible	Not Visible	Visible
Cleft above Cave 1 (42B01)	Not Visible		Not Visible	Not Visible	Visible
Cave 2 (42B02)	Visible	Not Visible		Not Visible	Visible
Cave 3 (42B01916)	Not Visible	Visible	Not Visible		Visible
Chournos Springs (42B01915)	Visible	Visible	Visible	Visible	

Table 6.3. Visibility between sites on Promontory Point.

One thing to note in these viewshed figures is the proximity of the sites to one another. Caves 1, 2 and 3 are all within 1 kilometer of each other and, even though there is not direct visibility between the three of them, good views can be obtained by walking a short distance from the mouths of the caves. I have no doubt that site intervisibility, if desired, could have easily been accommodated by nearby lookout locations, such as the cleft and saddle area above Cave 1 that is illustrated in Figure 6.6. Signalling among sites would certainly have been possible with additional points of observation. Figure 6.10 illustrates the cumulative viewshed of all of the sites on Promontory Point plus the cleft above Cave 1. When considering visibility from all sites, most of the west side of the point can be seen except for some of the mountain gullies or valleys. Also, there is visibility among all sites; such intervisibility would have made signalling between locations feasible. The proximity of these sites to one another is interesting when considering site clustering, line of sight communication and cooperation among sites, especially when we consider that these cave sites were all occupied by Promontory Culture peoples during the same time period in a foreign territory. Chournos Springs, the Fremont Culture site, is approximately 4 kilometers from the cave sites. It is still in relatively close proximity but located on the valley floor instead. Line of sight is also excellent between the Chournos Springs site and all three cave sites. Interaction between these groups would have almost been unavoidable. The relationship between these two groups is being further explored by Gabriel Yanicki in his Ph.D. research.

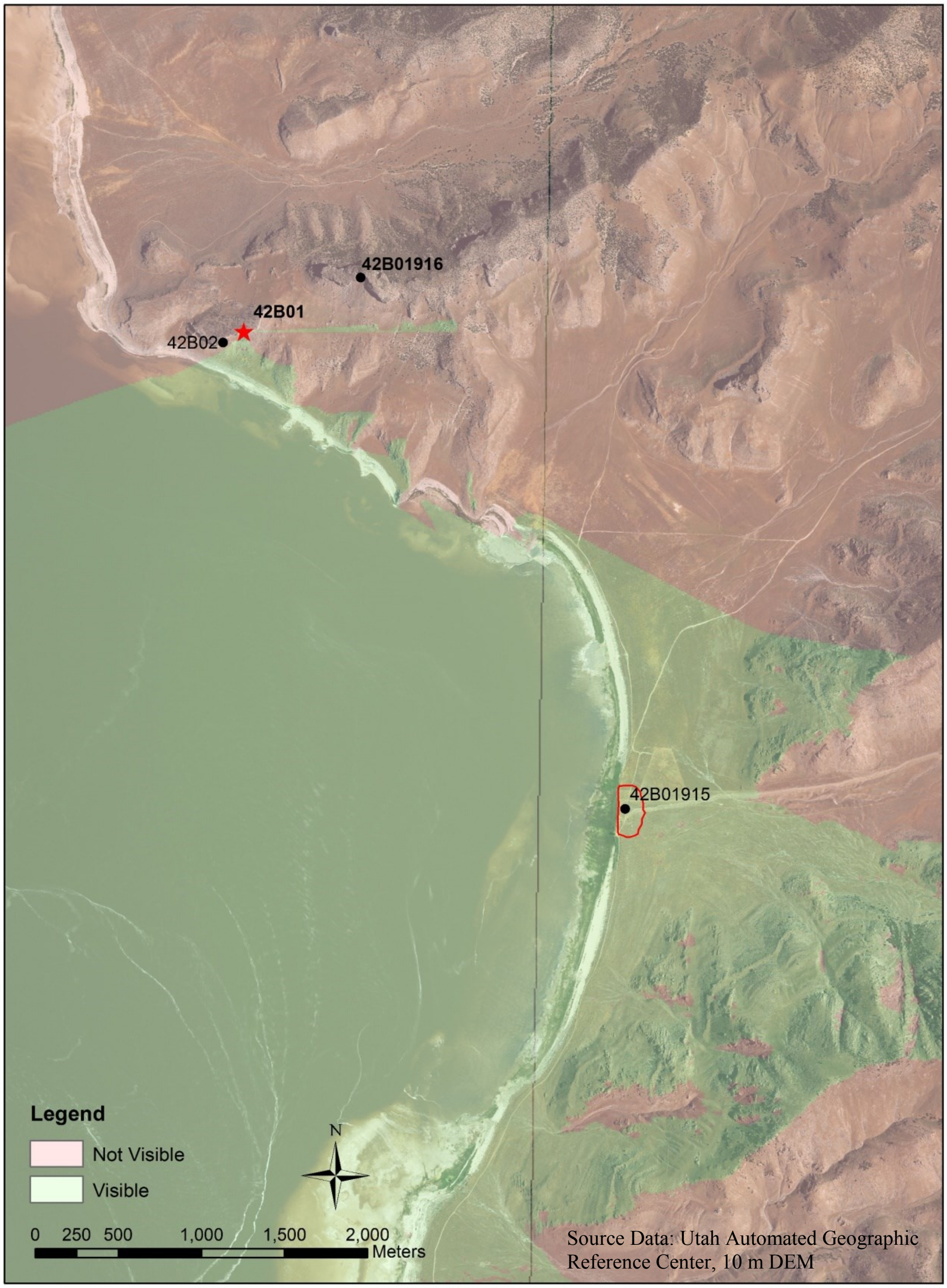


Figure 6.5. Viewshed analysis from the mouth of Promontory Cave 1 (42B01).

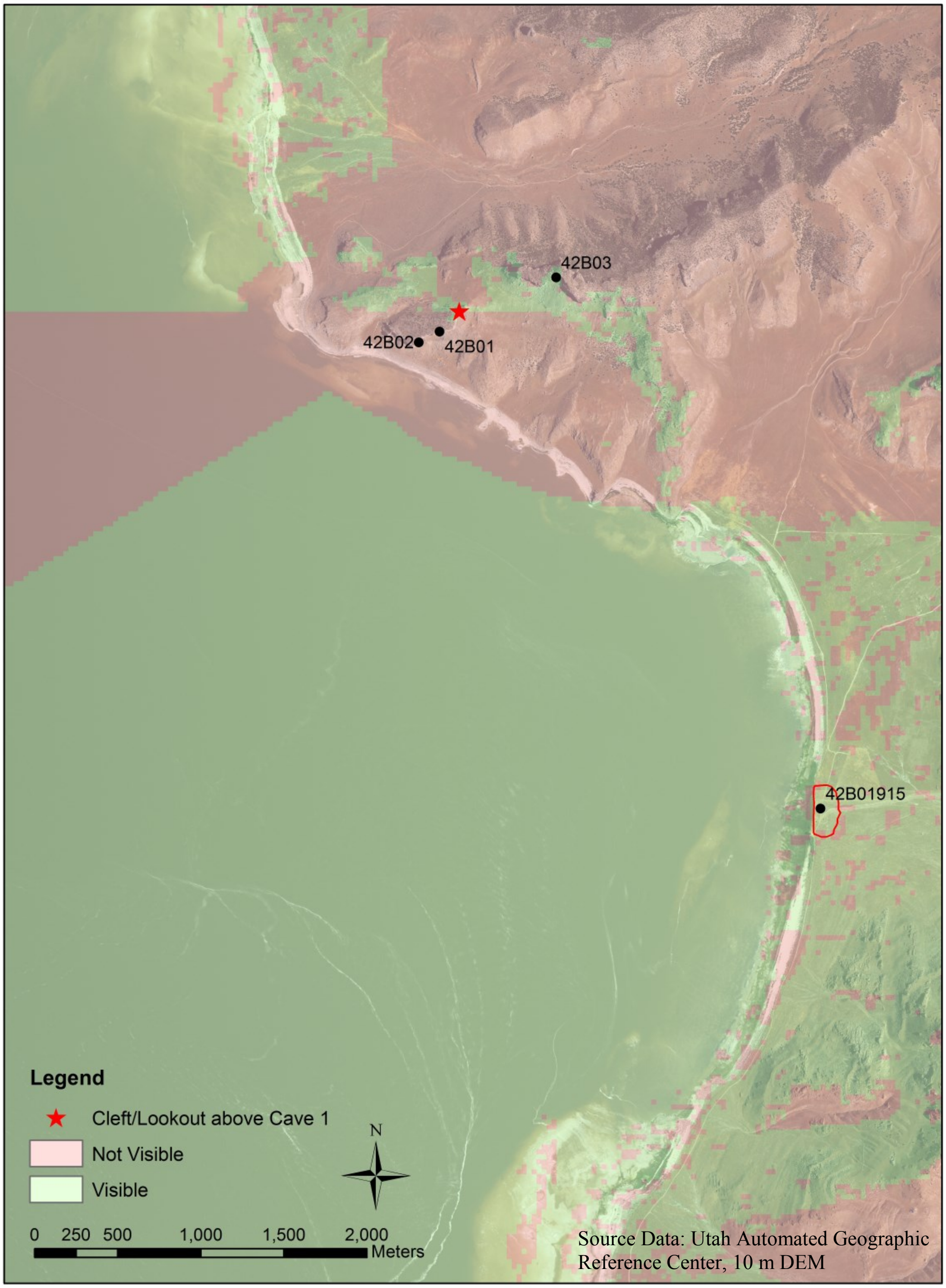


Figure 6.6. Viewshed analysis from the rock cleft above Promontory Cave 1 (42B01).

