Archaeological Investigations at the Swallow Site, Jefferson County, Colorado

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Memoir Number 7 of the Colorado Archaeological Society

2024

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Acknowledgments

This report is dedicated to Fred C. Rathbun (1928-2006) and Bill (William S.) Hammond (1931-2021), who led the archaeological investigations of the Swallow site. The fact that we have data from this extraordinary site is due to their efforts. Bill Hammond provided support to the Swallow Oversight Committee while he was alive through meetings at his home and numerous telephone conversations about the site and the analyses. Over the years, many Colorado Archaeological Society (CAS) members volunteered their time, both on the excavation and the artifact processing and analyses. A tremendous voluntary effort was conducted on everything from cleaning and numbering artifacts to completing analyses and writing report chapters. While we cannot begin to name them all here, their efforts have contributed to this final product and are greatly appreciated.

The Swallow Oversight Committee would like to thank Todd McMahon, formerly with the Office of Archaeology and Historic Preservation (OAHP) at History Colorado, for his assistance with the project, arranging for workspace at OAHP and helping in numerous other ways. Thanks also to Colton Snyder of OAHP for facilitating work at OAHP. Our thanks to Kevin Black for sharing his expertise and guidance on lithic material types, and to Robert Mutaw for sharing his expertise on human skeletal remains. Diane Rhodes graciously provided existing analytical spreadsheets and narratives. We are also grateful for the help from Bonnie Clark, Anne Amati, and Sarah Carlson at the University of Denver Museum of Anthropology for providing access to collections and photographic equipment. Thanks to Mary McIntyre from the Denver Chapter of CAS (DC-CAS) for help with finding artifacts at DU for photography. Karen Kinnear and Patricia Lacey provided copyediting and our gratitude goes to them, and to Paleocultural Research Group for report production.

The State Historical Fund provided two grants to the Swallow analytical efforts. SHF 1995-02-012 funded the Archaeo-Visualization System, a computer program to create 3-dimensional graphics of artifact and feature distribution. SHF 2004-M2-009 provided funding for radiocarbon dating. We appreciate that support. DC-CAS had also raised funds over the years for excavation costs, and for some radiocarbon dating and other analyses. We thank all folks who contributed financially.

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Preface

The Denver Chapter of the Colorado Archaeological Society (DC-CAS) conducted field investigations at Ken Caryl from 1973 through 1998. Survey, testing, and excavations at several rock shelter sites were carried out. The site with the greatest magnitude of cultural deposits and largest density and quantity of artifacts is the Swallow site, which was excavated for 16 seasons, from 1983-1998. Subsequent analysis of the Swallow material was conducted for over 20 years. Unfortunately, while a substantial amount of laboratory work was completed to identify and describe different materials recovered from the site, a lack of experience by chapter members in archaeological data analysis and reporting slowed efforts to complete report chapters. While data from the other Ken-Caryl sites were reported and published (Adkins 1997; Burris et al. 2008; Johnson et al. 1997), a final report of the Swallow site remained incomplete.

Efforts by DC-CAS to analyze the Swallow artifacts and document the archaeology of the site had resulted in a completed analysis of some artifact categories and several complete or nearly complete chapters for a report; however, work on the report had stagnated by 2016. The original Principal Investigator, Fred Rathbun, had died, as had several other CAS members involved with the project. The 2nd Principal Investigator, Bill Hammond, was in poor and declining health.

Swallow is an important site, artifactually rich with a long span of occupations. CAS recognized the importance of the site to Colorado archaeology and their responsibility to provide the data from the site to the archaeological community. In order to facilitate completion of the Swallow site report, State CAS formed the Swallow Oversight Committee (OC), comprised of professional archaeologists volunteering their time.

The Swallow OC was formed at the end of 2018, with Pete Gleichman, Jeannette Mobley-Tanaka, Mark Mitchell, Holly Norton, Kimball Banks, CAS Executive Secretary Karen Kinnear, and then CAS President Linda Sand as members. Kimball Banks and Linda Sand moved out of Colorado and stepped down in 2022 due to other obligations. Nick Dungey joined in late 2020, and Amy Gillaspie assisted briefly in 2022 and early 2023.

The OC mission has been to:

- Assist in the completion of a report presenting the data derived from the excavation of the Swallow site, through focusing efforts by directing format and compilation of the report and conducting technical editing. The report will be based on narratives and artifact analyses that have already been completed and written. The Committee will determine what further analyses should be completed and whether and how that research shall take place. Where necessary, this task has included some report writing by committee members to complete chapters that were not previously completed or to add in what information was available about neglected artifact classes.

- Communicate with all Chapter/Section authors to ensure they are involved with the editing process and are treated with courtesy, respect, and basic editorial ethics.

- Ensure that copyediting of the report is done.

- Determine how the finished report will be made available.

- Communicate with the DU Museum of Anthropology and the State Office of Archaeology and Historic Preservation (OAHP) regarding curatorial requirements and communication with DC-CAS on their curatorial responsibilities, determining what materials in addition to artifacts should be curated and ensuring those materials to be curated are placed at the museum.

History of Laboratory Efforts

At the inception of excavations at the Swallow site, DC-CAS already had a laboratory analysis system in place that they had employed throughout their Ken-Caryl Ranch excavations. Different CAS members had laboratories in their homes, and chapter volunteers gathered at these locations to clean, identify, and analyze materials. Volunteers received some training from other chapter members or professional archaeologists with knowledge and expertise in the appropriate subject area. These trainings turned into the Program for Avocational Archaeological Certification (PAAC), run by the State Archaeologist's office (Hammond 2020:3), but not all volunteers completed the certification, and knowledge and skills were variable among laboratory workers.

The Bone Lab, first in the home of Anne Sands and later that of Charlotte Bechtold, curated and utilized a comparative bone collection for their species and element identifications. This comparative collection was later transferred to Metropolitan State University where it continues to be used by students (Hammond 2020). The lithics lab, initially in the basement of Fred Rathbun's house and later moved to the University of Denver Museum of Anthropology, relied on the expertise of Rathbun, a retired geologist, and on the input of professional archaeologists, including John Gooding and Kevin Black. See Hammond (2020:10) for further discussion of laboratory efforts. While not mentioned in Hammond's discussion, J. Frank Adkins and Diane Rhodes were integral to the lab analysis efforts.

Material analyses that required expertise or equipment not available among the CAS members were sent to specialized/professional analysts or laboratories. These included pollen washes, radiocarbon dating, blood residue analysis, macrobotanical identification, ceramic materials analysis, and skeletal analysis of human remains.

A great many hours of laboratory work were completed, generating a substantial body of data. Unfortunately, the sheer amount of data became a roadblock to report completion, as volunteers were trained in the identification and handling of specimens, but less often in compilation and analysis of the resulting large data sets. To address this problem, several professional archaeologists were recruited to consult or assist with the analysis, including Diane Rhodes, John Gooding, and Jeannette Mobley-Tanaka, with varying results. As all were volunteering their time, work progressed slowly. Kevin Black, then Assistant State Archaeologist, arranged for the Indian Peaks Chapter of CAS (IPCAS) to analyze the projectile points and create a typology for the points.

What Had Been Done

Seven annual Interim Reports had been completed, for 1991-1997 (Rathbun, 1991, 1992, 1994, 1996, Rathbun and Hammond 1995, Hammond and Rathbun 1997, 1998). An article on the decorated animal bone was published in *Southwestern Lore* (Hammond et al. 2018). While the OC was working on the report, Bill Hammond published Swallow Site: A Principal Investigator's Memoir and Preliminary Report in *Southwestern Lore* (2020). This report was intended as a memoir of the work and relied on the impressions and memories of the author as much as on detailed analyses that had been completed for the final report. Some of the information in that report is therefore inconsistent with what is presented in this publication although Pete Gleichman worked with Hammond to ensure up-to-date information from the final report was available to him at the time.

Papers had been presented at conferences on a diachronic analysis of features (Mobley-Tanaka 2010, 2006) and on ovate to triangular bifaces as time markers (Hammond and Rhodes 2013). A handful of student projects were also conducted at Front Range Community College under the direction of Mobley-Tanaka, and at the University of Denver, Metropolitan State University, and University of Colorado, Boulder, but to the best of our knowledge, none of these papers have been published. Radiocarbon dates were submitted and included in the Colorado Radiocarbon Database Project (Dominguez Archaeological Research Group 2011). Sean Larmore (2002) included McKean Points from Swallow in the analysis of McKean Points from Colorado that served as his Master's Thesis from the University of Denver.

The Archaeo-Visualization System didn't function as planned and was supplanted by advances in software applications.

The OC met at the DU Museum of Anthropology (DUMA) in Dec. 2018 to start assessing the status of the Swallow material and determine what needed to be done to complete a report.

DUMA had agreed to curate the materials from Ken Caryl, including Swallow. Material from Swallow at DUMA included artifacts, catalog cards, field record forms, profile and map drawings, slides and photographs, and binders with lab analysis sheets for lithics. Artifacts from Swallow collected during the excavation had been cataloged on 3x5 cards, and original and archival copies of the 38,152 catalog cards were present. Original and archival copies of the field forms were also present. The artifacts were bagged and roughly organized in boxes, and each ceramic sherd, identifiable bone, and lithic, excepting debitage, had been labeled with the site number and catalog number.

Numerous boxes of paperwork files, which had been in Bill Hammond's possession were at DUMA. These were moved to OAHP, with the slides and photographs, to make the material more accessible to the OC. The original catalog cards and field forms were moved to OAHP storage. The archival copies remained at DUMA. The boxes of files were completely unorganized, so the box contents were inventoried and organized by Pete Gleichman with the intent of determining what would be useful for work on the report, what should be curated, and what to do with the remainder. Subsequent to Bill Hammond's death his estate provided more boxes of paper files and artifacts to the OC. Artifacts were returned to DUMA, and the files were inventoried and organized.

A digital catalog had not been done for the artifacts. A master photo log could not be found. Photo logs for some photos had been handwritten by Shirley Rathbun, and those photos had been scanned. Many slides and some photos were not logged. There are indications that we do not have all the scanned photos or even all the photos. Despite substantial efforts at lab analysis and chapter preparation the records for Swallow were in some disarray. The OC had drafts of the initial report chapters that had been written, some essentially complete; as well as some completed analytical studies. Diane Rhodes provided the OC with thumb drives and 11 discs with files and numerous spreadsheets of various analyses. Completed or nearly completed analytical studies of features, pollen, ceramics, human remains, and projectile points existed, and the faunal analysis was recently completed. Jeannette Mobley-Tanaka was involved with the analysis and report preparation for Swallow starting in 2005 and has authored or co-authored several chapters for the Swallow report. Her knowledge of the site and analytical efforts, and her written contributions to the report were instrumental to OC efforts.

Through 2019, work was done on gathering and organizing Swallow material, determining what should be done, and beginning the revision of existing chapters. Over the next several years every existing chapter for the report was reviewed and revised by combinations of OC members. Some of the analyses had been completed years ago.

The OC perspective on revision was to be as light-handed as possible. Some chapters needed almost no or only minor revision. As chapters were examined, it became clear that other chapters required considerable work, and the OC needed to be active and firm in making changes. All living authors were contacted and given the opportunity to update and revise their work, and to review any revisions done by the OC, a lengthy back-and-forth process. The chapter on dating and cultural correlation was problematic. Correlating cultural periods with set depths or levels was complex, complicated by extreme bioturbation of the deposits. Differing schemes had been devised over the course of lab work and analyses, so different analyses had slightly different temporal frameworks. The chapter was extensively reworked to try and create a coherent temporal structure. Mark Mitchell recalibrated the radiocarbon dates, and with Jeannette Mobley-Tanaka rearranged the dates in order by level. There were disparities in the existing documents, such as tables, spreadsheets, and feature descriptions, as to the depth below datum and level of the dated material, particularly for dated features. This was partly due to excavators having difficulty identifying features during excavation, understanding what they were, the level they started at, and how deep they extended. Features were not profiled during excavation, making the recognition of the level where they originated difficult. Features had sometimes been given different numbers in different excavation units. Mark Mitchell attempted to sort out this confusion and get the correct levels below ground surface for the dates by reexamining original forms, and was partially successful, but some uncertainties persist. Gleichman, Mitchell, and Mobley-Tanaka rewrote the discussion of dates and the cultural correlation. Despite there being 40 radiocarbon dates from Swallow, the site is not well-dated, and temporal control is weak.