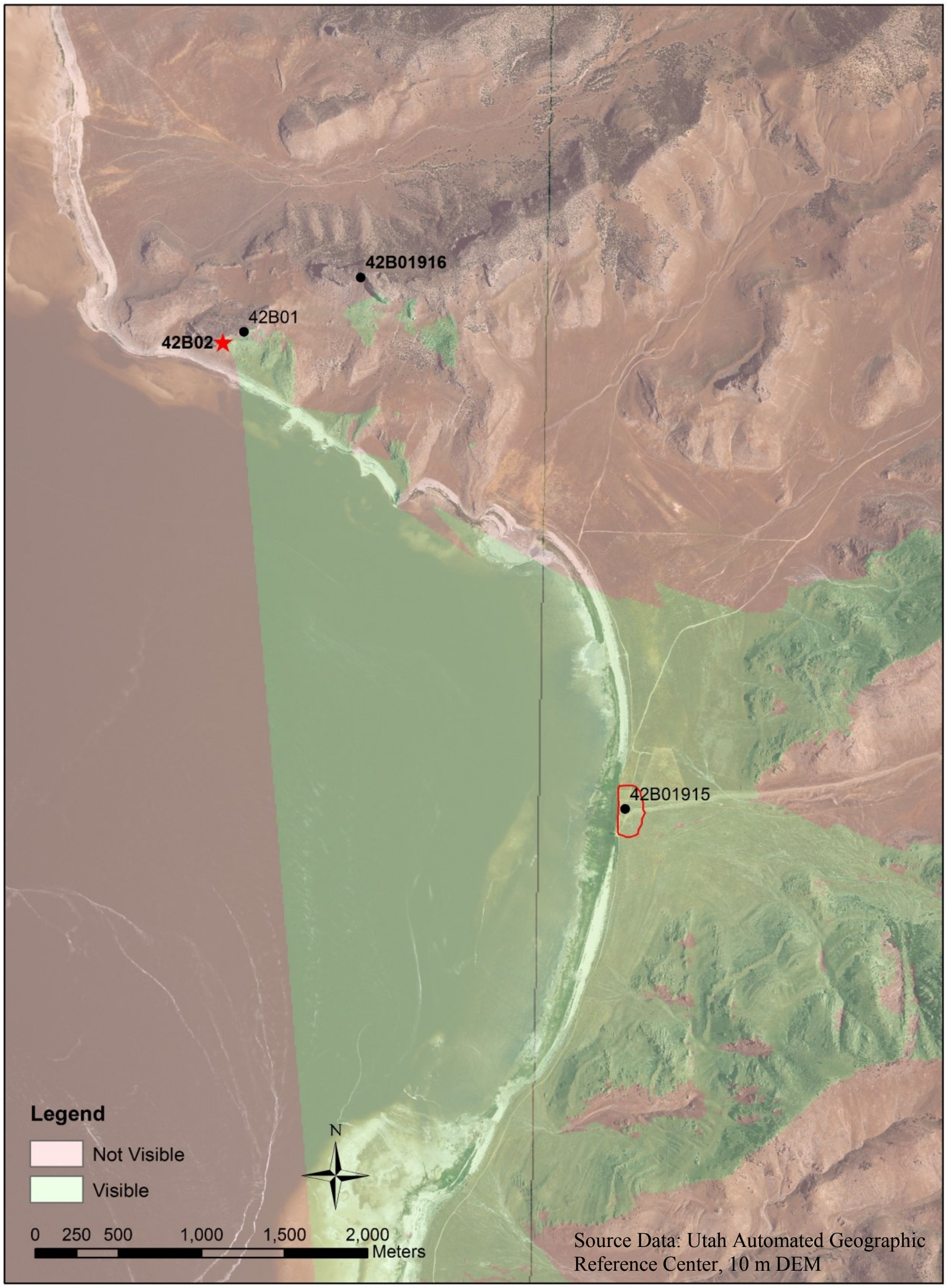


Figure 6.7. Viewshed analysis from the mouth of Promontory Cave 2 (42B02).

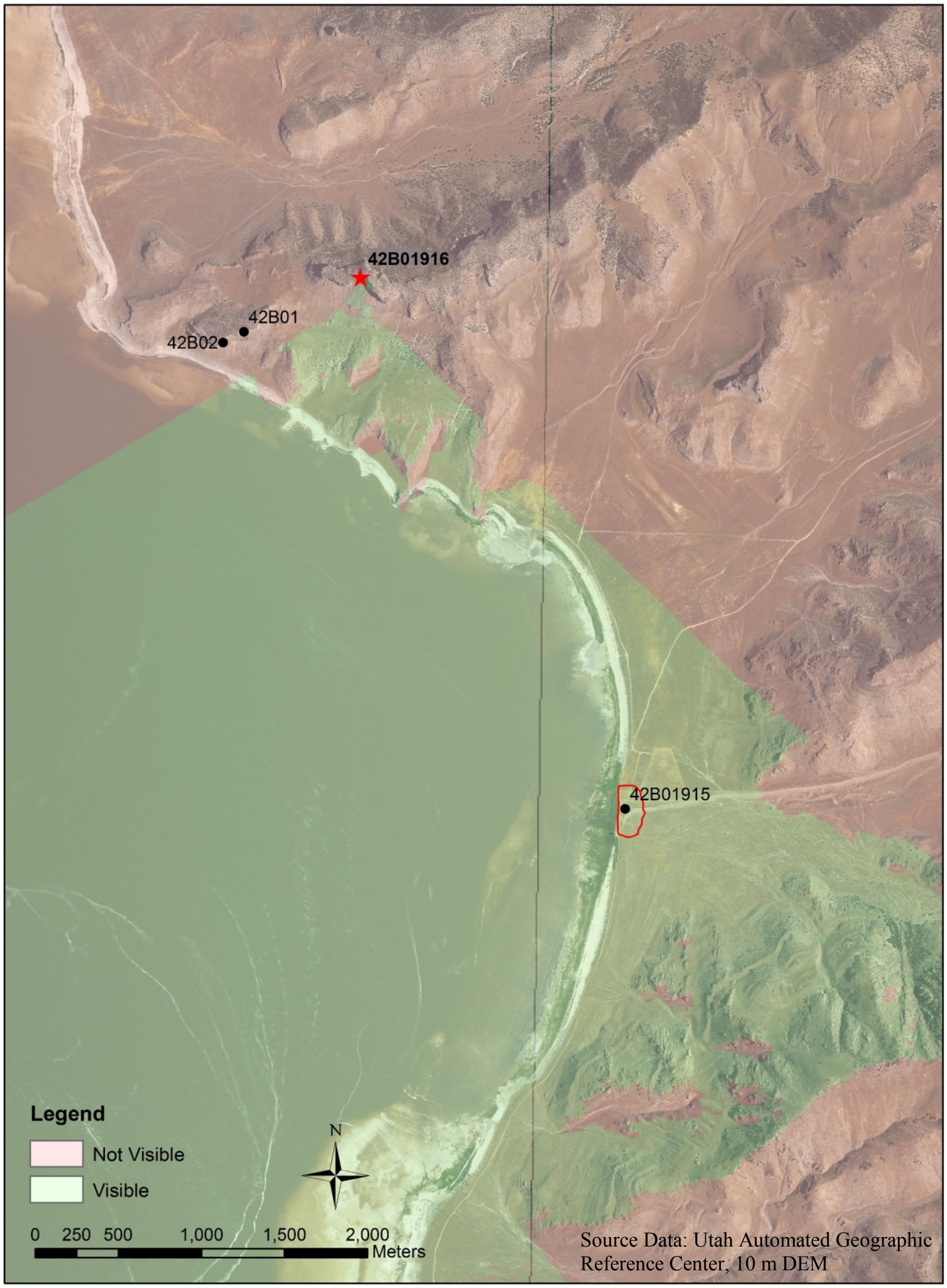


Figure 6.8. Viewshed analysis from the mouth of Promontory Cave 3 (42B01916).

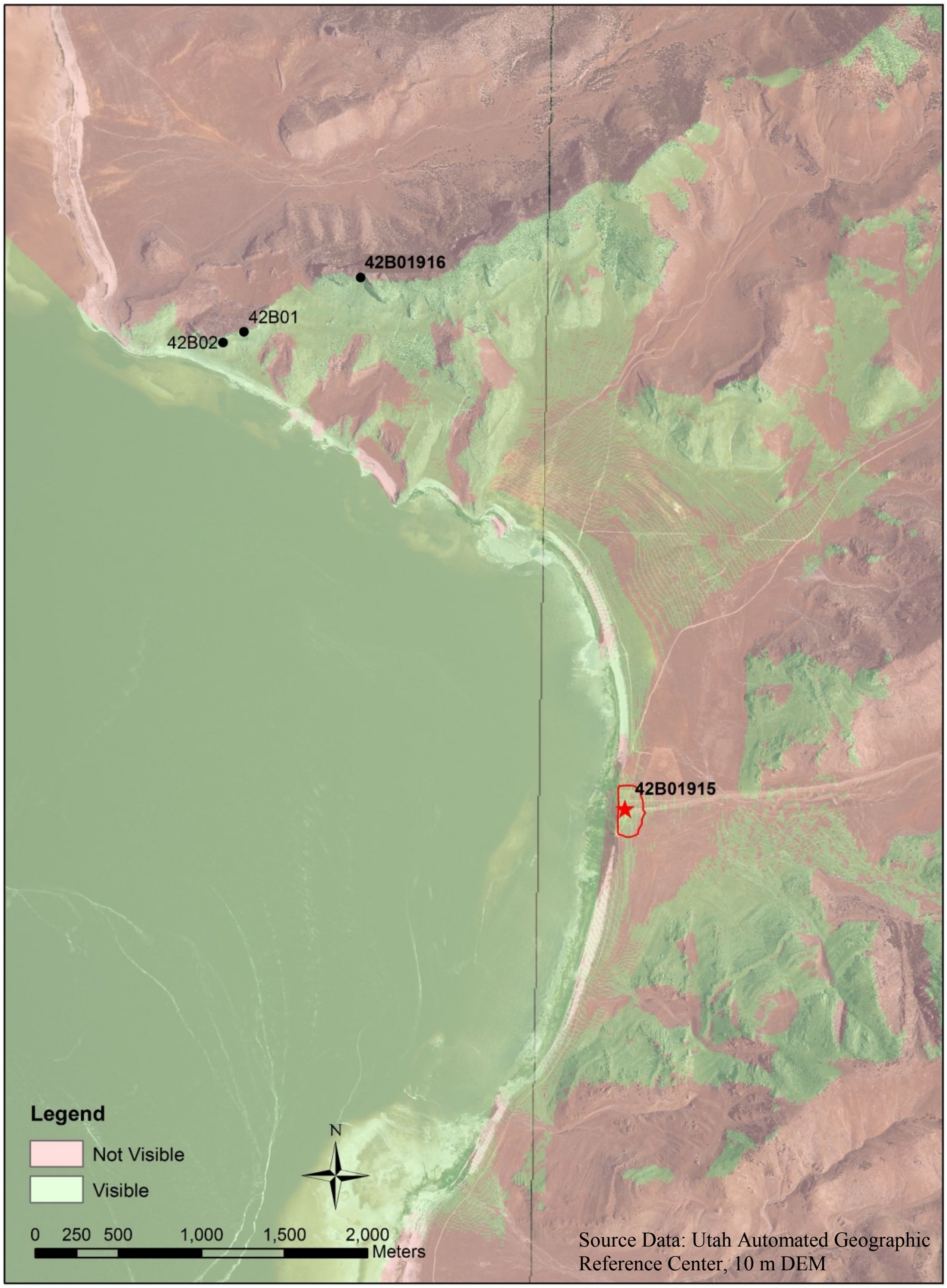


Figure 6.9. Viewshed analysis from Chournos Springs site (42B01915).