While some of the existing analyses are thorough, there are gaps in the analysis of lithics. Gleichman and Mobley-Tanaka rewrote the Lithic Materials chapter. Projectile points had been thoroughly documented by Katherine McComb and a crew from IPCAS. Other chipped stone tools and ground stone had only rudimentary summary documentation, without supporting data. While all small flakes were analyzed, only a 20 percent sample of point-plotted, large flakes was analyzed, and we are uncertain whether the analysis of cores is complete. Numerous slightly different spreadsheets exist for the other lithic tool types, and the most thorough are included as appendices to this report to provide basic data on lithics.

The huge number of bones recovered resulted in a lengthy faunal report by five authors that was extensively revised. The information was separated into two chapters, one on the faunal data, and one discussing and synthesizing the data, significantly rewritten by Mobley-Tanaka.

Only some of the basic data on tools tested for blood residue could be located.

Flotation samples were re-sorted by Gleichman to identify macrobotanical remains.

Throughout the lab work, some analyses were done by avocational volunteers that may not have had the skills or expertise to meet professional standards. These included identification of flake types (primary, secondary, thinning flakes, etc.), use-wear analysis on flakes and tools, and analyses of reduction stages. During the preparation of report chapters, Hammond expressed to the OC his level of trust in various analyses, where volunteers had adequate training and skills to provide accurate information and where they might not have. Analyses in which he had low confidence were sometimes removed from the report. Therefore, there are some data in the laboratory records that may or may not be useful but are not reported here, and there are certainly more data that could be collected and might yield important information but are beyond the reach of what could be done at the time of this publication. Specific details about shortcomings or limitations to the analyses are presented in the appropriate chapters.

The pandemic of 2020-2021 and the resulting lockdown and closure of DUMA and OAHP caused significant delays to the OC efforts. The delays also altered the overall scope of the OC efforts.

The OC had considered applying for grant funding to create a digital artifact catalog and do some additional lithic analysis. Since our efforts were largely stymied by the pandemic lockdown, and grant funds were not available, it was decided to not extend the effort for several more years to pursue funding for additional analyses but to finish the report with the existing analyses.

In 2024, it was decided that all material from Swallow and the other Ken Caryl sites will be permanently curated at History Colorado, and the artifacts and project records were moved to OAHP.

It is the hope of the OC that this report will provide adequate information and detail to address the research objectives of DC-CAS in excavating the site, and more importantly to allow Swallow site to take its rightful place in contributing to the archaeological understanding of the Front Range, and more broadly, of Colorado and the mountain-plains boundary. As always, there is much that still could be done with the collections and, to that end, we hope this report inspires other researchers to complete other analyses and explore the as-yet untapped potential of this rich assemblage.

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1 Introduction

Fred C. Rathbun and Bill Hammond

The Ken-Caryl Ranch Project

Situated at the junction of the Front Range of the Rocky Mountains and the Denver Basin of the Great Plains, the Hogback valley of central Colorado extends from the Table Mountains and city of Golden on the northeast to Roxborough Park on the southwest. The Hogback valley is in fact a series of valleys separated by streams which flow east from the foothills, and associated ridges. The valley was formed by uplifting and subsequent erosion of sedimentary layers at the east edge of the Rocky Mountains. Two parallel hogbacks or ridges, the Lyons and Dakota formations, run roughly NW-SE 2 to 5 km east of the mountains. The Hogback valley is the area between the mountains and the Dakota Hogback. The valley is a portion of the Hogback zone, which continues north through Boulder County into Larimer County. North of Golden the area between the base of the Front Range and the Dakota uplift or hogback is less definitive as a valley.

The Hogback valley has a more temperate climate than adjacent areas, a secure water supply, plentiful shelter and a plethora of useful plants and game animals. It provided an extremely favorable environment for prehistoric peoples and has long been known to be rich in archaeological resources.

In 1971, the Johns Manville Corporation purchased the Ken-Caryl Ranch in eastern Jefferson County, Colorado. The ranch includes a portion of the Hogback valley between Deer Creek on the south and Turkey Creek on the north. In 1973, Johns Manville established the Ken-Caryl Ranch Corporation to build a planned community on the property. Upon learning this, the Denver Chapter of the Colorado Archaeological Society (DC-CAS) requested and obtained permission from Johns Manville to conduct archaeological survey and excavation prior to construction (Figures 1.1 and

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Figure 1.1. Location of the Ken-Caryl Ranch, Jefferson County, Colorado.

1.2). Authorization for excavation was granted by the Office of the Colorado State Archaeologist. Since development was planned to start on the north end of the property (the North Ranch), DC-CAS began there in 1973 with a program of survey, site testing, and excavation. Three sites were excavated (5JF51- Bradford House II, 5JF52-Bradford House III, and 5JF60-Twin Cottonwoods). In 1976, DC-CAS shifted its activities from the north end of the property to the southern part (the South Valley). Again, a program of survey, testing and excavation was carried out. Three sites in addition to the Swallow site (5JF321) were excavated (5JF148-Crescent, 5JF211-Falcon's Nest, and 5JF246-Southgate). Tate and Johnson (1997) provide an overview of investigations at the Ken-Caryl Ranch.

DC-CAS opened the Swallow site, its last major Ken-Caryl Ranch excavation, in 1983. In 1987, the Manville Corporation sold the South Valley to Martin Marietta (later Lockheed-Martin) Corporation. Martin Marietta authorized DC-CAS to continue the excavation. Since the South Valley was still considered to be endangered, excavation proceeded. In 1996, the Jefferson County Department of Open Space bought a portion of the valley, including the Swallow site, for a park. With the encouragement of the County, DC-CAS continued the excavation for two additional seasons to finish the excavation.

DC-CAS carried out further survey of the ranch, identifying additional lithic scatters and a chalcedony quarry in the Morrison formation of the Dakota Hogback (Moore 2002). Of the early North Ranch excavations, Bradford House II (5JF51) and the larger Bradford House III (5JF52) are

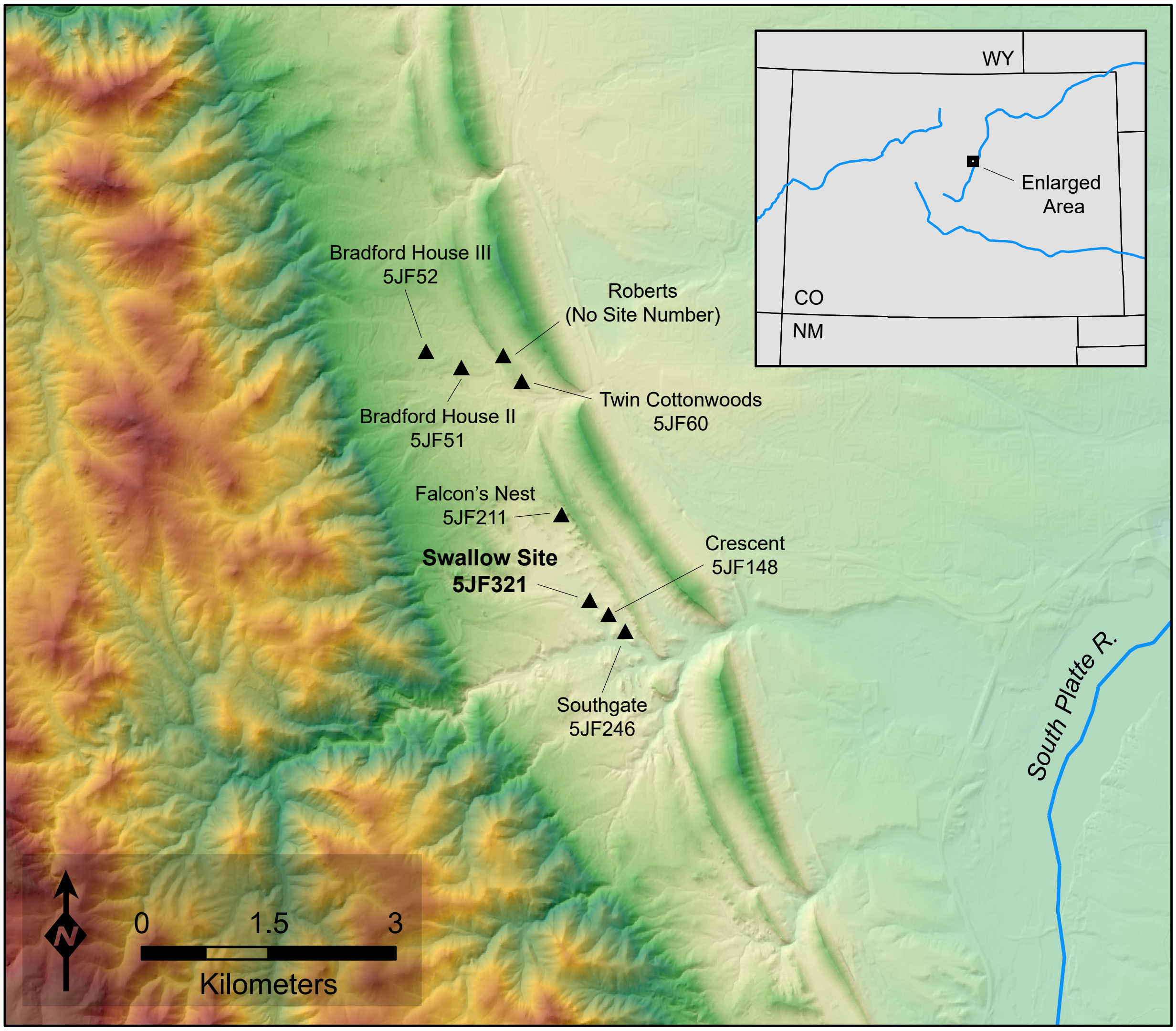

Figure 1.2. Locations of archaeological sites on the Ken-Caryl Ranch in the Hogback valley. All of the sites shown, except the Roberts site, were excavated by the Denver Chapter of CAS as part of the Ken-Caryl Ranch project.

sheltered habitation sites under the shallow overhangs of two Fountain formation monoliths. Both yielded hearths and a wide spectrum of artifacts indicative of hunting, butchering, hide and plant processing, and other activities, and are considered long-term, perhaps over-winter, habitations. Both are listed on the National Register of Historic Places. Twin Cottonwoods (5JF60) is an open site on the north side of Dutch Creek, where this small stream cuts through the Lyons formation ridge on its way to exiting the Hogback valley. Its artifact assemblage is very similar to that of the two Bradford House shelters; it is also thought to be a long-term habitation. All three of these sites have Early Ceramic and Late and Middle Archaic components. The Ken-Caryl Ranch site tests and excavations were published as Memoir 6 by the Colorado Archaeological Society (Johnson et al. 1997). Subsequent to that report, the final North Ranch test excavation at 5JF2213 was conducted in 1999. A looted bison skeleton eroding from this open site had been reported. The test unit yielded flakes, and three sherds at a depth of 40 cm. A scatter of bone including a bison rib fragment was encountered at a depth of 130 cm (Moore 2002).