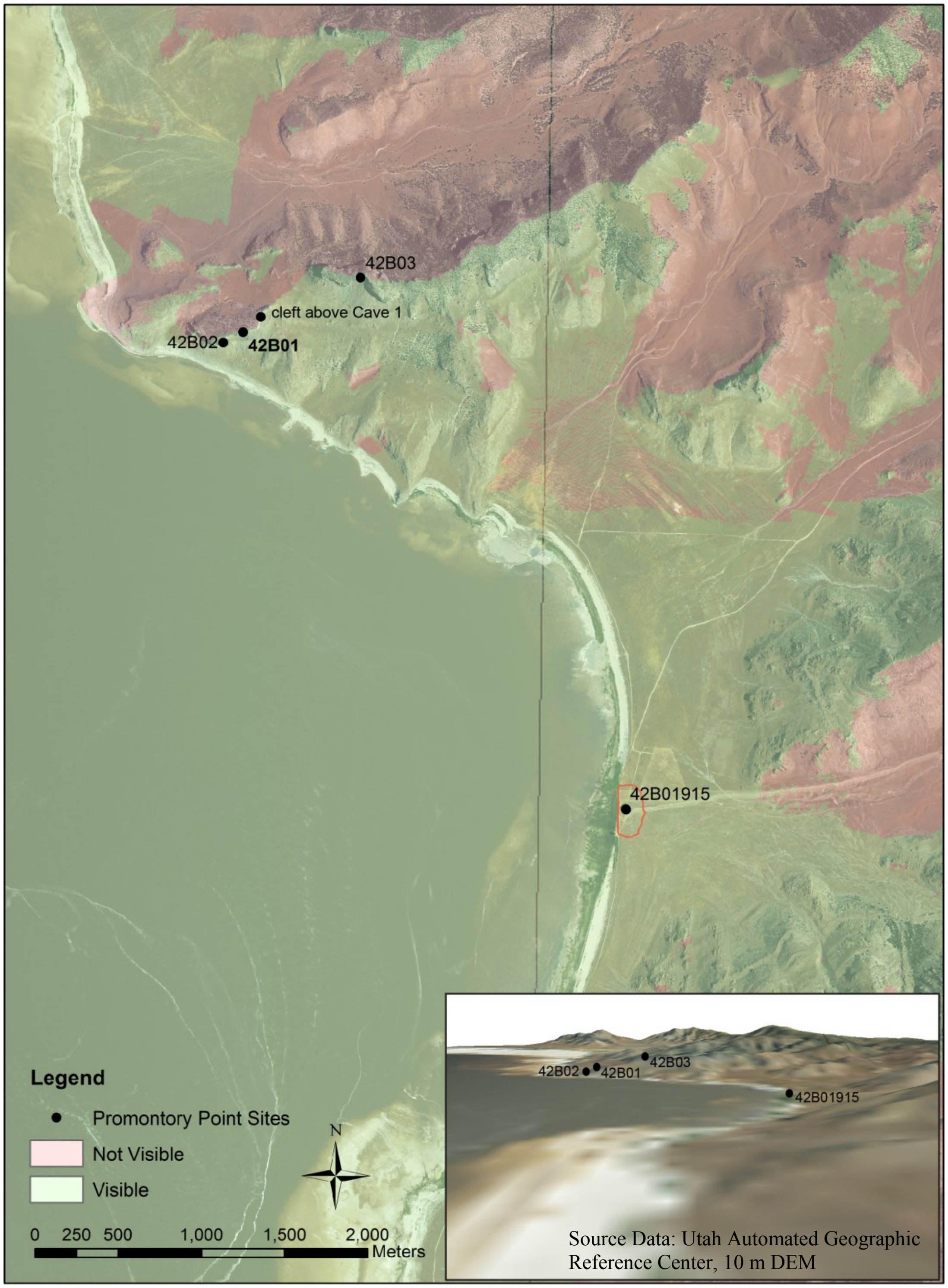


Figure 6.10. Combined viewshed analysis from all sites. Note the high amount of visibility among sites and on the whole of Promontory Point. Inset shows general terrain in the area.

6.3 Chapter Summary

Quantifying the defensibility of sites on Promontory Point has revealed that Caves 1, 2, and 3 have high defensibility indices. These three sites were all occupied by Promontory Culture peoples, a group new to the Great Basin, during a time of change and, as evidenced by the researchers above, a time of warfare, violence, and turmoil in the American Southwest, the Great Basin and the Great Plains (Bamforth 1994; Benson et al. 2007; Kohler et al. 2014; Lambert 2002; LeBlanc 1999; Schwindt et al. 2016; Solometo 2006). The Chournos Springs site, a Fremont Culture site, in the valley below has a low defensibility index of 1.04. This group may have had less concern for defense when they chose their settlement location since they had already been there for an extended period of time before the Promontory Culture people's arrival.

The main characteristics of defensibility, as evidenced by settlement patterns noted by the researchers in section 6.1 above, are shifts of sites to defensible landforms (caves included), site clustering, site intervisibility and use of topography to control site access. These characteristics all describe the Promontory Culture site locations. As mentioned before, there is no direct evidence of violence or warfare on Promontory Point, so that I have explored these cave sites as defensive locations as a working hypothesis. The larger thirteenth century sociopolitical environment of interior western North America was nonetheless competitive and characterized by violence. In this respect, the group in Cave 1 did have an abundance of weaponry, with the presence of significant numbers of arrowheads and arrow shafts. Hallson's (2017) artifact number projections suggest that there could be upwards of 2500 projectile points and 1850 arrow shafts in Cave 1. There is also evidence of advanced technology, with the presence of sophisticated composite bows (Steward 1937). These bows, and large number of projectile points, support the conclusion that the Promontory Culture group were very successful big game hunters. Clearly, such weaponry would also be effective for defensive purposes if required.

As mentioned earlier, the cave sites are not ideal in terms of ease of use. There are not any easily accessible freshwater sources close by (except when there is snow on the ground) and the hike into the caves can be strenuous. Everyday activities would have been much more difficult for the occupants of the cave sites versus people occupying the flats below the caves. The defensibility calculations have proven that the cave sites were highly defensible compared to the Chournos Springs site and other sites in North America. Given the less than ideal access the caves provide, defensibility is a good explanation for the Promontory Culture's choice of settlement locations. This choice may reflect the group's uncertainty about their presence in the area. There are several lines of research that indicate this group was a migrating group and new to the Great Basin region (Ives 2014; Steward 1937). If they were concerned about being an intrusive group, the ability to defend themselves may have heavily influenced their choice of settlement location. Though there is no evidence of outright violence, sometimes the "expectation of violence" is enough of a factor to exercise caution and take a defensible stance (Martindale and Supernant 2009:194).

CHAPTER 7

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This thesis has examined space in Promontory Cave 1, Utah, as a humanly-inhabited space in order to gain insight into how people occupied the space and what this group of people looked like in terms of group size and composition. By using ethnographic and archaeological data for group size, composition and dwellings of Western North American hunter-gatherer groups for comparison, informed calculations and models were able to be made. In addition, through Steward's and others' work on Promontory Point, it is evident that the Promontory Culture group were choosing to live in caves rather than build dwellings on lower elevation flats that were easier to access and closer to freshwater sources. The idea that this group was choosing to establish their dwellings in hard-to-reach caves for defensibility was also explored, and it was shown that, even compared to known fortresses and redoubts on the Northwest Coast and Fraser River Canyon areas of British Columbia, the caves are highly defensible.

7.1 Research Objectives Revisited

The goal of this thesis was to gain a deeper understanding of how people used space in Promontory Cave 1 and why they chose to live in the cave in the first place. Five research objectives were laid out in Chapter 1, and throughout the preceding chapters, these objectives were addressed. This section provides a summary of this research.

1) *How did people inhabit Promontory Cave 1, and in doing so, how did they partition space for activities? This will be explored using methods of space syntax analysis, analysis of black roof staining and smooth spots in the cave and archaeoacoustics.*

After analyzing the layout of dwellings of several different Western North American hunter-gatherer groups, a common pattern arose. While it is general, and there are minor variations and details between layouts, it became undeniable that certain aspects of dwelling layouts appeared repeatedly. This general pattern is: a central hearth, most often just one doorway (usually facing east), storage space next to the door, public space upon entrance where communal activities such as cooking and eating took place, and sleeping areas arranged around the perimeter of the dwelling. If there is a sacred space, it is located at the back of the dwelling, usually opposite the entrance. In dwellings that have divisions of space, there is often a men's half and a women's half. Most of these groups also laid down coverings on the floor such as willow, pine or spruce boughs, pine needles, and mats or hides.

This common pattern of the layout of built dwellings was applied to Promontory Cave 1. While Cave 1 is not a built dwelling, it seems reasonable to think that people would have organized space in the cave very much the same way as a built dwelling; in fact, social norms and practices would encourage it. Two models for the use of space in Cave 1 were presented in chapter five: the One-Dwelling model and the Two-Dwelling model. The One-Dwelling model treats the cave as one large dwelling, in which the main area of the cave with the most cultural deposition (Area A) is conceived of as the main public space where the central hearth lies. Around this central hearth, public activities such as cooking and eating, gaming, social interaction and other communal activities would have taken place. The private space would then be in the area of the cave to the east (Area B), an area that had less dense and diverse cultural material. This area would serve as space for sleeping and storage. Pictographs in the back of the cave would be the sacred space.

The Two-Dwelling model splits the cave into two, with each Area A to the west, and Area B to the east (both closer to the front of the cave), serving as separate spaces or dwellings. Each area would have its own central hearth, public space around the hearth, private space around the perimeter and sacred space at the back near the pictographs. In both models, there would have been floor coverings laid down, as evidenced by a large amount of juniper bark interspersed with cultural material. Robes or hides, which are abundant in the cave, may have also been used as floor coverings.

Both of these models are plausible and supported by archaeological evidence. Black roof staining from fires is present in each Area A and Area B, indicating that both areas had fires burning at some point in time. The artifacts found in both areas represent everyday activities such as cooking and eating, flintknapping and gaming. Pictographs are also present on each side of the cave, providing a sacred space for each Area A and Area B. It was also made apparent in this research that Area A and Area B are quite distinct spaces in terms of sound. Sound does not carry well from one area to the other, providing privacy between these spaces. All of this evidence would suggest that the Two-Dwelling model may be a better fit, with each of Area A and Area B being inhabited as separate dwellings. However, Hallson (2017) carried out density and diversity analysis on the artifacts recovered from the cave. She found that Area A had greater artifact diversity suggesting that it was preferred for daily activities over Area B. The density of artifacts in Area A is also much greater; however, the front portion of this area is interpreted to be a midden, which would account for the high density. It is unclear if this midden area would have been used for material from both areas or just from Area A. Regardless, Hallson's (2017) research does show that Area B was more limited in its use. This conclusion would support the One-Dwelling model, with more of the public, communal activities taking place in Area A and sleeping and storage in Area B.

Besides the common layout of built dwellings seen across ethnographic accounts of Western North American hunter-gatherer groups, there are other social factors that would dictate which of these models of space use the group may have used, including whether they practiced endogamy or exogamy. In an endogamous group, they may be more likely to utilize a One-Dwelling approach, in which the group is all together and they are occupying primarily Area A, then, as the group became larger, they may have expanded into available space, utilizing both areas but still having Area A serve as the main public space. In an exogamous group, they would be more likely to follow the Two-Dwelling model, where families or households would be separated where required. Some groups among the Athapaskans and the Apacheans practiced mother-in-law avoidance, a custom that required segregation. This practice could easily be accommodated in Cave 1 with the social partitioning of Areas A and B.

Currently there is not enough evidence to concretely say which model would apply. There is evidence to support both. However, space syntax analysis would suggest that Area A and Area B are parallel (same depth) and both public spaces. Therefore, I am inclined to favour the Two-Dwelling model of space use with social, rather than physical barriers (such as the rockfall separating sleeping areas) dictating public versus private space within the cave. However, these models are not mutually exclusive, and it is possible that both were employed as the Promontory occupation developed.

2) *Steward (1938) provided extensive data on Numic social structure and group composition for the Great Basin, and Ives (1990, 1998) and other researchers have provided similar data for northern Dene groups and other North American hunter-gatherer groups. I will compile data for Western North American hunter-gatherer groups including group size, group composition, space needs per person and characteristics of their built dwellings and apply this data to Cave 1 to gain insights into how space in the cave was used.*

Chapter four addressed this objective, where possible. I focused on five broad categories of Western North American hunter-gather groups, based on their proximity to Promontory Cave 1 and cultures that use their environment in similar ways. These groups included Subarctic Athapaskans, Subarctic Algonquians, Plains groups, Great Basin or Numic-speaking groups and

Apacheans. I looked at many ethnographic accounts of these cultures and pulled relevant data related to group size and composition, space needs per person and characteristics of their built dwellings.

I was able to calculate the average space needs per person of each group (except Great Basin groups due to lack of data), and from that calculate an overall space needs per person value for Western North American hunter-gatherer groups. The average space needs per person for each group was as follows: Athapaskans – 6.31 square metres; Algonquians – 4.21 square metres; Plains – 4.05 square metres and; Apachean – 2.4 square metres. The overall average space needs per person for all groups was calculated to be 4.24 square metres.

Several other researchers have explored hunter-gather group sizes and noticed consistency among groups worldwide (Binford 2001; Hamilton et al. 2007; Helm 1968; Hill et al. 2011; Honigmann 1946). The main group sizes are the individual (1 person), the family (5 people), the dispersed group (15 people), the aggregated group (54 people), periodic aggregation (165 people) and the entire population (839 people). When I looked at the Western North American hunter-gather groups in terms of group size, they matched these universal values fairly closely. The Athapaskan and Algonquian groups matched them almost exactly, but the Plains groups were a bit higher than the averages, while the Great Basin groups were a bit lower than the average. These differences can likely be attributed to either abundance or lack of resources, respectively, or because of different cultural practices that in the Plains case would have involved equestrian societies. However, I would argue that the main factor is availability of resources. The Plains groups usually had an abundance of food available either through bison hunting or horticulture, while the Great Basin, at the time the ethnographic work was carried out, had scarcer resources. The Apachean values were also higher than the universal averages. This could be because of their clan organization, or simply because of a lack of available data. Knowing the average group size values of hunter-gatherer groups was a good check against the values obtained for the maximum group size possible for the Promontory Cave occupants, which is addressed in the next question.

Group composition was also noted where possible. The most common theme that arose from this was several families making up one larger group. The larger group was often determined by kinship ties, with either an adult child living close to their parents, or a group of siblings living in the same community. Hill et al. (2011:1287) noticed patterns worldwide, such as parents living with offspring of both sexes, and brothers and sisters co-residing (forming sibling cores), with an overall tendency for male kin to co-reside versus female kin. This same pattern was noted among many of the groups looked at in this research. In terms of group composition related to space use, two patterns were noted. One pattern was a single family household where one family (a conjugal pair, their children and other dependents) would have their own dwelling. The second was a multi-family household where more than one family would occupy one dwelling. These patterns would have implications for how space in a dwelling was organized.

The layout of dwellings was also noted among these groups. As mentioned and described under point one, a common pattern was noticed in the layout of built dwellings. This pattern applied to most of the dwellings examined and consisted of a central hearth, public space for communal activities around the hearth, private space around the perimeter of the dwelling, storage near the door and sacred space at the back of the dwelling, opposite the door. This pattern applied regardless of the shape of the dwelling.

3) *How many people could have occupied the cave at one time? Steward (1937) speculated that the livable space in Cave 1 would only be approximately 200-300*

square metres, enough room for roughly 100-150 people. I will explore this idea by comparing livable space in the cave (calculated from 3D scan data) with space needs per person values (compiled in the second research question). Using those calculations, I can then determine how many people the cave likely accommodated at any one time, given the variety of activities taking place.

The average space needs per person of Western North American hunter-gatherer groups (calculated in chapter four and discussed in point two above) was applied to Cave 1. The livable area in Cave 1 was calculated from the 3D scan data to be 449 m^2. With a space needs per person value of 4.24 m^2 (calculated in chapter four), the maximum number of people that could occupy Cave 1 works out to about 106. However, in common group sizes and hierarchies seen among hunter-gather groups worldwide, this number falls right in between an aggregated group or tribe (Binford's Group 2) and a group that periodically aggregates (Binford's Group 3) (Table 4.1). Given that the archaeological evidence shows a group inhabiting this cave relatively permanently for one to two generations, it seems unlikely that aggregation would be periodic. This means that it is more likely that the actual number of people inhabiting the cave at one time would be smaller than 106, leaning towards the aggregated group, tribe, or regional band whose average worldwide number is 54 people (Table 4.1). When comparing this to Steward's (1937) estimate, the value of 106 inhabitants matches his number of 100-150 people closely, but the livable area of 449 m^2 calculated from the 3D scan is quite a bit higher. He estimated a livable area of 200 to 300 square metres, meaning that he only allowed for about two square metres of space per person. I think his estimate of space needs per person was a bit low, but his estimate of livable area was correct, if Area C is excluded, and we only consider areas with actual cultural deposition.

As mentioned above, Area C at the back of the cave has very few artifacts, suggesting that it wasn't used as a dwelling area, at least not like Areas A and B were. If that area is excluded from the calculation, as well as portions of Area B that do not have cultural deposits, then the livable area value would drop to 239 m^2. The portions of the cave that contained cultural material were mapped by Jennifer Hallson during the 2014 field season which has allowed the definitively inhabited area to be refined even further than with just the 3D scan (Figure 5.14). With an average space needs per person value of 4.24 m^2 and a livable area of 239 m^2, this would take the maximum number of people down to 56, which brings the value, almost exactly, to the worldwide aggregated group value of 54.

Another factor to consider is that the material culture is quite possibly from ancestral Athapaskans (Steward 1937; Ives 2014). If we consider Athapaskans only, the space needs per person value is a bit higher at an average of 6.31 m^2. Space needs per person values used by Casselberry (1974) and Brown (1987) are also approximately 6 m^2 so, while I am using this value because it is close to Athapaskan averages, it is also relevant for other hunter-gatherer groups. With 239 m^2 of definitively inhabited space and the Athapaskan space needs per person value, the maximum number of people inhabiting the cave would lower to 37.9.

With these calculations, it would be logical to conclude that the maximum group size occupying Promontory Cave 1 at any one time would range from 35 to 50 people. This value falls close to universal hunter-gatherer group size values, and also fits in line perfectly with Zhou et al.'s (2005) social brain hypothesis which classifies a "band" as anywhere from 35 to 50 people (chapter four, section 4.2).

4) By using moccasin lengths as a proxy for stature, and stature as a proxy for age, Billinger and Ives (2015) examined the population structure of Cave 1. This information can be integrated with results from the first two research questions to provide insights into the social structure of the group(s) inhabiting Cave 1.

While exploring the ethnographic data for built dwellings, two common themes were noted among most of the groups. The first is a single family occupying one dwelling and the second was two or more families in one dwelling. If the Promontory group reached its maximum size of 35 to 50 people, the group would have been made up of multiple families. This applies regardless of the cave being occupied as one large dwelling or partitioned into two separate spaces.

The "multi-family household model" is based on two or more families in one household. Each family would be made up of a husband, his wife and their children. In a group of 50 to 60 people, representing approximately seven households (based on the average household size for Western North American hunter-gatherer groups, table 5.4), the composition might look something like: 14 adult males, 14 adult females and anywhere from 28 to 42 children, plus perhaps additional adults representing grandparents or unmarried siblings or relatives. These numbers are based on two families per household, but there could be more families in each household. This type of group composition would consist of quite a few more children. The drawback with this model is that the numbers do not leave a lot of room for the presence of other relatives (grandparents, unmarried siblings, etc.) or non-related visitors who would no doubt be present.

If the multi-family household model is applied only to Athapaskans, the group composition for a group of 35 to 40 people in four households might look like: eight adult males, eight adult females and anywhere from 16 to 24 children. Again, these numbers are based on two families per household.

The moccasin data compiled by Billinger and Ives (2015) indicate that a high number of children were present in the cave. This suggests that the Promontory Cave group was growing, meaning that conjugal pairs may have been having more children than the universal average of two or three which would alter the demographics presented above a little bit. However, the values presented above still support that children outnumbered adults, with about 40% of the population consisting of adults and 60% consisting of children.

5) Were Caves 1, 2 and 3 chosen for occupation because of their defensibility? This idea will be explored by calculating the defensibility of known Promontory site locations and comparing their values to other sites.

It was noted in chapter six that there was evidence of conflict and and turmoil in the American Southwest, the Great Basin and the Great Plains at the time of Promontory Culture occupation of Caves 1, 2 and 3 (mid-late A.D. 1200's) (Bamforth 1994; Benson et al. 2007; Kohler et al. 2014; Lambert 2002; LeBlanc 1999; Schwindt et al. 2016; Solometo 2006). While there is no direct evidence that conflict was occurring on Promontory Point during that time period, it was suspected that defensibility may have been a factor in choice of settlement location. The Promontory Culture was a migrating group that was new to the area and potentially intruding on the resident Fremont population occupying the Chournos Springs site on the nearby flats. The cave sites are not easy to access, and there are no freshwater sources nearby, so they are not ideal in terms of the ease of carrying out everyday activities. It made us wonder why they would choose to intensively occupy these cave sites instead of placing their settlement on a location on the Promontory that provided easier access to resources.