In the South Valley, Falcon's Nest (5JF211) and Southgate (5JF246) sites are small habitation sites under rock formations similar to Bradford House II. Falcon's Nest has Early Ceramic as well as Archaic components, while Southgate has only an Early Ceramic component. The DC-CAS excavations at Southgate and the Crescent site are summarized briefly in the Ken-Caryl Ranch publication by Johnson and colleagues (1997). Falcon's Nest is described in detail in an unpublished site report (Adkins 1997a) and summarized in *Southwestern Lore* (Burris et al. 2008).

Crescent site (5JF148) is a larger habitation site, also under the shallow overhang of a Fountain formation outcrop. Excavations were conducted by DC-CAS between 1980 and 1983 (Adkins 1997b; Ford 1983). Radiocarbon dates from the Crescent site indicate an Early Archaic occupation as well as Middle and Late Archaic and Early Ceramic occupations. The University of Colorado Denver and Metropolitan State College subsequently excavated for two seasons at Crescent site (Stone 1994; Stone and Mendoza 1994). Radiocarbon dates from this work indicate a Middle Ceramic occupation in addition to the occupations that DC-CAS identified.

The Swallow Site Excavation

Swallow site (5JF321) is another large, multicomponent sheltered habitation under the shallow overhang of a high Fountain formation monolith in the South Valley of the Ken-Caryl Ranch (Figure 1.3). The site is named for the cliff swallow nests on the monolith wall.

The site is approximately 24 km southwest of central Denver, north of Deer Creek and just east of Docmann Gulch, a south-flowing ephemeral stream, which drains the Hogback valley in this vicinity. The site is on a gentle uphill slope extending from Docmann Gulch on the west to the prominent Lyons Hogback on the east. The elevation of the site datum is 1780 m above sea level.

DC-CAS decided to excavate Swallow site because it appeared likely to have an Early Archaic component. The Early Archaic is poorly represented and inadequately characterized in the Colorado plains-mountains transition zone. After the first excavation season it was apparent that the very large amount of cultural material recovered would potentially be relevant to a number of research topics about regional prehistory.

In the spring of 1983, DC-CAS established an alphanumeric grid system of 2 x 2-m excavation units along true north-south lines using a surveyor's optical level. A datum was placed at the southwest corner of excavation unit E4S. Distance above or below datum was measured for each grid corner. The highest corner of the unit was designated zero elevation for that grid unit. Units were excavated in 10 cm vertical levels measured from that point. Thus, the levels reflect the depth

Figure 1.3. Swallow site, located at the base of this large, slightly overhanging monolith of Fountain formation sandstone. View east, with Lyons Hogback in background.

below modern ground surface for each excavation unit rather than depth below datum. Site-wide vertical control was maintained with a surveyor's level and rod. Excavation was primarily by trowel; a few units were partially excavated by shovel skimming. Large blocks of fallen rock were removed by jackhammer.

Chipped and ground stone tools, identifiable bones and bone fragments, large flakes (approximately 2.5 cm or more in greatest dimension), and other significant specimens were point-plotted. They were given sequential numbers and entered into a field catalogue. Small lithic debitage, unidentifiable bone fragments, and small pieces of charcoal were bagged together for each level. Plan view maps and notes were made for each unit and level. Dirt was screened through ¼ in wirecloth.

The excavation, begun as a four-unit test, was extended through the 15 subsequent seasons to include all or parts of 42 2 x 2-m excavation units dug to various depths. Approximately 200 m^2 of dirt was excavated, with eight units excavated to bedrock. In addition, a trench consisting of six end-to-end 2 x 1-m units was dug as a westward extension of excavation Row 3 South to define the downslope extent of the site. Finally, two shallow 2 x 1-m test units were placed, one north and the other west of the site. Excavations concluded and the site was backfilled at the end of the 1998 season, with Jefferson County Open Space Department providing a front-end loader and operator to backfill. A portion of the site, primarily at the south end, was left unexcavated. A more detailed description of the extent of the excavation is given in Chapter 4.

Laboratory Analysis

In 1986, laboratory work was begun on the recovered materials. Artifacts were only minimally cleaned to preserve residues for possible future analysis. Artifacts were given permanent catalogue numbers, weighed, measured, and assigned to provisional artifact classes and subclasses. Some artifacts and samples were submitted for ceramic, pollen, blood residue, macrofloral analysis, and radiocarbon dating. Ivol Hagar and Fred Rathbun provided workspace in their basements until 1987 when the laboratory was moved to the Department of Anthropology at the University of Denver. Using a comparative faunal collection prepared by DC-CAS (Sands 1997), bone identification and analysis was performed separately in the Colorado Archaeological Society's bone laboratory, originally organized by Anne Sands and Charlotte Bechtold and later led by Bechtold and Katherine Bryant. A team from the Indian Peaks Chapter of CAS analyzed the projectile points, measuring and photographing the points and creating a projectile point typology. Additional analysis and report writing continued in Rathbun's home and at the University of Denver.

Seven human burials were recovered from the DC-CAS excavations on the Ken-Caryl Ranch. Three were from Falcon's Nest (5JF211) (Finnegan 1997), one from Crescent (5JF148) (Finnegan and Kilgore 1997), one from Bradford House III (Finnegan 1978), and two from the Swallow site (Finnegan and Meitl, this report). After consultation with NAGPRA officials in Washington, D. C., NAGPRA coordinators at the University of Denver, and officials of the Ken-Caryl Ranch Master Association, DC-CAS's intent to repatriate was published in the Federal Register, and, in 2010, the remains were repatriated to the Ute Mountain Ute Tribe and were reburied.

Field and laboratory records, artifacts, and other specimens from the Swallow site have been housed at the University of Denver Museum of Anthropology. They will be permanently curated at History Colorado. The comparative faunal collection is housed in the Department of Anthropology at Metropolitan State University of Denver.

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2

The Swallow Site Environment

Linda M. W. Groth and Bill Hammond

Introduction

Swallow site is located in the central portion of the Hogback valley. It is situated under one of the valley's many large Fountain formation erosional-remnant monoliths (Figure 1.1). The valley is a long, narrow (40 km long by 2-4 km wide) strike valley extending south-southeast from the city of Golden and the North and South Table Mountains to Roxborough Park, just north of the South Platte River as it exits the foothills of the Front Range. The valley is bounded by the foothills of the Front Range of the Rocky Mountains to the west and the Dakota Hogback to the east. Further east is the Denver Basin. Thus, the Hogback valley is in a transitional zone between the higher, cooler, more moist montane forests and the lower, warmer, drier plains grasslands.

The terrain around the Swallow site monolith slopes down to the southwest, to the meadow of Docmann Gulch (Figure 2.1). The small stream that drains this portion of the valley probably originates from a spring in the foothills, then flows south through the valley and empties into Deer Creek. Other permanent and ephemeral streams also drain the valley; these streams rise in the mountains, cut through the hogback ridges to the east, and flow into the South Platte River. Docmann Gulch is the closest tributary to such a stream and the closest source of water to the Swallow site.

Local Geology

Geologically, the Hogback valley is bounded by Precambrian igneous and metamorphic rocks of the foothills/mountains to the west, and an erosion-resistant Cretaceous sandstone formation of the Dakota Ridge to the east. Sedimentary formations within the valley range from the Permian/

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Figure 2.1. View east at Docmann meadow with Docmann Gulch in foreground, Swallow site monolith, and Lyons Hogback in background.

Pennsylvanian arkosic Fountain formation on the west through the Lyons, Lykins, Ralston Creek and Morrison formations to the Hogback ridge of Cretaceous Dakota formation on the east (Figure 2.2).

The Hogback valley began forming during late Cretaceous/early Tertiary times when uplift and faulting of Precambrian rocks along the Front Range brought the sedimentary strata sequence to the surface and tilted it 30 degrees or more to the northeast (Bryant et al. 1973). Therefore, the Permian/Pennsylvanian Fountain formation is at the surface and lies unconformably on the Precambrian rocks. Subsequent weathering and erosion removed much of the softer sedimentary rock. These processes resulted in the exposure of numerous large monolithic remnants of Fountain sandstone more resistant than the rest of the Fountain formation in the valley.

A ridge of resistant Cretaceous Dakota sandstone forms the Hogback, which defines the valley's eastern flank. Differential erosion also resulted in a steep but smaller ridge of resistant Permian Lyons sandstone within the valley east of the Fountain formation. This ridge separates the main, western portion of the valley from a narrower eastern part between the Lyons ridge and the Dakota Hogback. This narrower part of the valley contains the Lykins, Ralston Creek and the western, lower part of the Morrison formation. The eastern, upper part of the Morrison makes up the lower part of the western flank of the Hogback ridge.

The sedimentary Fountain formation forms the floor of the main, western part of Hogback valley. The formation is a distinctive reddish to orange to brown arkosic sandstone-mudstone-conglomerate. It

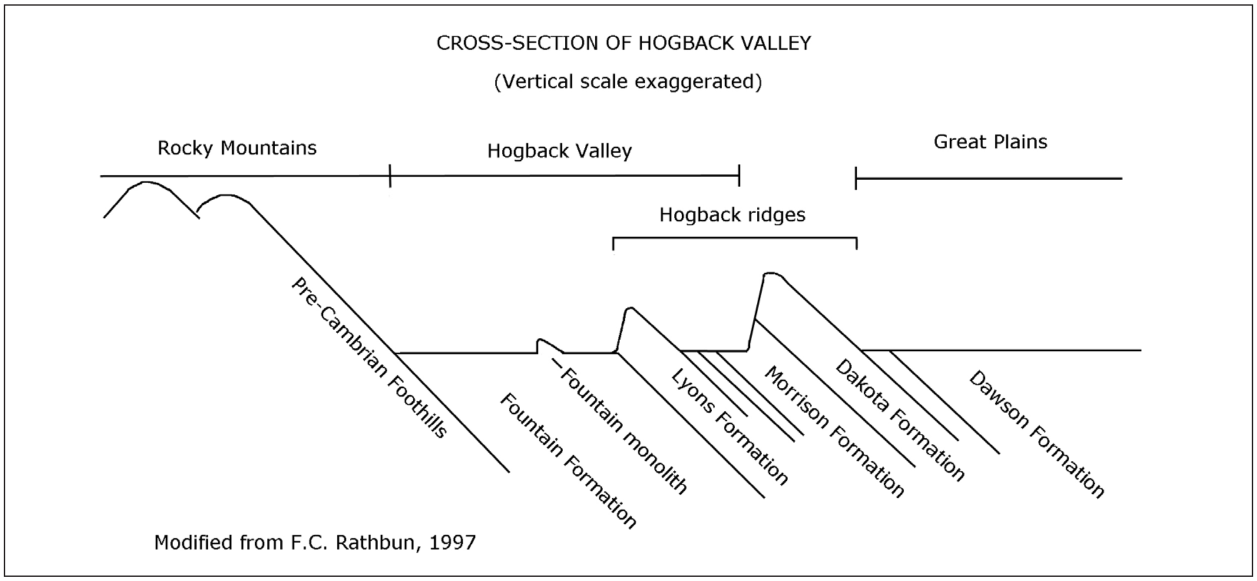

Figure 2.2. Geologic cross-section of the Hogback Valley on the Ken-Caryl Ranch. Modified from Rathbun (1997).

contains fine- through cobble-sized grains of Precambrian rocks, orthoclase feldspar, iron-stained quartz, and muscovite cemented by calcium carbonate, silica, and iron oxide. The sediments are mainly fluvial in origin; the sands and gravels originated from streams carrying eroded Precambrian rocks from the west (Rathbun 1997). The 30-degree northeast dip of the formation is easily seen in the monolithic outcrops within the Valley. Some of these monoliths are relatively high; that of Swallow site is about 20 m, creating ample space for human activity within its shelter.