Chapter six addressed this question by using Martindale and Supernant's (2014) defensibility index (DI). While signs of defensiveness are visible in the archaeological record, and often assumed to be defensive, Martindale and Supernant (2009) saw a need to quantify defensibility to obtain a definitive answer rather than rely on assumptions. They focused on the biomechanical functionality of a site as a measure of defensibility and created a defensibility index (DI) based on four main variables: visibility, elevation, accessibility and area (Martindale and Supernant 2009). I applied this equation to the known sites on Promontory Point including

Caves 1, 2 and 3 and the Chournos Springs site. I left area out of the equation, as it did not apply well to the cave sites. The results obtained from the calculations show that all of the Promontory Culture sites (Cave 1, 2 and 3) are highly defensible, while the Chournos Springs site has low defensibility. When I compared the results to sites on the Northwest Coast and in the Fraser River Canyon region (where DI was calculated by Martindale and Supernant 2009 and Supernant 2014, respectively) the cave sites proved to be highly defensible. Promontory Caves 1, 2 and 3 all have equal to, or higher, DI values than the most defensible sites on the Northwest Coast and in the Fraser River Canyon region (Tables 6.1 and 6.2). This suggests that defense was one of the primary concerns for the Promontory Cave inhabitants.

7.2 Research Contributions

This research has looked, in detail, at space needs per person, group size and composition and layout of built dwellings of Western North American hunter-gather groups. These data, which can be expanded upon, provide a basis from which further research can be carried out. While my interests were specifically for application of these data to Promontory Cave 1, it can easily be applied to other archaeological research focusing on Western North America. This project also provides a dataset upon which other researchers can build, as I am sure the available information from ethnographic data has not been exhausted.

For Promontory Cave 1 research, I have provided a solid footing for future research into group size and composition and use of space in Promontory Cave 1, and answered several key questions, such as the maximum group size that would have been able to occupy the cave, and possible models of group composition and space use. I was also able to explore certain aspects of space in the cave such as sound, which was proven be quiet and quite distinct between Areas A and B. We also learned definitively that the black staining on the roof was from fires. The models of space use and group composition presented in this thesis can be built upon with future excavation and testing, including the exploration of areas of the cave as public, private or sacred. I have also shown that the Promontory cave sites are highly defensible, indicating that defense was likely a factor in the group's choice of settlement locations.

7.3 Future and Other Research

Radiocarbon dating has shown that Promontory Cave 1 was occupied over a 50 year period from ca. A.D. 1240-1290. The calculations for group size and composition presented in this thesis do not necessarily take changes over time into account; it is more a snapshot in time and represents the maximum group size possible in Cave 1. The group was no doubt dynamic over time, and group size and composition would have fluctuated. Other research might consider this aspect of time, and how changes in the group may have occurred over this 50 year time period. Jennifer Hallson (2017), a graduate student at the University of Alberta, tackled this question, in part, by calculating densities for artifacts found during the 2011, 2013 and 2014 field seasons and projecting these numbers into the entire cave volume to determine how much cultural deposition likely occurred over this entire time period.

Gabriel Yanicki, also a graduate student at the University of Alberta, has completed excavations at the Chournos Springs site (42B01915) and is exploring Fremont-Promontory interactions on Promontory Point. This research will have implications for the idea of defensibility of sites on Promontory Point, and the difference in location of Fremont and Promontory sites and, possibly, group composition of the Promontory Culture group. If interactions between these groups occurred, and marriage exchanges were taking place, then it would show that the Promontory group was practicing exogamy and changing through the process of fusion with other groups. In addition to the Chournos Springs site, there were a lot of contemporary sites on the other side of Bear River, on the NE shore of Great Salt Lake. This population may have also been a source of considerable Fremont-Promontory interaction and may have contributed to the Promontory Cave groups concern with defense. Gabriel Yanicki is also exploring this potential interaction through ceramic analysis.

For insights into the choice of settlement locations or defensibility on Promontory Point, it would also be useful if more survey was done on the point. Steward noted twelve Promontory cave locations, but only four are definitively known today. Survey of the area to locate additional Promontory Culture sites, and perhaps Fremont sites, would add to the number of sites that could be compared for defensibility. It would also have implications for the total number of Promontory Culture peoples present in this area during that time period and how these people interacted. If more Promontory sites were found, the idea of interaction and intervisibility could be built on. Perhaps there was a network of intervisible locations on Promontory Point, with Promontory groups working together. This would strengthen their defensibility even more. If there was a larger network of Promontory sites it would also have implications for where they were finding marriage partners which would influence group composition through either the practice of exogamy or endogamy.

Lastly, this thesis has shown that a maximum group size of 35 to 50 people at any one time was possible in Cave 1. With additional people in surrounding caves, this could result in a significant number of adept hunters, perhaps as many as 50 to 60. A group this size could potentially have significant impacts on a big game population on Promontory Point. The Promontory Culture occupation on the Point ended about as suddenly as it began, and across the Great Basin, including Promontory, bison populations diminished in a widespread way around A.D. 1300-1350 (Grayson 2006; Lupo and Schmitt 1997). After the Cave 1 occupation, the

Promontory Phase became prominent in the Utah Valley to the south (Janetski and Smith 2007). If the group was reaching its maximum size and becoming crowded in Cave 1, and other factors like overhunting were in play, the lack of available resources for a group of that size may have resulted in the group leaving Promontory Point and moving to resource-rich areas around Utah Lake in the Utah Valley region, or group fissioning, with a wider dispersal of daughter groups.

REFERENCES CITED

Adams, William Y. and Ian Skoggard
2004 Culture Summary: Navajo. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Ahmon, J.
2004 The application of short-range 3D laser scanning for archaeological replica production: The Egyptian tomb of Seti I. *The Photogrammetric Record* 19(106):111-127.

Aikens, Melvin C.
1967 Plains Relationships of the Fremont Culture: A Hypothesis. *American Antiquity* 32(2):198-209.

Aletta, Francesco and Jian Kang
2015 Soundscape approach integrating noise mapping techniques: a case study in Brighton, UK. *Noise Mapp* 2:1-12.

Al-Kheder, S., Al-Shawabkeh, Y., and Haala, N.
2009 Developing a documentation system for desert palaces in Jordan using 3D laser scanning and digital photogrammetry. *Journal of Archaeological Science* 36(2):537-546.

Anthony, David W.
1990 Migration in Archaeology: The Baby and the Bathwater. *American Anthropologist* 92(4):895-914.

Arkush, Brooke S.
2014 Report of Archaeological Investigations at 10Oa275 on the Curlew National Grassland in Southeastern Idaho. Department of Anthropology and Sociology, Weber State University. Submitted to Caribou-Targhee National Forest. Cooperative Agreement 04-CS-11041563-033.

Arkush, Brooke S. and Bonnie L. Pitblado
2000 Paleoarchaic Surface Assemblages in the Great Salt Lake Desert, Northwestern Utah. *Journal of California and Great Basin Anthropology* 22(1):12-42.

Arkush, Elizabeth N. and Mark W. Allen
2006 *The Archaeology of Warfare: Prehistories of Raiding and Conquest*. Florida University Press, Florida.

Asch, Michael L.
1980 Steps toward the Analysis of Athapaskan Social Organization. *Arctic Anthropology* 17(2): 46-51.

1988 Kinship and the Drum Dance in a Northern Dene Community. *The Circumpolar Research Series*. Edmonton: The Boreal Institute for Northern Studies and Academic Printing and Publishing.

Ascher, Robert
1961 Analogy in Archaeological Interpretation. *Southwestern Journal of Anthropology* 17(4):317-325.

Bafna, Sonit
2003 Space Syntax: A Brief Introduction to Its Logic and Analytical Techniques. *Environment and Behaviour* 35(1):17-29.

Bamforth, Douglas B.
1994 Indigenous People, Indigenous Violence: Precontact Warfare on the North American Great Plains. *Man* 29(1):95-115.

Barton, J.
2009 3D laser scanning and the conservation of earthen architecture: A case study at the UNESCO World Heritage Site Merv, Turkmenistan. *World Archaeology* 41(3):489-504.

Beck, Charlotte and George T. Jones
1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11(2):161-236.

Beierle, John
2012 Culture Summary: Chiricahua Apache. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Benson, Larry V., Michael S. Berry, Edward A. Jolie, Jerry D. Spangler, David W. Stahle and Eugene M. Hattori
2007 Possible impacts of early-11th-, middle-12th-, and late 13th-century droughts on western Native Americans and the Mississippian Cahokians. *Quaternary Science Reviews* 26:336-350.

Berger, Elliot, Rick Neitzel, and Cynthia A. Kladden
2015 Noise Navigator Sound Level Database. Electronic document, http://www.dangerousdecibels.org/education/information-center/decibel-exposure-time-guidelines/, accessed November 11, 2015.

Berry, Michael S. and Claudia F. Berry
2003 *An Archaeological Analysis of the Prehistoric Fremont Culture for the Purpose of Assessing Cultural Affiliation with Ten Claimant Tribes*. Report prepared for Upper Colorado Regional Office, Bureau of Reclamation, Salt Lake City, Utah.

Billinger, Michael and John W. Ives

2015 Inferring Demographic Structure with Moccasin Size Data from the Promontory Caves, Utah. *American Journal of Physical Anthropology* 156:76-89.

Billings, William D.

1951 *Vegetational zonation in the Great Basin of western North America*. Les Bases Ecologiques de la Régénération de la Végétation des Zones arides. International Union of Biological Sciences, Series B, No.9.

Binford, Lewis R.

1967 Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning. *American Antiquity* 32(1):1-12.

2001 *Constructing frames of reference: an analytical method for archaeological theory building using hunter-gatherer and environmental data sets*. University of California Press.

Birket-Smith, Kaj

1976 *Contributions to Chipewyan Ethnology*. Report of the Fifth Thule Expedition, 1921-24 Vol. VI No. 3. AMS Press, New York.

Blackwelder, R. Eliot

1948 *The Geological Background*. The Great Basin: with emphasis on glacial and post-glacial times. *Bulletin of the University of Utah* Vol. 38, No. 20. University of Utah, Salt Lake City.

Blesser, Barry and Linda-Ruth Salter

2007 *Spaces Speak, Are You Listening?: Experiencing Aural Architecture*. The MIT Press, Cambridge, Massachusetts.

Bocinsky, R. Kyle

2014 Extrinsic site defensibility and landscape-based archaeological inference: An example from the Northwest Coast. *Journal of Anthropological Archaeology* 35:164-176.

Broughton, J.M., D. Madsen and J. Quade

2000 Fish Remains from Homestead Cave and Lake Levels of the Past 13,000 Years in the Bonneville Basin. *Quaternary Research* 53:392-401.

Brown, Barton M.

1987 Population Estimation from Floor Area: a Restudy of "Naroll's Constant". *Cross-Cultural Research* 21(1):1-49.

Brown, Jennifer S.H. and John Beierle

2000 Culture Summary: Ojibwa. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Bustard, W.
1999 Space, evolution, and function in the houses of Chaco Canyon. *Environment and Planning B: Planning and Design* 26(2):219-240.

Butler, Robert B.
1983 *The Quest for the Historic Fremont and a Guide to the Prehistoric Pottery of Southern Idaho*. Occasional Papers of the Idaho Museum of Natural History, Number 33, Pocatello, Idaho.

Butler, Bert S. and Victor C. Heikes
1916 *Notes on the Promontory District, Utah*. Contributions to Economic Geology, Part I. pubs.usgs.gov/bul/0640a/report.pdf

Byrne, William. J.
1978 An archaeological demonstration of migration on the northern Plains. In *Archaeological Essays in Honor of Irving B. Rouse*, edited by Robert C. Dunnell and Edwin S. Hall, pp. 246-273. Moulton Publishers, New York.

Casey, Edward S.
2008 Place in Landscape Archaeology: A Western Philosophical Prelude. In *Handbook of Landscape Archaeology* edited by Bruno David and Julian Thomas, pp. 44-50. Left Coast Press, Walnut Creek, California.

Casselberry, Samuel E.
1974 Further refinement of formulae for determining population from floor area. *World Archaeology* 6(1):117-122.

Clark, Annette McFadyen
1996 *Who Lived in This House? : A Study of Koyukuk River Semisubterranean Houses*. Canadian Museum of Civilization, Hull.

Coltrain, Joan B. and Steven W. Leavitt
2002 Climate and Diet in Fremont Prehistory: Economic Variability and Abandonment of Maize Agriculture in the Great Salt Lake Basin. *American Antiquity* 67(3):453-485.

Commission for Environmental Cooperation
1997 *Ecological Regions of North America: Toward a Common Perspective*. Commission for Environmental Cooperation, Montreal, Quebec.

Conaty, Gerald T. and John Beierle
1999 Culture Summary: Blackfoot. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Copeland, James M. and Hugh C. Rogers
1996 In the Shadow of the Holy People, Ceremonial Imagery in Dinetah. In *The Archaeology of Navajo Origins*, edited by Ronald H. Towner, pp. 213-229. University of Utah Press, Salt Lake City.

Currey, Donald R., Genevieve Atwood, and Don R. Mabey
1984 *Major levels of Great Salt Lake and Lake Bonneville*. Utah Geological and Mineral Survey, Map 73.

CyArk and Partners
2014 About page. Electronic document, http://www.cyark.org/about/, accessed October 25, 2015.

Dawson, Peter C.
2002 Space syntax analysis of Central Inuit snow houses. *Journal of Anthropological Archaeology* 21(4):464-480.

Dawson, Peter C. and Richard Levy
2005 A Three-Dimensional Model of a Thule Inuit Whale Bone House. *Journal of Field Archaeology* 30(4):443-455.

Dawson, Peter C., Richard Levy, Don Gardner, and Matthew Walls
2007 Simulating the behaviour of light inside Arctic dwellings: implications for assessing the role of vision in task performance. *World Archaeology* 39(1):17-35.

Dawson, Peter C., Margaret M. Bertulli, Richard Levy, Chris Tucker, Lyle Dick, and Panik Lynn Cousins
2013 Application of 3D Laser Scanning to the Preservation of Fort Conger, a Historic Polar Research Base on Northern Ellesmere Island, Arctic Canada. *Arctic* 66(2):147-158.

Devereux, Paul
2002 Ears & Years: Aspects of Acoustics and Intentionality in Antiquity. In *Archaeoacoustics*, edited by Christopher Scarre and Graeme Lawson, pp.23-30. Cambridge: McDonald Institute for Archaeological Research.

Dunbar, R.I.M.
1993 Coevolution of neocortex size, group size and language in humans. *Behavioural Brain Science* 16:681-694.

Dyen, Isadore and David F. Aberle
1974 *Lexical Reconstruction: The Case of the Proto-Athapaskan Kinship System*. Cambridge University Press, Cambridge.

Eggan, Fred
1980 Shoshone Kinship Structures and Their Significance for Anthropological Theory. *Journal of the Steward Anthropological Society* 11(2):165-193.

English Heritage
2011 *3D Laser Scanning for Heritage*. 2nd Ed. English Heritage, Swindon.

Fiero, Bill
2009 *Geology of the Great Basin*. Max C. Fleischmann Series in Great Basin Natural History, University of Nevada Press, Reno.

Forsyth, Donald.W.
1986 Post-Formative Ceramics in the Eastern Great Basin. *Journal of California and Great Basin Anthropology* 8(2):180-203.

Foucault, Michel
1977 [1975] *Discipline and Punish: The Birth of the Prison*. Alan Sheridan, trans. New York: Vintage Books.

Fowler, Catherine S.
2012 Culture Summary: Northern Paiute. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Gilmore, Kevin P.
2005 National Register Nomination Form: Franktown Cave (5DA272) Douglas County, Colorado. United States Department of the Interior, National Park Service.

Godsey, Holly S., Charles G. Oviatt, Daniel M. Miller, and Marjorie A. Chan
2011 Stratigraphy and chronology of offshore to nearshore deposits associated with the Provo shoreline, Pleistocene Lake Bonneville, Utah. *Palaeogeography, Palaeoclimatology, Palaeoecology* 310:442-450.

Goebel, Ted, Kelly E. Graf, Bryan Hockett, and David Rhode
2007 The Paleoindian Occupations at Bonneville Estates Rockshelter, Danger Cave, and Smith Creek Cave (Eastern Great Basin, U.S.A.): Interpreting Their Radiocarbon Chronologies. In *On Shelter's Ledge: Histories, Theories and Methods of Rockshelter Research*, edited by Marcel Kornfeld, Sergey Vasil'ev, and Laura Miotti. BAR, International Series. Oxford, England.

Goebel, Ted, Bryan Hockett, Ken D. Adams, David Rhode and Kelly E. Graf
2011 Climate, environment, and humans in North America's Great Basin during the Younger Dryas, 12,900-11,600 calendar years ago. *Quaternary International* 242:479-501.

Goodwin, Grenville
1942 *The Social Organization of the Western Apache*. University of Chicago Press.

Government of Canada, Minister of Justice
2015 Canadian Occupational Health and Safety Regulations. Electronic document, http://laws-lois.justice.gc.ca, accessed November 12, 2015.

Grayson, Donald K.
2006 Holocene bison in the Great Basin, western USA. *The Holocene* 16(6):913-925.
2011 *The Great Basin: A Natural Prehistory*. University of California Press, Berkeley.

Greenfield, Philip J. and John Beierle
2002 Culture Summary: Western Apache. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Hallson, Jennifer
2017 A Quantitative Analysis of Promontory Cave 1: An Archaeological Study on Population Size, Occupation Span, Artifact Use-life, and Accumulation. Unpublished Master's thesis, Department of Anthropology, University of Alberta, Edmonton.

Hamilton, Marcus J., Bruce T. Milne, Robert S. Walker, Oskar Burger, and James H. Brown
2007 The complex structure of hunter-gatherer social networks. *Proceeding of the Royal Society* B 274, pp. 2195-2202.

Hanson, Julienne
1999 *Decoding Homes and Houses*. Cambridge University Press, Cambridge.

Harvey, David
1989 *The Condition of Postmodernity*. Oxford: Blackwell.

Hearne, Samuel
2007 *A journey to the northern ocean: the adventures of Samuel Hearne*. Touchwood Eds, Surrey, B.C.

Heidegger, Martin
1971 *Poetry, Language, Thought* trans. Albert Hofstadter. Harper Colophon Books, New York.

Helm, J.
1961 The Lynx Point People: Dynamics of a Northern Athabaskan Band. *National Museum of Canada Bulletin* 176, Ottawa.
1968 The Nature of Dogrib Socioterritorial Groups. In *Man the Hunter*, edited by R.B. Lee and I. Devore, pp. 118-125. Chicago: Aldine.
1993 "Always with Them Either a Feast or a Famine": Living off the Land with Chipewyan Indians, 1791-1792. *Arctic Anthropology* 30(2):46-60.

Helm, J. and N.O. Lurie
1961 *The Subsistence Economy of the Dogrib Indians of the Lac la Martre District of the NWT*. Northern Coordination and Research Center, Department of Northern Affairs and Natural Resources, Ottawa.

Hermon, Sorin
2008 Reasoning in 3D: a critical appraisal of the role of 3D modelling and virtual reconstructions in archaeology. In *Beyond Illustration: 2D and 3D Digital Technologies as Tools for Discovery in Archaeology,* edited by Bernard Frischer and Anastasia Dakouri-Hild, pp. 120-137. Archaeopress, Oxford.

Hill Kim R., Robert S. Walker, Miran Bozicevic, James Eder, Thomas Headland, Barry Hewlett, A. Magdalena Hurtado, Frank Marlowe, Polly Wiessner, and Brian Wood
2011 Co-Residence Patterns in Hunter-Gatherer Societies Show Unique Human Social Structure. *Science* 331, 1286.

Hillier, Bill
1996 *Space is the machine: a configurational theory of architecture*. Cambridge University Press, Cambridge.

Hillier, Bill and Julienne Hanson
1984 *The Social Logic of Space*. Cambridge University Press, Cambridge.

Honigmann, John J.
1946 *Ethnography and Acculturation of the Fort Nelson Slave*. Yale University Press.
2012 Culture Summary: Kaska. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Ives, John W.
1990 *A Theory of Northern Athapaskan Prehistory*. Westview Press/University of Calgary Press, Boulder, Colorado/Calgary, Alberta.
1998 Developmental Processes in the Pre-Contact History of Athapaskan, Algonquian, and Numic Kin Systems. In *Transformations of Kinship,* edited by Maurice Godelier, T.R. Trautmann, and F.E. Tjon Sie Fat, pp. 94-139. Smithsonian Institution Press, Washington.
2012 Evaluating Steward's Proposition that Apachean Ancestors Were in the Promontory Caves. Paper presented at the Great Basin Archaeological Conference, Lake Tahoe.
2014 Resolving the Promontory Culture Enigma. In *Archaeology in the Great Basin and Southwest: papers in honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski, pp. 149-162. University of Utah Press, Salt Lake City.

Ives, John W. and Michael Billinger
2012 Moccasin Biographies – Demographic Inferences from the Promontory Footwear. Paper presented at the Great Basin Archaeological Conference, Lake Tahoe.

Ives, John W., Duane G. Froese, Joel C. Janetski, Fiona Brock, and Christopher Bronk Ramsey
2014 A High Resolution Chronology for Steward's Promontory Culture Collections, Promontory Point, Utah. *American Antiquity* 79(4):616-637.

Ives, John W. and Sally Rice
2008 Correspondences in Archaeological, Genetic and Linguistic Evidence for Apachean History. Submitted for the Proceedings Volume, edited by Bernard Comrie, International Conference on Languages and Genes, September 6-10, 2006, University of California, Santa Barbara.