Soil Development

Adjacent to the streams flowing through the Valley are prominent Pleistocene alluvial and colluvial deposits. Other unconsolidated sediments of the valley floor consist of Lower Holocene Pre-Piney Creek alluvia and colluvia. The sediments within the site itself are sand and pebbles weathered from the face of the monolith, sediments washed downhill around the edges of the monolith, and loess blowing and silting in from the west. This admixture has resulted in some poorly sorted sediments, incipient soils, and developed soils within the Swallow site rockshelter.

Sediments at the Swallow site basically came from three sources:

1. Residual soils from general physical weathering and erosion of the Fountain formation outcrop adjacent to and overhanging the site. The characteristics of the formation explain the reddish/orange/brown soil colors and the large range of unsorted sediment particle sizes in some horizons. Accumulation rates depend on weather/climatic conditions.

2. Eolian sediments from winds transporting fine sediment particles into the site area. The westerly/northwesterly winds can be strong and pick up particles from various unconsolidated surficial deposits to the west. These deposits include the Slocum Alluvium (Pleistocene), the Pre-Piney Creek Alluvium (Lower Holocene), and the Piney Creek Alluvium (Upper Holocene) (Bryant et al. 1973). The winnowing effect of wind action results in two types of deposits: fine sands by saltation and surface creep, and loess deposits of fine silts, clays and organic particles. Major eolian deposits commonly accumulate during arid and semi-arid conditions when vegetation cover is sparse, but some wind-effect particles are commonly in the air at this site because it is a generally windy area.

3. Slope wash flowing onto the site from adjacent higher ground.

Other substances making up the site fill are calcium carbonate and charcoal, ash, bone, and a variety of organic materials from animal and human activities. No alluvial soils should be present except around the edges of the monolith. No significant erosion of the accumulated sediments should have occurred because the site is relatively protected from the adjacent upslope areas by the monolith.

Docmann Meadow

The meadow morphology is atypical for an area created by meandering streams. Rathbun (1997) noted that the present streams seem too small to have formed the valley. The geomorphic cross-section of the area shows a relatively level surface with slightly inclined margins. There are no linear "ripples" which would indicate active stream beds in the past. There is no evidence of a central stream channel through which significant water flows now nor in the past before the historic water diversion projects existed. The present rivulets are small, ephemeral, sluggish and shallow, and not capable of transporting much inorganic sediment. Considering the large areal size of the meadow, meteoric water should have been sufficient for the presence of surface water, but evidence of such is lacking.

The government soil survey (Price and Amen 1983) for this area shows that the main soil units with 0 to 9% slope are deep (up to 60+ in) sandy loams that are well-drained with moderate to rapid permeability. Therefore, the meadow soil is so porous that water readily infiltrates it. This is seen in the area around a grove of cottonwoods about 100 m northwest of Swallow site, where minimal water is flowing above ground. However, groundwater must be close to the surface because cottonwoods must have their roots in permanent water.

Therefore, the meadow is not considered to be a flood plain created by flowing water but is composed of wind-deposited loess. The probable scenario is that large amounts of surficial silt were deposited in the shallow valley by winds blowing from the western canyons and across the coarse, previously-deposited Docmann unconsolidated valley fill deposits. After vegetation, primarily grasses, became established, the meadow acted as a windscreen and captured even more wind-blown and silted sediments. Water traveled principally below the surface, and thus streams did not create physical disturbances on the relatively level plain.

Modern Climate

The Denver region is semi-arid (mean annual rainfall of 15 to 18 in) and is subject to wide diurnal and annual temperature variations. There is a relatively short mean growing season of 157 days (and in a "bad" year as little as 130 to 135 days) (Colorado State University 2012). The Hogback valley in the Denver region lies within a pocket of air which is warmer by six to eight degrees F. in winter and three to five degrees in summer than the nearby plains (Figure 2.3). Diurnal temperature fluctuation is similarly decreased. Mean temperature in the valley is estimated at 31 degrees F. in January and 72 degrees F. in July, with a mean diurnal variation of 29 degrees F. (W. Tate 1997). One of the causes of this very local amelioration of climate is the warming effect of the downslope "Chinook" winds from the mountains. Movements of cold air from Alaska and warm air from the Southwest and the Gulf of Mexico also make the valley a windy although temperate place.

Another factor which makes the Hogback valley attractive for human habitation is the orientation of the Fountain formation monoliths, which face to the southwest. Afternoon sunshine heats these relatively dark-colored rocks, and this heat radiates out during the night, ameliorating the drop in nighttime temperature.

Paleoclimate

The climate in the American West has varied considerably over the course of the Holocene. After the end of the ±1,000 year-long Younger Dryas cold interval the climate became warmer, culminating in the warm, dry Altithermal (Antevs 1955), lasting from about 7500 to 5000 BP. In the high mountains of the Colorado Front Range the Altithermal was followed by further warming, reaching a maximum at about 4000 BP, and then a cooler, moister interval of about 1,000 years. A subsequent warming period ended about 2000 BP, giving way to a more recent episode of cooling until about 800 BP (Doerner 2007).

However, the climate in the West has varied regionally (Cordell 1984), and quite possibly locally, from the overall pattern. Doerner's (2007) analysis of the mountains of the Colorado Front Range does not necessarily describe the past climate in the microenvironment of the Hogback valley. A palynology study (Chapter 6) suggests climate fluctuations during and subsequent to the Middle Archaic period (5000 to 3000 BP). Although sampling for the study did not extend into the Early Archaic levels, pollen analysis from the Early Archaic level of the nearby Massey Draw site (5JF330) was interpreted to indicate a warm, dry climate consistent with the Altithermal (Cummings 1994).

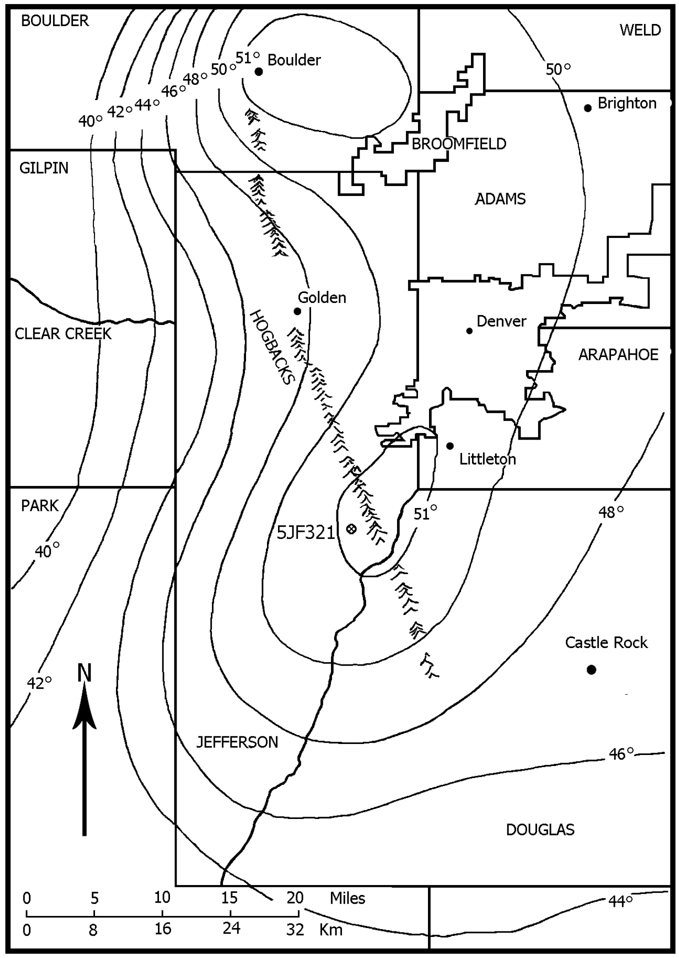

Figure 2.3. Temperature gradients along the northern Front Range, showing a warm zone around the Swallow site. Redrawn from W. Tate (1997:19).

Flora and Fauna

At the junction of mountains and plains, the Hogback valley lies in the foothills life zone, a dry shrub ecosystem, with elements from both the plains grasslands and the montane ponderosa pine/ Douglas fir forest. This zone has a greater diversity of flora and fauna than either adjacent zone. Streams within and coursing through the valley give rise to riparian habitats. Scattered ponderosa and pinon pine, juniper and Douglas fir grow along and near the Dakota and Lyons ridges. More prominent are stands of mountain mahogany and Gambel oak. Numerous grasses, predominantly blue grama and western wheatgrass, are present, as well as buffalo grass, mullein, dropseed, sedges, sagebrush, rabbitbrush, yucca, prickly pear cactus, sumac, gooseberry and currant (M. Tate 1979, Lyons 1997). Goosefoot, thistles and ragweed, which typically grow on disturbed soils, are also present. Big bluestem, characteristic of tall grass prairie, is found between the Lyons and Dakota ridges; it is presumably a relic of the moist conditions of the Pleistocene. Riparian species include cottonwood, river birch, willow, chokecherry, wild plum, cattail, and hackberry.

Modern herbivores include mule deer, elk, jackrabbits and cottontails, and many species of rodents, including prairie dogs, squirrels, voles, pocket gophers, and mice. There are also many species of birds and insects as well as a few species of amphibians. Cliff swallows nest on the face of the Swallow site monolith, giving the site its name. In the past, buffalo were present in the valley, as evidenced by a bison skeleton eroding out of the cutbank of a branch of Massey Draw (Moore 2000). Whether they were present in large herds or as occasional individuals is not known. Species dependent on these herbivores include mountain lions, bobcats, coyotes, skunks, rattlesnakes, bull snakes, golden eagles, hawks, falcons, and owls. Black bears are occasionally seen in the valley today; in the past grizzly bears were undoubtedly present as well. Detailed lists of modern plants and animals observed on the Ken-Caryl Ranch are available (Ludlow 1997; Lyons 1997).

The Adjacent Plains and the Foothills

Geologically, the Plains region to the east of the Hogback valley consists of the structural Denver Basin, which covers approximately 7,000 square miles of eastern Colorado. This basin is a large and very asymmetrical syncline with its deepest point (approximately 13,000 feet) located just west of Denver. Strata in the basin range from the Cretaceous Pierre Shale, Laramie, and Arapahoe formations up through the Paleocene interfingering Denver/Dawson formations at the surface. The South Platte River and its tributaries have eroded a broad valley into these rocks. Holocene terrace gravels occur along the river, and to the west are pediments capped with other sands and gravels eroded from the mountains during Pleistocene times.

Soils in the Denver Basin are generally highly permeable, well-drained sandy loams and silt loams formed in alluvial and eolian deposits. They can be relatively deep in many places and can support ranching grasslands and, in places, farming. Saline soils are commonly found where the water table is relatively close to the surface. They may support salt-tolerant plants or have only barren white salt crusts.

Flora in the Denver Basin are dominated by little bluestem, buffalo and blue grama grasses. In addition, shrubs and forbs include prickly pear and cholla cactus, yucca, rabbitbrush, saltbush, ragweed, amaranth, and many more. Fauna are similar to those in the Hogback valley, but also include large numbers of pronghorn, prairie dogs, and of course bison (Mutel and Emerick 1992).

On the west side of the Hogback valley is a complex geologic transition zone. The Permian/Pennsylvanian sedimentary Fountain formation lies unconformably on a Precambrian metamorphic gneiss that has been brought to the surface by vertical uplift. Rising steeply westward are various other Precambrian intrusive metamorphic and igneous masses of quartzite, gneiss, schist and granite which are often cut by pegmatite dikes and thousands of faults. Pleistocene glaciers carved many of the rugged peaks.

Mountain soils tend to be poorly developed because they are young, shallow, coarse textured, acidic and deficient in nutrients. They result from physical weathering of surface rocks and from chemical weathering of granite. In high valleys, soils can be thicker and more developed.