Janes, Robert R.
1983 Archaeological Ethnography among the Mackenzie Basin Dene, Canada. *The Arctic Institute of North America Technical Paper No. 28,* University of Calgary.
1989 An Ethnoarchaeological Model for the Identification of Prehistoric Tepee Remains in the Boreal Forest. *Arctic* 42(2):128-138.

Janetski, Joel C. and Teferi Abate Adem
2009 Culture Summary: Ute. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Janetski, Joel C. and Grant C. Smith
2007 *Hunter-Gatherer Archaeology in Utah Valley*. Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Jett, Stephen C. and Spencer, Virgina E.
1981 *Navajo Architecture: forms, history, distributions*. University of Arizona Press, Tucson, AZ.

Johansen, Peter
2004 Landscape, monumental architecture, and ritual: a reconsideration of the South Indian ashmounds. *Journal of Anthropological Archaeology* 23(3): 309-330.

Johansson, Lindsay D.
2013 Promontory Culture: The Faunal Evidence. Unpublished Master's thesis, Department of Anthropology, Brigham Young University, Provo.

Jones, George T., Charlotte Beck, Eric E. Jones, and Richard E. Hughes
2003 Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin. *American Antiquity* 68(1):5-38.

Kehoe, Thomas F.
1985 *Stone tipi rings in north-central Montana and the adjacent portion of Alberta, Canada: their historical, ethnological and archaeological aspects*. J&L Reprint Co., Lincoln, NB.

Kent, Susan
1982 Hogans, Sacred Circles and Symbols – The Navajo Use of Space. In *Navajo Religion and Culture: Selected Views: Papers in honor of Leland C. Wyman,* edited by David M. Brugge and Charlotte J. Frisbie, pp. 128-137. Museum of New Mexico Press, Santa Fe, NM.
1984 *Analyzing Activity Areas: An Ethnoarchaeological Study of the Use of Space*. University of New Mexico Press: Albuquerque.

1993 A cross-cultural study of segmentation, architecture and the use of space. In *Domestic Architecture and the Use of Space: an interdisciplinary cross-cultural study*. Cambridge University Press.

Kloor, Keith
2007 The Vanishing Fremont. *Science Magazine*, 7 December: 1540-1543.

Knoll, Michelle
2009 *Culture History of the Eastern Great Basin and Northern Colorado Plateau*. Gallery Interpreter Training, Utah Museum of Natural History, Anthropology Department, Salt Lake City.

Kohler, Timothy A., Scott G. Ortman, Katie E. Grundtisch, Carly M. Fitzpatrick, and Sarah M. Cole
2014 The Better Angels of Their Nature: Declining Violence Through Time Among Prehispanic Farmers of the Pueblo Southwest. *American Antiquity* 79(3):444-464.

Krauss, Michael E. and Victor K. Golla
1981 Northern Athapaskan Languages. In *Subarctic, Handbook of the North American Indians*, Volume 6, edited by June Helm, pp. 67-85. Smithsonian Institution Press, Washington.

Lambert, Patricia M.
2002 The Archaeology of War: A North American Perspective. *Journal of Archaeological Research* 10(3):207-241.

Laubin, Reginald and Gladys Laubin
1964 *The Indian tipi: its history, construction, and use*. University of Oklahoma Press, Norman.

LeBlanc, Steven
1971 An Addition to Naroll's Suggested Floor Area and Settlement Population Relationship. *American Antiquity* 36(2):210-211.
1999 *Prehistoric Warfare in the American Southwest*. University of Utah Press, Salt Lake City.

LeBlanc, Steven A. and Glen E. Rice
2001 Southwestern Warfare: The Value of Case Studies. In Rice, G.E. and LeBlanc, S.A., eds., *Deadly Landscapes: Case Studies in Prehistoric Southwestern Warfare*, pp. 1-18. University of Utah Press, Salt Lake City.

Lefebvre, Henri
1991 [1974] *The Production of Space*. Donald Nicholson-Smith, trans. Oxford: Blackwell.

Leone, Mark P.
1995 A Historical Archaeology of Capitalism. *American Anthropologist* 97(2): 251-268.

Levi-Strauss, Claude
1963 *Structural Anthropology*. Translated by Claire Jacobson and Brooke Grundfest Schoepf. Basic Books, Inc., New York.

Levy, Richard M., Peter C. Dawson, and Charles Arnold
2004 Reconstructing traditional Inuit house forms using three-dimensional interactive computer modelling. *Visual Studies* 19(1):26-36.

Longacre, William A. and James E. Ayres
1968 Archaeological Lessons from an Apache Wickiup. In *New Perspectives in Archaeology,* edited by Sally R. Binford and Lewis R. Binford, pp. 151-159. Aldine Publishing Company, Chicago, IL.

Lupo, Karen D. and Dave N. Schmitt
1997 On Late Holocene Variability in Bison Populations in the Northeastern Great Basin. *Journal of California and Great Basin Anthropology* 19(1):50-69.

Lyman, R. Lee and Michael J. O'Brien
2001 The Direct Historical Approach, Analogical Reasoning, and Theory in Americanist Archaeology. *Journal of Archaeological Method and Theory* 8(4):303-342.

Madsen, David B.
1989 *Exploring the Fremont*. University of Utah Occasional Publication No. 8. Utah Museum of Natural History, Salt Lake City.
2000 *Late Quaternary Paleoecology in the Bonneville Basin*. Utah Geological Survey Bulletin 130, Salt Lake City.

Madsen, David B. and James F. O'Connell (editors)
1982 *Man and Environment in the Great Basin*. SAA Papers No. 2. Society for American Archaeology, Washington, D.C.

Magne, Martin P.R.
2012 Modeling Athapaskan Migrations. In *From the Land of Everwinter to the American Southwest. Athapaskan Migrations, Mobility and Ethnogenesis*, edited by Deni J. Seymour, pp. 356-376. University of Utah Press, Salt Lake City.

Mandelbaum, David G.
1979 *The Plains Cree: an ethnographic, historical and comparative study*. Canadian Plains Research Center, University of Regina, Regina, SK.

Martindale, Andrew and Kisha Supernant
2009 Quantifying the defensiveness of defended sites on the Northwest Coast of North America. *Journal of Anthropological Archaeology* 28:191-204.

Marwitt, John P.
1970 *Median Village and Fremont Culture Regional Variation*. University of Utah Anthropological Papers No. 95, University of Utah Press, Salt Lake City.

McAllister, J. Gilbert
1955 Kiowa-Apache Social Organization. In *Social Anthropology of North American Tribes*, edited by Fred Eggan, pp. 99-129. University of Chicago Press, Chicago.

McGee, David, Jay Quade, R. Edwards Lawrence, Wallace S. Broecker, Hai Cheng, Peter W. Reiners, and Nathan Evenson
2012 Lacustrine cave carbonates: Novel archives of paleohydrologic change in the Bonneville Basin (Utah, USA). *Earth and Planetary Science Letters* 351-352:182-194.

Means, Bernard K.
2007 *Circular Villages of the Monongahela Tradition*. The University of Alabama Press.

Meltzer, David J.
2009 *First Peoples In A New World: Colonizing Ice Age America*. University of California Press, Berkeley.

Morgan, Lewis Henry
1881 *Houses and House-Life of the American Aborigines*. Department of the Interior, Government Printing Office, Washington.

Morton, Shawn G., Meaghan M. Peuramaki-Brown, Peter C. Dawson, and Jeffrey D. Seibert
2012 Civic and Household Community Relationships at Teotihuacan, Mexico: a Space Syntax Approach. *Cambridge Archaeological Journal* 22(3):387-400.

Museum of Peoples and Cultures, Brigham Young University
2013 *Handbook of Archaeological Field Methods: Promontory Caves 2013*. Technical Series. Provo, Utah.

Nabokov, Peter and Easton, Robert
1989 *Native American Architecture*. Oxford University Press, New York.

Naroll, Raoul
1962 Floor Area and Settlement Population. *American Antiquity* 27(4):587-589.

National Park Service
n.d. The Fremont Culture. Electronic document, http://www.nps.gov/care/historyculture/fremont.htm, accessed November 2013.

Oetelaar, Gerald A.
2000 Beyond Activity Areas: Structure and Symbolism in the Organization and Use of Space Inside Tipis. *The Plains Anthropologist* 45(171):35-61.

Olson Richard H.
1960 Geology of the Promontory Range, Box Elder County, Utah. Unpublished Ph.D. dissertation, Department of Geology, University of Utah, Salt Lake City.

Opler, Edward M.
1941 *An Apache Life-Way: The Economic, Social, and Religious Institutions of the Chiricahua Indians*. University of Chicago Press, Chicago.

Osicki, Aaron A.
2012 *The Chosen Path: Movement Pattern Analysis and Land-Use within Jasper National Park and the Central Canadian Rocky Mountains*. Unpublished PhD. Thesis, University of Calgary, Calgary, Alberta.

Oviatt, Charles G., Donald R. Currey, and Dorothy Sack
1992 Radiocarbon chronology of Lake Bonneville, Eastern Great Basin, USA. *Palaeogeography, Palaeoclimatology, Palaeoecology* 99(3-4):225-241.

Oviatt Charles G., David B. Madsen, and Dave N. Schmitt
2003 Late Pleistocene and early Holocene rivers and wetlands in the Bonneville basin of western North America. *Quaternary Research* 60:200-210.

Peck, Trevor and Rod J. Vickers
2006 Buffalo and Dogs The Prehistoric Lifeways of Aboriginal People on the Alberta Plains, 1004-1005. In *Alberta Formed, Alberta Transformed*, edited by Michael Payne, Donald Wetherell, and Catherine Cavanaugh, pp.54-85. University of Alberta Press, Edmonton and University of Calgary Press, Calgary.

Perry, Richard J.
1991 *Western Apache Heritage: People of the Mountain Corridor*. University of Texas Press, Austin.
1993 *Apache Reservation: Indigenous Peoples and the American State*. University of Texas Press, Austin.

Quigg, J. Michael
1981 Stone Circle Excavations in Alberta to 1978: A Summary. In *Megaliths to Medicine Wheels: Boulder Structures in Archaeology,* edited by Michael Wilson, Kathie L. Road and Kenneth J. Hardy, pp. 47-67. University of Calgary Press, Calgary.

Ramadanta, Asyra and Endang Titi Sunarti B. Darjosanjoto
2012 Application of Space Syntax as Presentation and Analysis Technique in the Study of Spatial Integration in Contoured Landform. *Journal of Basic and Applied Scientific Research* 2(7) 6850-6856.

Ravenstein, E.G.
1885 The Laws of Migration. *Journal of the Statistical Society of London* 48(2):167-235.

Reid, Gerald
1996 Culture Summary: Iroquois. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Renfrew, Colin and Paul Bahn
2010 *Archaeology Essentials: Theories, Methods, and Practice* (second edition). Thames and Hudson, London.