As the foothills and then the mountains rise to the west of the Hogback valley, the dominant flora change from pinon-juniper to Douglas fir-ponderosa pine to spruce-subalpine fir forests, and finally to alpine tundra. Pronghorn and bison were present, in addition to elk, mule deer and other species. With the changes in flora at increasing altitude in the mountains, the faunal assemblage changes from that of the Hogback valley to include porcupine, marmot, pica, snowshoe hare, lynx and bighorn sheep (Mutel and Emerick 1992). The last were also present at lower elevations; at the present time a herd of bighorn sheep lives in the Platte River canyon, a few miles to the south of the Ken-Caryl Ranch.

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3

Cultural Overview

Marcia J. Tate

This cultural overview will use the framework provided in the Colorado Council of Professional Archaeologists, *Colorado Prehistory: A Context for the Platte River Basin* by Gilmore and others (1999). Portions of this overview have been taken from the National Register of Historic Places (NRHP) nomination form for the *South Ranch, Ken-Caryl South Valley Archaeological District,* prepared by Tucker and others (2002) (see also M. Tate 1997). However, the overview also contains considerable added information and updates by discussions of more recent work in the hogbacks and foothills and on the nearby plains and Palmer Divide region, all pertinent to the present study.

Swallow site (5JF321) is in the South Valley of the Ken-Caryl Ranch, which is distinguished by numerous isolated monoliths of Fountain formation sandstone, under which more often than not are found prehistoric sites, some with cultural deposits greater than five feet thick (Johnson and Adkins 1997:153). Tens of thousands of artifacts have been collected from these sites and dozens of cultural features exposed. These data demonstrate repeated use of the valley, most likely during winter, but also probably during the spring and fall, principally by Archaic and Early Ceramic period peoples (Johnson and Adkins 1997:156). The available data indicate less intensive use of the valley for the Late Paleoindian and Middle Ceramic periods. After approximately AD 1150, the hogbacks/foothills apparently were not used as often or as intensively as they had been for six or seven millennia, a cultural hiatus that is not yet clearly understood (Johnson and Adkins 1997:157). For a summary of the work conducted by the Denver Chapter of the Colorado Archaeological Society (DC-CAS) at the Ken-Caryl Ranch, see Tate and Johnson (1997). The Ken-Caryl Valley lies near the western edge of the Platte River Basin, which drains eastern Colorado from the Continental Divide to the Nebraska border and south to the northern edge of the Arkansas River Basin (Chenault 1999a:1). Human groups have inhabited this region for at least 12,000 years. Generally, prehistoric subsistence strategies, based on hunting and gathering, and settlement patterns on the plains and in

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the adjoining hogbacks/foothills area of eastern Colorado have remained relatively stable through time, although intensity of settlement has varied considerably.

The chronology presented in Table 3.1 summarizes the regional culture history. This chronological framework includes four cultural stages that are represented with greater or lesser frequency in the Ken-Caryl Valley. This chapter discusses the salient aspects of each stage. Synthetic works on the region's prehistory include the *Archaeology of Colorado* (Cassells 1997), *Prehistoric Hunters of the High Plains* (Frison 1991), *Archaeology of the High Plains* (Gunnerson 1987), and *Denver: An Archaeological History* (S. Nelson et al. 2001).

Table 3.1. Prehistoric chronology of the Platte River Basin.

Stage	Period	Age Range
Protohistoric		AD 1540-1860
Late Prehistoric	Middle Ceramic	AD 1150-1540
	Early Ceramic	AD 150-1150
Archaic	Late Archaic	1000 BC-AD 150
	Middle Archaic	3000-1000 BC
	Early Archaic	5500-3000 BC
Paleoindian	Plano	10,850-5500 BC
	Folsom	11,340-8720 BC
	Clovis	12,040-9750 BC

Source: Chenault (1999a:3).

Paleoindian Stage

The Paleoindian stage in Colorado includes a number of cultural complexes, all of which shared a big-game hunting tradition believed to be rooted in Eastern Asia. The traditional theory is that human groups crossed the land bridge over the Bering Sea in Late Pleistocene times. Recently, however, researchers have posited multiple migrations of people by boat, who followed the edge of the ice mass from one continent to another, Asia to North America or Europe to North America (see, for example, Bradley and Stanford 2004).

The Paleoindian inhabitants of the Platte River Basin focused on the hunting of large game animals such as mammoth and bison, a specialized adaptation to late Pleistocene/early Holocene environments (Chenault 1999b), although the Clovis economy also included plants and smaller game (Zier 1999). The stage includes three periods, Clovis, Folsom, and Plano or Late Paleoindian, defined on the basis of distinctive technology and/or subsistence patterns. A pre-Clovis period has been hypothesized from limited evidence at a few sites in Colorado, but never conclusively demonstrated. These sites include the nearby Lamb Spring site (5DA83) (see Stanford et al. 1981, for example).

Clovis Period

The Clovis period is defined by a distinctive fluted lanceolate projectile point that is often found in association with mammoth bone. There are several Clovis components in eastern Colorado (see Chenault 1999b), but only at the Dent site, in the South Platte River valley south of Greeley, did investigators find Clovis points in association with mammoth bones (Frison 1991; Figgins 1933). A reinvestigation of the site indicated that while the faunal remains, representing one or more matriarchal family herds, and the associated artifacts appear to have been redeposited, there was strong evidence for butchering activities in the tool assemblage (Brunswig and Fisher 1993; Chenault 1999b).

Folsom Period

The Folsom period, known for a distinctive fluted lanceolate projectile point type, is often identified at kill sites of extinct forms of bison. The Powars site near Kersey, Colorado was a camp which yielded Folsom artifacts from an area of dunes along the South Platte River (Roberts 1937). Also, near Orchard, Colorado, at the Fowler-Parrish site (also Folsom), investigators found points associated with bison bone beds (Agogino and Parrish 1971). Lindenmeier is one of the best-known Folsom sites in Colorado. Located north of Fort Collins, the site is a camp and butchering locale (Wilmsen and Roberts 1978; Frison 1991).

Plano Period

The Plano period is characterized by an array of unfluted projectile point types, each of which identifies a specific cultural complex. The various Plano complexes include Hell Gap, Agate Basin, Alberta, Cody, and various other variations. Near Wray, Colorado, the Jones Miller site was an extensive bison kill locale with Hell Gap points (Stanford 1974, 1975). At Lamb Spring, just east of the hogbacks southwest of Denver, Cody complex artifacts were found in association with bison bones (Rancier et al. 1982). The earliest known burial in Colorado was found northwest of Fort Collins, at the Gordon Creek Burial site (5LR99), from which a radiocarbon sample resulted in an age estimate of approximately 9700±250 BP (Anderson 1966).

In the Colorado Front Range, a number of different parallel and transverse-oblique flaked, non-fluted lanceolate projectile point types provide evidence for Plano occupations in the mountains. A projectile point found at the Caribou Lake site in the Indian Peaks area resembled the Kersey type from the Jurgens site, which can be placed within the Cody complex. The artifact was associated with a hearth dating to the Plano period (Benedict 1985a). At the Fourth of July Valley site, also in the Indian Peaks area, Benedict (1981) identified another Plano artifact, a James Allen type projectile point.

Thus far, there is little evidence for Paleoindian components in the Ken-Caryl Valley or in the hogback environs. There are hints of Paleoindian occupation in the vicinity, however. The artifact assemblage from the LoDaisKa site (Irwin and Irwin 1959) includes a Paleoindian point and investigators at the Lamb Spring site recovered a Cody point (Chenault 1999b:77). Excavations at the Crescent site (5JF148) revealed two projectile point fragments that resemble James Allen points (Late Paleoindian period) (Stone and Mendoza 1994:97).

Archaic Stage

After the decimation of the large Pleistocene herds, human groups adapted to changing environmental conditions by adopting subsistence strategies that exploited a broad range of flora and fauna. Residents followed a nomadic or semi-nomadic existence, making seasonal rounds in search of available food resources. The Archaic stage is divided into three periods, each of which is defined by distinctive artifacts (Tate 1999).

Archaeologists have formulated several models to explain Archaic occupation on the High Plains and in the Rocky Mountains (Tate 1999:92). The Mountain Refugium model posits that foraging hunters and gatherers abandoned the drought-affected plains and western plateaus during the Altithermal droughts and sought refuge in the relatively cooler and moister Rocky Mountains (Benedict and Olson 1978; Benedict 1979), returning to repopulate the plains during a cooler interval. Benedict envisioned a simple model of seasonal transhumance from winter base camps at lower elevations to summer hunting camps along the Continental Divide, and back to the lower elevations in the fall. Benedict (1990) also proposed the more complex Grand Circuit model of seasonal transhumance. Cultural groups, who had wintered in the foothills, traveled north in the spring along the flank of the Front Range into the Laramie Basin of southern Wyoming. From there, they moved south into North Park and Middle Park, where plant resources, large game, and waterfowl were plentiful. As summer waned, they moved east into the high country along the Continental Divide to hunt large game. Finally, in the fall, they returned to the winter camps at lower elevations. In a third model, Black (1991) has defined a Mountain Tradition, in which indigenous groups occupied the high country year-round and, in doing so, established a pattern of cultural continuity that lasted from Late Paleoindian period into the Late Prehistoric era. Tate (1999:165) has observed that these models can be summarized as mountain-oriented (Mountain Refugium and Grand Circuit) or mountain-based (Mountain Tradition) adaptations. They are not necessarily mutually exclusive and contain overlapping elements.

Early Archaic Period

The Early Archaic period is characterized by a group of large, side- and corner-notched dart points, variously known in the Rocky Mountains and surrounding areas as Hawken, Bitterroot, Pahaska, and Simonsen, and by those described by Frison (1991) as Altithermal Side-notched. Local types include Mount Albion (Benedict and Olson 1978), MM 3, and MM 4, the latter known first from the Magic Mountain site (Irwin-Williams and Irwin 1966). The Early Archaic period generally coincides with the Altithermal, an arid climatic episode defined by Antevs (1955), probably but one of various Holocene drought episodes (Painter et al. 1995). Some archaeologists believe that during the Altithermal the plains were abandoned as people took refuge in the mountains. Evidence for the Early Archaic period is sparse in the Ken-Caryl Valley but is present at the Crescent site (5JF148) in the Ken-Caryl South Ranch. The nearby Magic Mountain site (Irwin-Williams and Irwin 1966), and the Massey Draw site (5JF339) immediately east of the Dakota Hogback, also contained Early Archaic components (Tate 1999:111-112).

The Crescent site (5JF148) is located next to an overhang of Fountain formation on the Ken-Caryl South Ranch. Its horizontal dimensions are 60-x-9 m, covering an area of approximately 0.05 hectares. Radiocarbon samples from test excavations provided eight dates. These dates range from 6200±240 BP to 550±70 BP (Adkins 1997:123), with dendrocalibrated age ranges of 5560-4594 BC to AD 1290-1458. During deep backhoe trenching, charcoal was obtained from an apparent hearth and yielded the 6200 BP date, but the walls of the trench collapsed before they could be carefully examined. A human burial was recovered in 1982 (Adkins 1997:125; Finnegan and Kilgore 1997:246). The burial was found about 40 cm above a hearth. A sample from the hearth returned a radiocarbon age of 5680±110 BP, with a dendrocalibrated age range of 4784-4333 BC. The skeletal remains, of an adult female, represent the only Early Archaic burial known in the Platte River Basin in Colorado (Tate 1999:112).

Two open camps with well-dated Early Archaic components are known in the north Denver Basin, Monaghan Camp (5DV3041) (Tucker 1990) and Rock Creek site (5BL2712) (Gleichman et al. 1995). Monaghan Camp was one of numerous sites encountered during the inventories of Denver International Airport (Tate et al. 1989). The site, which no longer exists, was situated on top of a low knoll between what is presently Concourses A and B. Three discrete concentrations of artifacts were found at the site, each associated with one or more of the eight hearths encountered during excavations at the site and representing both Early and Middle Archaic components. A concentration of artifacts at the south end of the site (Block III) was found in association with Feature C. A radiocarbon sample (from Feature C, a shallow basin hearth filled with charcoal-stained and flecked soil) returned an age estimate of 4920±210 BP, representing a dendrocalibrated age range of 4231-3109 BC. The feature yielded abundant pollen of the Saxifragaceae family. A member of this family is alumroot, which is used medicinally. The plant presently grows above 9,000 feet in moist environments, indicating that the site's inhabitants may have gathered it during forays into the mountains. The hearth also contained charred goosefoot seed remains, indicating processing activities. Only one diagnostic artifact was recovered, a side-notched projectile point. However, as the implement had been reworked for use as a knife, it is not a good temporal indicator for site occupation. The artifact resembles the local MM 4 type dart point and the Hawken side-notched type found on the Northwestern Plains, both Early Archaic types. Lithic debitage, mostly secondary decortication and interior flakes of petrified wood, dominated the site assemblage, suggesting that tools were brought into camp either partially or wholly finished and completed, modified, or repaired between hunting forays. A knife, a few bifaces, and several utilized flakes indicate that the final processing of animals butchered elsewhere occurred at the camp. Ground stone was relatively abundant at the site: manos were made of locally available quartzite and granite stream cobbles, while tabular sandstone from the hogbacks to the west was used for metates. The radiocarbon age estimate for Feature C overlaps Benedict's later drought period and the moist intermediate interval. Soil studies at the site indicate that conditions prior to this first occupation were at least as dry, or drier than present. The top of the pollen record, 30 cm below present ground surface, indicates a reduced relative frequency for the warm climate Cheno-ams and increases in the relative frequencies for grasses, sagebrush, pine, and juniper, indicating a cooler and possibly more mesic environment at the time (Tucker 1990).

The Rock Creek site (5BL2712) is situated on the north bank of Rock Creek on the plains near Broomfield, approximately 10 miles east of the hogbacks/foothills transition zone. Located on land owned by the Boulder County Parks and Open Space Department, it was discovered by Native Cultural Services in 1989 and subsequently tested and excavated over the course of the next several years. The site is a multicomponent camp with evidence for occupations during the Early and Middle Archaic, as well as the Early and Middle Ceramic periods. The Early Archaic evidence is confined to a single slab-lined hearth, Feature 12, found eroding out of the creek bank at the northern edge of the site. A charcoal sample from this hearth returned a radiocarbon age estimate of 6240±190 BP, with a dendrocalibrated age range of 5563-4726 BC. The hearth contained charred pigweed, goosefoot, bulrush, and cocklebur seeds, as well as a small amount of bone, but no associated artifacts (Gleichman et al. 1995).

In the mountains northwest of the Ken-Caryl Ranch area is a substantial number of well documented sites, primarily camping/processing sites and game drives. The camps include the Hungry Whistler site (5BL67) and Site 5BL70 (Benedict and Olson 1978), the Ptarmigan (5BL170) and Fourth of July (5BL120) sites (Benedict 1981), Albion Boarding House site (5BL73) (Benedict 1975a) and Coney Lake site (5BL94) (Benedict 1990). There are more than 50 game drive sites known in the continental divide area between Boulder and Middle Park. The game drive sites with Early Archaic components are the Hungry Whistler (5BL67) and Trail Ridge Game Drive (5LR15) sites (Benedict 1996).

Albion Boarding House is an open camp situated on the valley floor. The site has both Early Archaic and Early Ceramic components. However, like the Fourth of July site, while both provided Early Archaic radiocarbon dates, the associated artifacts are McKean-like (Benedict 1975a; Benedict 1981). The Hungry Whistler site is a game drive and butchering site used in late summer and fall. Present are a dry-laid stone wall and 187 cairns (Benedict and Olson 1978).

The Trail Ridge Game Drive site has three low stone walls and five circular or semi-circular blinds. The Early Archaic component returned a dendrocalibrated age range of 3506-3096, while the Late Archaic has a dendrocalibrated age range of 844-746 BC. The Flattop Mountain Game Drive, located at the head of the Big Thompson River, is one of the most extensive game drive systems. While the majority of projectile points at the site date from the Early Archaic, radiocarbon data indicate use in the Middle and Late Archaic periods, and the Early Ceramic period (Benedict 1996).

Middle Archaic Period

The Middle Archaic period is marked by the appearance of a group of stemmed, indented-base dart points, termed McKean complex. These artifacts include the lanceolate McKean, Duncan, and Hanna projectile points, and the side-notched Mallory point. There is evidence for a proliferation of various fire pit features attesting to food cooking and processing (Tate 1999). The earliest basin house structures known in the South Platte Basin of Colorado date to this period (Gantt 2007). On the Ken-Caryl North Ranch, investigators excavated three multi-component sites, all of which contained Middle Archaic components (Johnson et al. 1997). These include Bradford House II (5JF51), Bradford House III (5JF52), and Twin Cottonwoods (5JF60). On the Ken-Caryl South Ranch, investigations at Falcon's Nest (5JF211) (Adkins 1993-1994; Burris et al. 2008) also revealed a Middle Archaic component.

Bradford House II is a small, sheltered camp at the south end of a protuberance of the Lyons Sandstone hogback. The site has Middle and Late Archaic remains, as well as evidence for Early Ceramic components. The site's Middle Archaic component included a slab-lined hearth associated with Duncan projectile points. Also found were Magic Mountain (MM 3), McKean, Hanna, and Mallory points. Faunal remains recovered from the Archaic zone include 12 species, predominantly mule deer, but bison and rabbit were also relatively common (Johnson and Lyons 1997a; Richardson 1974).

At Bradford House III, charcoal from hearth Feature 23, one of 25 features uncovered at the site, returned a radiocarbon age estimate of 3810±149 BP (Johnson and Lyons 1997b:82). In the same level as this feature was a living floor, Feature 21. At the base of the excavations was a cist, which consisted of a low wall, three courses high, that incorporated the back wall of the shelter. Artifacts from Middle Archaic occupations of the site included 22 MM 3-type projectile points but few McKean complex points. While there was a wide variety of flaked tools at Bradford House III compared with Bradford House II, many more formal tools than retouched or utilized flakes were found (Johnson and Lyons 1997a, 1997b; Medina 1974, 1975; Richardson 1974).

The Twin Cottonwoods site is located in a channel wash on the southern end of the Lyons Sandstone formation, near a water gap, in a topographical setting similar to the Magic Mountain site (Horner and Horner 1974; Beal and Beal 1997). Excavations revealed 10 hearths and artifacts similar to the Middle Archaic component at Bradford House II (Johnson and Lyons 1997a).

Dutch Creek site (5JF463), a multi-component open camp dating from Middle Archaic times, is located on the plains immediately east of the Dakota Hogback (Jepson and Hand 1994). Hearth Features 5 and 6 at the site yielded charcoal samples that returned radiocarbon ages of 4210±100 BP and 4210±80 BP (Jepson and Hand 1994:32), or dendrocalibrated age ranges of 3033-2492 BC and 3010-2507 BC. Investigators recovered bison and deer bone from Middle Archaic Strata F and G. The presence of upper and lower bison limbs suggests transportation from a nearby kill site. The presence of fetal bone indicates a spring kill, while goosefoot seeds recovered from a hearth would have been processed in late summer or early fall. The artifact assemblage indicates that tool finishing and maintenance, as well as game processing, were the principal activities conducted at the site during Middle Archaic times (Jepson and Hand 1994).

In recent years, a plethora of open camps have been investigated along the northern Palmer Divide south of Denver. These include Bayou Gulch (5DA265) (Gilmore 1991) and several sites along Newlin Gulch in the Cherry Creek drainage in an area planned for the Reuter-Hess reservoir. These latter sites include two large, multi-component base camps, the Hess (5DA1951) and Oeskeso (5DA1957) sites, and a group of smaller, less complex, temporary camps as well. Of particular interest is that these sites for the most part have Middle Archaic and Late Prehistoric period components but lack evidence for occupation during the Late Archaic period (Gantt 2007). While both the Hess and Oeskeso sites contained Early Archaic components, these residential base camps are especially significant in that both contained the remains of basin houses of Middle Archaic age, unknown heretofore, in the South Platte River Basin.

At the Bayou Gulch site (5DA265), investigations revealed a single Early Archaic artifact, a MM 4 projectile point. The Middle Archaic component is better represented. Eleven hearths, the majority of them basin-shaped, were found. Two radiocarbon age estimates document site occupation during the Middle Archaic. The older of the two, derived from a charcoal sample from Feature 14 resulted in a radiocarbon age estimate of 3410±70 BP (Gilmore et al. 1999:23), with a dendrocalibrated age range of 1885-1520 BC. All of the flaked lithics in the component were of locally available materials, the majority of which were petrified wood. The high frequency of expedient flake tools led to the interpretation that extractive subsistence activities were an important activity at the site (Gilmore 1991).

The Hess site has well stratified Early and Middle Archaic components, which produced a suite of 13 radiocarbon dates, 12 dating occupations during the Middle Archaic period. These dates indicate that there were at least three occupations over a 450-year period and are supported by the presence of 20 dart points of the stemmed-indented base, or McKean, type. There were 45 features found in the Archaic components at the site; two small features representing the Early Archaic period, about which little is known at the site, and 43 of Middle Archaic age. The Middle Archaic features included portions of two partially intact basin houses (Features 2 and 3), constructed at different times, and a large stain that may represent the remains of a third basin house. Feature 2 had a diameter of at least 4.5 m and six interior features, including four storage pits, a central basin hearth, and a hearth cleanout. Feature 3 had a diameter of at least 3.5 m and six internal features (Gantt 2007).

Investigations at the Oeskeso site also revealed both Early and Middle Archaic components, the former very sparse and shallowly buried. These, and two additional components, one of Early Ceramic age and one non-designated, are horizontally separate and sometimes stratified. The radiocarbon data and diagnostic artifacts indicate multiple occupations spanning more than 4,500 years. Investigators identified two Middle Archaic components (MA1 and MA2). A group of 17 radiocarbon dates indicates at least two Middle Archaic occupations; MA1 has a calibrated age range of 3262-2206 BC, while the age of MA2 has a calibrated age range of 1601-1131 BC. In the MA1 component, there was a basin house (Feature 4) and 14 associated features. Feature 4 is a relatively intact basin house with nine internal features, which included two storage pits, two central basin hearths, a separate basin hearth, a hearth cleanout, a small midden, a lithic reduction area, and a post remnant. Outside the house perimeter were five associated features: two post remnants, a possible post hole, a large midden, and a basin-shaped feature in the midden. Feature 4 is at least 5 m in diameter along the north/south axis and approximately 3.5 m along the east-west axis. Eleven features comprise the early MA2 component, seven of which are basin hearths, a hearth cleanout, a storage pit, and an activity area, the latter the locus of both flaked stone reduction and functions involving use of ground stone (Gantt 2007).

In the same general vicinity as the Reuter-Hess sites are some seasonal camps with Middle Archaic components, including the East Plum Creek site (5DA1008) (Kalasz et al. 2003), located in the town of Castle Rock and the Ridgegate site (5DA1000) (Kalasz et al. 2008). Investigators found two cultural components at the East Plum Creek site, a largely destroyed Early Ceramic component with no features and few artifacts and a Middle Archaic component with fire-related features, faunal remains, and ground and flaked stone artifacts. The latter included 10 stemmed, indented-base projectile points. The authors believe that these represent an expansion of a point style from the Continental Divide, which has been in place there for the last 4,000 years and ultimately originated in the Great Basin, rather than an influx of McKean populations from the north. All of the lithics at the site were of locally available materials, except a projectile point of Kremmling Chert (Kalasz et al. 2003).