Rhode, David, Ted Goebel, Kelly E. Graf, Bryan S. Hockett, K.T. Jones, David B. Madsen, Charles G. Oviatt, and Dave N. Schmitt
2005 Latest Pleistocene – early Holocene human occupation and paleoenvironmental change in the Bonneville Basin, Utah – Nevada. *Field Guides* 2005(6):211-230.

Rhode, David, David B. Madsen, and Kevin T. Jones
2006 Antiquity of early Holocene small-seed consumption and processing at Danger Cave. *Antiquity* 80:328-339.

Ridington, Robin
1968 The Environmental Context of Beaver Indian Behavior. Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University.

Robinson, Brian S., Jennifer C. Ort, William A. Eldridge, Adrian L. Burke, and Bertrand G. Pelletier
2009 Paleoindian Aggregation and Social Context at Bull Brook. *American Antiquity* 74(3):423-447.

Rocek, Thomas R.
1995 *Navajo Multi-Household Social Units: Archaeology on Black Mesa, Arizona*. University of Arizona Press.

Rogers, Edward S.
1962 *The Round Lake Ojibwa*. Published by the Ontario Dept. of Lands and Forests for the Royal Ontario Museum.
1967 *The material culture of the Mistassini*. National Museum of Canada Bulletin no. 218.
1969 Band organization among the Indians of eastern subarctic Canada. In *Contributions to Anthropology: Band societies*. Bulletin (National Museums of Canada) 228:21-55.

Rüther, H., M. Chazan, R. Schroeder, R. Neeser, C. Held, S.J. Walker, A. Matmon, and L.K. Horwitz
2009 Laser scanning for conservation and research of African cultural heritage sites: The case study of Wonderwerk Cave, South Africa. *Journal of Archaeological Science* 36(9):1847-1856.

Sack, Dorothy I.
1989 Reconstructing the chronology of Lake Bonneville. In Tinkler, K.J. ed., *History of Geomorphology,* pp. 223-256. Unwin Hyman Press, London.

Salt Lake Tribune [Salt Lake City, Utah]
1913 Article titled "Trip Described by Prof. Cummings" 21 April: 3. Salt Lake City, Utah.

Sapir, Edward
1936 Internal Linguistic Evidence Suggestive of the Northern Origin of the Navaho. *American Anthropologist* 38:224-235.

Scarre, C.
2006 Sound, Place and Space: Towards an Archaeology of Acoustics. In *Archaeoacoustics,* edited by Christopher Scarre and Graeme Lawson. Cambridge: McDonald Institute for Archaeological Research.

Schwindt, Dylan M., R. Kyle Bocinsky, Scott G. Ortman, Donna M. Glowacki, Mark D. Varien, and Timothy A. Kohler
2016 The Social Consequences of Climate Change in the Central Mesa Verde Region. *American Antiquity* 81(1):74-96.

Seymour, Deni J.
2008 Nineteenth-century Apache wickiups: historically documented models for archaeological signatures of the dwellings of mobile people. *Antiquity* 83:157-164.
2013 Geronimo's Wickiup: Methodological Considerations Regarding Mobile Group Hut Signatures. *International Journal of Historical Archaeology* 17:182-195.

Shapiro, J.S.
1999 New Light on Old Adobe: A Space Syntax Analysis of the Casa Grande. *Kiva* 64(4):419-446.

Sharp, Henry S. and John Beierle
2001 Culture Summary: Chipewyans. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Silberman, Neil Asher (editor)
2012 *The Oxford Companion to Archaeology*. 2nd ed. Oxford University Press.

Simms, Steven R.
1985 Acquisition Cost and Nutritional Data on Great Basin Resources. *Journal of California and Great Basin Anthropology* 7(1):117-126.
2008 *Ancient Peoples of the Great Basin and Colorado Plateau*. Left Coast Press, Inc. Walnut Creek, CA.

Slobodin, Richard
1962 *Band Organization of the Peel River Kutchin*. National Museum of Canada Bulletin No. 179. Department of Northern Affairs and National Resources, Ottawa.

Smith, Cecilia and Ethan E. Cochrane
2011 How is visibility important for defence? A GIS analysis of sites in the western Fijian Islands. *Archaeology in Oceania* 46:76-84.

Smith, David E., Donald R. Currey, and Charles G. Oviatt
1997 Lake Bonneville Classic Depositional Shore Features: Geochronology, Geomorphology, Stratigraphy and Sedimentology. *Geological Society of America 1997 Annual Meeting*, Field Trip #17, Salt Lake City, Utah.

Smith, Grant C.
2004 Promontory Ware or Promontory Gray? Revisiting the Classification Problems of Eastern Great Basin Ceramics. Unpublished Master's Thesis, Department of Anthropology, Brigham Young University, Provo.

Smith, James G.E.
1976 Local Band Organization of the Caribou Eater Chipewyan In the Eighteenth and Early Nineteenth Centuries. *The Western Canadian Journal of Anthropology* 6(1): 72-90.
1981 *Western Woods Cree*. Washington, D.C.: Smithsonian Institution pg.256-284.
2009 Culture Summary: Western Woods Cree. eHRAF World Cultures Database. Human Relations Area Files, http://ehrafworldcultures.yale.edu.

Solometo, Julie
2006 The Dimensions of War: Conflict and Culture Change in Central Arizona. In Arkush, E.N. and Allen, M.W., eds., *The Archaeology of Warfare: Prehistories of Raiding and Conquest*, pp. 23-65. University Press of Florida, Gainesville.

Steward, Julian
1933 *Early Inhabitants of Western Utah*. Bulletin of the University of Utah 23:7, Salt Lake City.
1937 *Ancient Caves of the Great Salt Lake Region*. Smithsonian Institution Bureau of American Ethnology Bulletin Number 115, Washington.
1938 *Basin-Plateau Aboriginal Sociopolitical Groups*. Bureau of American Ethnology Bulletin Number 120.
1940 Native Cultures of the Intermontane (Great Basin) Area. In *Essays in Historical Anthropology of North America. Published in Honor of John R. Swanton*, edited by Julian Steward, pp. 445-502. Smithsonian Miscellaneous Collections Vol. 100, Washington, D.C.
1941 *Culture Element Distributions: XIII Nevada Shoshone*. University of California Press, Berkeley and Los Angeles.
1942 The Direct Historical Approach to Archaeology. *American Antiquity* 7(4):337-343.

Steward, Julian and Erminie Wheeler-Voegelin
1974 *Paiute Indians III: The Northern Paiute Indians*. Garland Publishing Inc., New York.

Strang, Veronica
2008 Uncommon Ground: Landscape as Social Geography. In *Handbook of Landscape Archaeology* edited by Bruno David and Julian Thomas, pp. 51-59. Left Coast Press, Walnut Creek, California.

Stratford, Valerie C.
1999 Coastal Landforms and Relict Features of Lake Bonneville – A Literature Review. *Geology of Northern Utah and Vicinity*, Utah Geological Association 27:367-377.

Sturtevant, William C. (editor)
2001 *Handbook of North American Indians: Plains volume 13*. USGPO, Smithsonian Institution, Washington, D.C.

Supernant, Kisha
2014 Intervisibility and Intravisibility of rock feature sites: a method for testing viewshed within and outside the socio-spatial system of the Lower Fraser River Canyon, British Columbia. *Journal of Archaeological Science* 50:497-511.

Trigger, Bruce G.
2006 *A History of Archaeological Thought*. 2nd ed. Cambridge University Press, Cambridge.

Turner, A., M. Doxa, D. O'Sullivan, and A. Penn
2001 From isovists to visibility graphs: a methodology for the analysis of architectural space. *Environment and Planning B: Planning and Design* 28: 103-121.

UCL and the Space Syntax Laboratory
2004 UCL Space Syntax Software Manuals: Axman, Orangebox, Netbox, NewWave, Pesh and Spacebox (The Bundle). University College, London.

United States Geological Service
2004 Geologic Provinces of the United States: Basin and Range Province. Electronic Document, http://geomaps.wr.usgs.gov/parks/province/basinrange.html, accessed November 5, 2013.

Utah Geological Survey
n.d. Great Salt Lake, Lake Bonneville & Bear Lake. Electronic document, geology.utah.gov/utahgeo/gsl/index.htm, accessed November 2012.

Van Dyke, R.M.
1999 Space Syntax Analysis at the Chacoan Outlier Site of Guadalupe. *American Antiquity* 64(3):461-473.

Waller, Steven J.
2002a Psychoacoustic Influences of the Echoing Environments of Prehistoric Art. Paper presented at the First Pan-American/Iberian Meeting on Acoustics, Cancun.
2002b Intentionality of Rock-art Placement Deduced from Acoustical Measurements and Echo Myths. In *Archaeoacoustics,* edited by Christopher Scarre and Graeme Lawson, pp. 31-40. Cambridge: McDonald Institute for Archaeological Research.

Watson, Aaron
2002 (Un)intentional Sound? Acoustics and Neolithic Monuments. In *Archaeoacoustics,* edited by Christopher Scarre and Graeme Lawson, pp. 11-22. Cambridge: McDonald Institute for Archaeological Research.

Wedel, Waldo R.
1979 House Floors and Native Settlement Populations in the Central Plains. *Plains Anthropologist* 24 (84 Part 1): 85-98.

Wheat, Margaret M.
1967 *Survival arts of the primitive Paiutes*. University of Nevada Press, Reno.

Wiessner, Polly
1974 A Functional Estimator of Population from Floor Area. *American Antiquity* 39(2):343-350.

Wilson, Gilbert
1934 *The Hidatsa Earthlodge*. Arranged and edited by Bella Weitzner. The American Museum of Natural History, New York City.

Willey, Gordon R., C.C. Dipeso, W.A. Ritchie, I. Rouse, J.H. Rowe and D.W. Lathrap
1956 An archaeological classification of culture contact situations. In *Seminars in Archaeology: 1955*, Robert Wauchope (editor), pp. 1-30. Memoirs of the Society for American Archaeology 11.

Wylie, Alison
1985 The Reaction against Analogy. *Advances in Archaeological Method and Theory* 8:63-111.

Yanicki, Gabriel M.
2014 Chournos Springs: The Late Prehistoric Transition on Promontory Point. PhD Dissertation Prospectus, University of Alberta, Edmonton.

Yanicki, Gabriel M. and John W. Ives
2015 Mobility, Exchange, and the Fluency of Games: Promontory in a Broader Sociodemographic Setting. Invited presentation for the session Games People Play: Prehistoric Games of Indigenous North America, SAA 80th Annual Meeting, San Francisco, California, April 15-19.

Yellowhorn, Eldon
2015 Digging up the Rez: Piikani Historical Archaeology. Electronic document, https://www.youtube.com/watch?v=0zhx9WaU9go, accessed December 16, 2015.

Zhou, W.X., D. Sornette, R.A. Hill, R.I.M. Dunbar
2005 Discrete hierarchical organization of social group sizes. *Proceedings of the Royal Society B* 272, pp. 439-444.