The Ridgegate site has cultural deposits representing the Early-Middle Archaic transition and the Late Prehistoric period, which at this site includes both Early and Middle Ceramic components. Based on eight radiocarbon samples, the Archaic component spans a period from 3500-2670 BC. The artifact assemblage for the component contains no features or diagnostic artifacts and is primarily lithic debitage (Kalasz et al. 2008).

Franktown Cave (5DA272) is a rockshelter on the north Palmer Divide in the Cherry Creek drainage basin. The University of Denver investigated the site and/or analyzed its cultural materials several times beginning in the 1940s. The shelter contains evidence dating occupations from the Early Archaic through the Protohistoric periods. While the Early Archaic period is dated only relatively, through Mount Albion and MM 3 type dart points, radiocarbon data has provided age ranges for the later components. The Middle Archaic component was assigned a calibrated age range of 3350-2470 BC, based on a suite of 12 contributing radiocarbon age ranges. A relative abundance of perishable materials, much of it dating to the Middle Archaic, was found at the site. These materials include six open weave sandals, five coiled basket fragments, and a piece of what may have been a rabbit fur robe (Gilmore 2005).

In the mountains to the northwest is Bode's Draw (5LR1370), a multi-processing locale with

Late Archaic, Late Prehistoric, and Protohistoric components (Benedict 1993). A game drive site, Devil's Thumb Game Drive site (5BL103/5GA20), also has both Middle Archaic and Early Ceramic components (Benedict 1996).

Late Archaic Period

The Late Archaic period is characterized by both side- and corner-notched projectile point types, including the Pelican Lake and Besant forms, with little else to distinguish it from the preceding period. Late Archaic sites evidence numerous rock-filled and slab-lined features. Also seen are gaming pieces and decorative items, such as bone beads, pendants, ocher, and amazonite (Tate 1999). While the lifestyle and basic technology followed the Archaic tradition, the number of known Late Archaic components shows a significant increase over the previous Middle Archaic period in much of the Front Range and Denver Basin. An exception is the Palmer Divide (Kalasz et al. 2008), where investigations at numerous sites have revealed Middle Archaic and Late Prehistoric components, with largely unexplained gaps for the Late Archaic record. However, at Franktown Cave, a radiocarbon sample from a hearth produced a component age of AD 130-420, albeit actually transitional Late Archaic/Early Ceramic. A large, corner-notched projectile point was found in association with the hearth (Gilmore 2005).

Most of the rockshelters on the Ken-Caryl Ranch are multicomponent camps, several with Late Archaic components. These latter sites include Bradford House II (5JF51) and Bradford House III (5JF52) on the North Ranch, and Falcon's Nest (5JF211) on the South Ranch. Late Archaic projectile points recovered from Bradford House II include three large side-notched points and 11 triangular corner-notched specimens, as well as a Park point. The latter is a type known from the Trout Creek area at the edge of South Park (Stewart 1970) and found only occasionally on the plains and along the Front Range, at sites such as LoDaisKa (see Johnson and Lyons 1997a) and in the Two Forks survey area (Windmiller and Eddy 1975). At Bradford House III, archaeologists found three Late Archaic features, two hearths and a burial. No bone tools were found, but there was evidence for decoration in the Archaic and Early Ceramic levels: pigment grinding stones, bone pendants, and amazonite (Johnson and Lyons 1997b). The burial was a flexed skeleton with no burial goods except two metates placed over the individual's head. The skeleton was determined to be a male about 40 years of age. The skeletal remains indicate that the individual while living had an atrophied right arm, limiting its use (Finnegan 1978). Three Late Archaic skeletons (one male, one female, and one child) were recovered from Falcon's Nest (5JF211) in the South Ranch (Finnegan 1997).

Massey Draw (5JF330), located immediately east of the Dakota Hogback adjacent to the Ken-Caryl Ranch, is an open camp and bison processing station. The major site occupations date to Late Archaic times. Most of the bones associated with Late Archaic use of the site are bison; however, pronghorn, deer, and mountain sheep bone were also recovered. Macrofloral analysis of hearth remains at the site revealed that the site inhabitants used Cheno-Am, hedgehog cactus, sunflower, and rose seeds for food or medicinal purposes. In addition to abundant flaked tools, including edge-modified flakes, non-bifacial cobbles, and bifaces, investigators recovered several corner-notched points similar to the Pelican Lake type and several stemmed points. Also present were bone awls, a probable bone bead, ground stone, and ocher. Investigators concluded that the site was occupied intermittently for short periods during late spring and that bison butchering was a dominant activity (Anderson et al. 1994).

Several Late Archaic hearths were uncovered during the course of investigations of the Dutch Creek site, also located just east of the Dakota Hogback. Here, investigators found a large quantity of bison bone in the Late Archaic component. In addition to flaked lithic tools and ground stone, the investigations revealed a corner-notched MM 20-type projectile point (Jepson and Hand 1994; Gilmore and Baugh 1987). Massey Draw and Dutch Creek may have been part of a larger resource procurement area, as the site investigators have opined. It would have been relatively easy for hunters with base camps in the hogbacks to process the meat at sites east of the Dakota Hogback, near the actual kill sites, and then transport the reduced resources back to base camps in the hogback rockshelters (Jepson and Hand 1994).

In the hogbacks south of the Ken-Caryl Ranch, the Window Rock site (5DA306) is located in Roxborough State Park. The site is an open camp overlooking Willow Creek, situated in a topographic setting similar to several hogback sites (e.g., Magic Mountain, Twin Cottonwoods on the Ken-Caryl Ranch and a site (University of Denver K:12:13) located immediately north of the park). All these sites are located on south-facing slopes of the Lyons Sandstone formation Hogback ridge at water gaps. When first inventoried, an extensive gully had cut through the site, exposing several stone-lined hearths. A Duncan projectile point was recovered from the cutbank and a small, corner-notched point was found on the surface (Tate 1979). Unfortunately, over the years, several of the hearths were lost to erosion. However, in 1988, a crew, which was led by Kevin Black of the Office of the State Archaeologist of Colorado (OSAC), salvaged fill from two of the remaining hearths. A charcoal sample from one of the hearths, Feature 3, returned a radiocarbon age estimate, a dendrocalibrated age range of cal. 50 BC-AD 136, dating what appears to have been an extensive occupation to Late Archaic times. Charcoal from another hearth (Feature 1) returned an age estimate from an Early Ceramic component (Tate 1999:147).

In the mountains, investigators have found resource processing locales, such as the Bode's Draw site (5BL1340) (Benedict 1993), game drive sites, specifically, Murray Game Drive site (5BL65) (Benedict 1975b) and Flattop Mountain (5LR6) (Benedict 1996), and sacred sites, the best known of which is Old Man Mountain (5LR12) (Benedict 1985b).

Bode's Draw (5BL1340) is an example of a multicomponent campsite used first in the Late Archaic period and later during both the Early and Middle Ceramic periods. Here, archaeologists found evidence for plant and animal food roasting, bone marrow processing, hide processing and sewing. There were two large roasting pits at the site. One of these, Feature 4, produced a dendrocalibrated age range of 481-112 BC, dating to the Late Archaic component. Charcoal from a hearth returned a dendrocalibrated age range of AD 1030-1284 for the Early Ceramic component. Investigators have inferred that the site is a processing locale associated with a nearby unknown camp site (Benedict 1993).

The Murray Game Drive site, found near the summit of Mount Albion, is an extensive game drive of Early and Middle Ceramic age. Here investigators found 483 cairns, 13 stone walls, and 16 circular or semi-circular pits (Benedict 1975b). Flattop Mountain, one of the largest game drives in the Southern Rocky Mountains, revealed 90 hunting blinds, 848 cairns and 14 stone walls. Samples from some of the features returned dendrocalibrated age ranges of 3255-2669 BC and 894-557 BC, evidencing use during the Middle Archaic and Late Archaic periods (Benedict 1996).

Old Man Mountain is a prominent landform affording a spectacular view. The site is a vision quest site (Clark 1999) used likely into historic times. The site consists of a large granite knob with five artifact concentrations found on the approach to the summit. These are viewed by the investigator as way stations for those beginning a vision quest. In addition to boulders and flaked lithics, a steatite bowl and various ceramics were present. The ceramics are of several traditions and include Woodland cord-marked, possibly Fremont grayware, Ute and Intermountain tradition pottery, and several unidentified plain wares (Benedict 1985b).

In the Platte River Basin to the north of the Ken-Caryl Ranch area, occasional isolated burials have been discovered. For a listing, see Zier et al. (2005); they include the Wilkins Burial (5AH6) (Swedlund and Goodman 1966), Webster Feedlot Burial (5WL2005) (Wanner and Brunswig 1992), Carter Lake Burial (5LR42) (Gleichman and Mutaw 1994), and Site 5AM1733 (Zier et al. 2005). At the C&A site (5DA1687) to the south on the Palmer Divide, investigators found a primary double burial, accompanied by bone beads, unmodified shell, and lithic debitage. Based upon a radiocarbon assay taken from the burial fill, the feature dates to the Late Archaic period. However, the investigators question the date because Post-Piney Creek fill containing charcoal was put back in the burial pit (URS 2003).

Late Prehistoric Stage

The Late Prehistoric stage includes the Early Ceramic and the Middle Ceramic periods (Gilmore 1999). The presence of ceramics at prehistoric sites in eastern Colorado heralds the beginning of the Late Prehistoric stage. Projectile point technology also changed with the introduction of the bow and arrow during this time. Lifeways continued to revolve around a hunting and gathering subsistence pattern.

Much research on the Late Prehistoric stage has focused on whether or not Plains Woodland and Upper Republican groups from the Central Plains actually settled on the Colorado plains or in the nearby hogbacks/foothills. The presence of Early Ceramic period ceramics and other artifacts on sites in the mountains and hogbacks/foothills suggests that either Plains Woodland people actually traveled to these areas, traded for these items, or adopted technological traits from their neighbors (Gilmore 1999:266). Their relative abundance on these sites, however, argues against the explanation that they are all trade wares. In the case of the Middle Ceramic Upper Republican, investigators are also beginning to believe that this pottery type represents actual settlement by cultural groups related to Plains Village populations known from Nebraska and Kansas (Roper 1990), rather than seasonal hunters who had simply ventured westward, as was originally posited (J. Wood 1967; W. R. Wood 1971, 1990).

Very limited evidence exists for the use of cultigens, but no fully Formative culture developed in the foothills or plains of northeastern Colorado. Gilmore (2004a) has proposed a "South Suburban Fertile Crescent," extending from the LoDaiska site in the hogbacks to Lehman Cave on the Palmer Divide, because the area contains the only recovered maize pollen from Late Prehistoric sites in the Platte Valley. There is a collection of about 15 sites where evidence of maize has been found, including the two sites mentioned above, Franktown Cave, Bayou Gulch, and Colorow Cave. Four of the Ken-Caryl sites are included in this grouping; however, investigators at the time attributed each instance to contamination from modern sources (Johnson et al. 1997a). Gilmore (2004a) interprets evidence for incipient horticulture as a result of increasing population pressure in this area, where population peaked approximately AD 600-700.

Early Ceramic Period

The Early Ceramic period is also referred to as the Colorado Plains Woodland episode (Cassells 1997; Butler 1986). The artifacts commonly associated with the Early Ceramic period include conoidal-shaped, cord-marked pottery vessels, as well as corner-notched dart and arrow points with straight to convex bases. In the hogbacks/foothills, as in surrounding areas, Early Ceramic components are the most abundant of any prehistoric period. In fact, despite a paucity of diagnostic artifacts found in a cultural resources inventory of the Dinosaur Ridge area, located about 4 mi north of the Ken-Caryl Ranch, all were ascribed Early Ceramic affiliation (Black 1992).

All of the large multicomponent rockshelters and open camps in the hogbacks west of Denver have important Early Ceramic components. Perhaps best known of these is Magic Mountain (5JF223) (Irwin-Williams and Irwin 1966), but Early Ceramic components were also found at numerous other sites, the Early Ceramic being the best-represented period in the South Platte River basin. The rockshelters and Twin Cottonwoods site (5JF60) (Horner and Horner 1974; Beal and Beal 1997) at the Ken-Caryl Ranch, and Site 5DA300 (Tate 1979) in Roxborough State Park, all contained Early Ceramic components. At Dancing Pants Shelter (5DA29) in the foothills, there is also an Early Ceramic component (Liestman and Kranzush 1987). Open camps east of hogbacks, some of which have been discussed above (e.g., Dutch Creek), also contain Early Ceramic components. The Lena Gulch site (5JF1780) burials near the town of Golden date to the Early Ceramic period (Jepson and Hand 1999). Evidence for occupation during this period is also well represented at sites along the Palmer Divide to the south.

In their early investigations at Magic Mountain, Irwin-Williams and Irwin (1966) identified a number of artifact types that were associated with the Early Ceramic or Plains Woodland component of the site. These include several small, corner-notched projectile point types, designated types MM 31-38; large corner and basal-notched points, MM 26 and 27; and side-notched types, MM 19 and 20; along with other tools such as distinctive types of end scrapers and drills, ground stone implements, and cord-marked potsherds. Identified faunal remains include mostly deer, with bison and small animals also represented. Of particular relevance, recent investigations in the 1990s uncovered the remains of two superimposed habitation structures. Feature 9 is a floor of decomposed sandstone with discrete areas of dark fill and an associated rock wall. Feature 11 is a large, semicircular alignment of boulders and cobbles that was not completely excavated. Several burials at the site are associated with Early Ceramic occupations (Kalasz and Shields 1997). Two that were described by Irwin-Williams and Irwin (1966) include an interment of two individuals in a bell-shaped pit, one in a vertical seated position with legs tightly flexed and the other that was too disturbed by backhoe operations to determine position. Two bone beads were associated with these burials. The other burial consisted of an individual lying on one side in a tightly flexed position and accompanied by six *Olivella* shell beads (Gilmore 1999).

At LoDaisKa (5JF142), Complexes A and B were believed to represent Early Ceramic Period occupations. Evidence of these occupations includes potsherds, corner-notched points, numerous other flaked lithic tools, ground stone, tubular beads, and possible gaming pieces (Irwin and Irwin 1959). The faunal assemblage was mostly deer, with bison, elk, bighorn sheep, canine, small rodents, and birds also represented. A decayed cob of popcorn was found just beneath Complex B. This item may be associated with the Woodland component that immediately overlies it (Gilmore 1999).

At the Lena Gulch site (5JF1780), located at the junction of I-70 and C-470, east of the Dakota Hogback, archaeologists recovered the remains of two burials that had been uncovered by backhoes during a wetlands mitigation project. Situated on the first terrace of Lena Gulch, the two burials were accompanied by a large and diverse assemblage of artifacts that includes pottery, small corner-notched projectile points, hafted bifaces, other flaked lithic artifacts, and bone awls. Also present were several decorative items, including shell pendants, stone and bone beads, a bracelet of rabbit incisors, and unprocessed malachite. Many of the artifacts were recovered from a cache found within the Burial 2 pit. Burial 1 had been largely displaced from its original burial pit by construction activity, but Burial 2 was found *in situ* in a flexed position. The results of osteological analyses indicated that skeletal materials from Burial 1 likely represented the remains of a male in his late 30s or early 40s. The Burial 2 individual was a female in her mid- to late-30s. However, because some commingling of skeletal remains occurred due to the highly disturbed nature of the site, the gender determinations are equivocal (Jepson and Hand 1999).

In the Ken-Caryl Valley North Ranch, Bradford House II (5JF51) and Bradford House III (5JF52) rockshelters contained evidence for Early Ceramic occupations, as did several smaller sites. At Bradford House II, 41 small corner-notched projectile points, many with serrated blades, and several larger corner-notched points were attributed to Early Ceramic occupation. In addition to the usual complement of lithic tools found, bone beads and drills, manos, metates, and palettes, as well as a few cord-marked potsherds, were also found. Faunal analysis indicates that in terms of numbers of individuals, deer were predominant, followed by elk, rabbit, bison, pronghorn, beaver, porcupine, canids, and bighorn sheep. Bobcat, raccoon, skunk, and various rodents were also represented (Johnson and Lyons 1997a).

At Bradford House III, where investigators identified five cultural strata, the top three strata were associated with a Woodland occupation. Woodland features included 15 hearths. The flaked tool assemblage contained 216 small, corner-notched points, many with serrated edges; 11 large, corner-notched points; and numerous small, triangular unnotched bifaces. Knives, and other biface fragments, scrapers, drills, gravers, and retouched tools, as well as polyhedral cores, were also recovered at the site (Johnson and Lyons 1997b).

In the Ken-Caryl Valley South Ranch, several rockshelters contained significant Early Ceramic components. These include the multi-component Falcon's Nest (5JF211) (Adkins 1993-1994) and, Crescent (5JF148) (Adkins 1997) sites, as well as Southgate Shelter (5JF246) (Johnson et al. 1997b), and Site 5JF210 (W. Tate 1997).

Southgate Shelter is located at the base of a large outcropping of Fountain formation, immediately north of Deer Creek. The site covers an area of about 0.007 ha. The excavations at the site exposed 19 features, at least half of which are described as fire hearths. No chronometric age estimates were obtained from any of these features. The investigators also recovered hundreds of artifacts, which include flaked lithics (small, corner-notched projectile points, bifaces, scrapers, and retouched flakes), cord-marked ceramics, ground stone, and worked and unworked animal bone (Johnson 1997b:110-112). The worked bone collection includes scrapers, reamers, and awls, as well as beads. Deer dominates the faunal record, but bison and antelope remains are nearly as prevalent. Diagnostic artifacts found in this assemblage document an Early Ceramic period occupation. Deer Creek may have removed earlier deposits (Johnson 1997b).

Site 5JF210 is a small site located underneath a large Fountain formation outcrop. Excavations here resulted in the recovery of chipped stone, including a small, corner-notched point, ground stone artifacts, charcoal, and worked and unworked animal bone (W. Tate 1997).

Evidence for occupation during this period is also well represented at sites along the Palmer Divide to the south, at sites that include Franktown Cave (Gilmore 2005), Bayou Gulch (Gilmore 1991), the Oeskeso site and Site 5DA1936 (Gantt 2007), and the Ridgegate site (Kalasz et al. 2008). At Franktown Cave, the Early Ceramic component age range of AD 660-880 was derived from AMS dates on a fragment of single bundle coiled basketry, a reconstructed pot, and a reconstructed rim sherd. The component assemblage also includes hundreds of potsherds and a single small corner-notched projectile point. Gilmore (2005) noted that the basketry technology is the same as in the Middle Archaic specimens from the site, indicating a continuity that persisted more than 4,000 years.

At Bayou Gulch (5DA265), there are materials representing the Early and Middle Archaic, Early and Middle Ceramic periods, and the Protohistoric Period. However, due to methodological problems, Gilmore (1991) determined that the majority of cultural materials could not be assigned a stratigraphic provenience more exact than coarse cultural units. Among numerous other features, the majority of which are hearths, were Features 33 and 37. Feature 33 was a semi-circular basin covering about 7-x-5 m, with a central hearth, and some post holes. The hearth was sampled for a radiocarbon assay, which resulted in a 2-sigma cal range of 1885-1520 BC (Gilmore 1991). Feature 37 was a partially exposed basin, approximately 4 m in diameter, with a central rock-filled basin hearth. A steatite pipe was recovered from the feature (Gilmore 1999). In addition to various flaked lithic artifacts, there were 56 corner-notched projectile points. There were also specimens of three ceramic types represented at the site. Most of the ceramics resembled those of the Valley Phase and Harlan Cord-Roughened of the Keith Phase, both known from Nebraska and Kansas. A small amount of a third untyped plain ware was also recovered (Ellwood 1987; Gilmore 1999). The faunal assemblage includes several game species, of which bison was dominant. There is also a bison scapula in the artifact assemblage, which shows evidence for use as a digging tool (Gilmore 1999).

The Early Ceramic component at the Oeskeso site is represented by a suite of nine radiocarbon dates, representing three distinct occupations. A variety of features was found, the majority of which are basin hearths. Also present were roasting pits, hearth clearouts, and three possible postmolds. Investigations also revealed cord-marked potsherds, and a small zoomorphic effigy, as well as flaked lithics and ground stone. Investigations at Site 5DA1936 indicated the presence of mixed Early and Middle Ceramic Stage components. There were seven features present, including a stone circle, basin hearths, and fire-cracked concentrations representing former hearths. From Feature 3, a radiocarbon sample was recovered, which produced a 2-sigma calibrated age range of AD 649-807. While no ceramics were recovered, two projectile points were found. One was a small corner-notched projectile point and the other was a small side-notched projectile point, representing the Early and Middle Ceramic periods, respectively (Gantt 2007).

At the Ridgegate site (5DA1000), there is considerable evidence for the Early Ceramic period, dating between approximately AD 410-1030 and limited Middle Ceramic remains, dating from approximately AD 980-1260. At the site were 11 rock clusters, which appeared to represent cooking facilities, pounding platforms, and game drive markers. The features were distinctly aligned and were likely used intermittently for hundreds of years. There is some indication that the site was used in late winter-early spring, which has led investigators to speculate that Front Range hunter/gatherers left winter residences in the foothills to restore their supplies and that their rounds extended eastward onto the Palmer Divide and the Piedmont. They see this as a common settlement/subsistence pattern minimally from at least the Middle Archaic through the Early Ceramic periods (Kalasz et al. 2008).

On the plains in the Denver area are several open camps with Early Ceramic components. Two of these, Box Elder-Tate Hamlet (5DV3017) and the Senac site (5AH380) also have Middle Ceramic components. The Early Ceramic component at Box Elder-Tate contained two small pithouse remains with numerous hearth features and a rich variety of flaked stone artifacts, as well as cord-marked pottery, groundstone and miscellaneous stone (i.e., hammer stones and hide processors), and abundant animal bone (Tucker et al. 1992). The Senac site (5AH380) is an open campsite with evidence for seasonal use, particularly spring and fall, probably as part of scheduled rounds. While numerous activities were carried out at the site, the primary function was focused on faunal processing (O'Neil et al. 1988).

Middle Ceramic Period

The Middle Ceramic period is distinguished by small triangular, un-notched or side-notched projectile points used with the bow and arrow, and smoothed-over cord-marked pottery from globular vessels with collared rims. These ceramics are related to the Upper Republican culture, first defined in Kansas and Nebraska, where such materials are usually associated with sedentary horticultural villages (Cassells 1997:213). The fact that few Upper Republican sites have been found in the Colorado foothills convinced Eighmy (1984) that the post-AD 1000 occupation of the area was light. In fact, Gilmore (1999:245) has noted that there are relatively few Middle Ceramic components in the South Platte River Basin compared with the site density of the Early Ceramic period. Most of the documented Middle Ceramic components are in multi-component sites where substantial Early Ceramic components are also present, indicating relative stability of adaptive patterns. A majority of the larger, single-component Middle Ceramic sites are found close to the edge of the High Plains and manifest artifact assemblages related to the Upper Republican tradition to the east (Gilmore 1999). More rarely seen are sites with pottery generally associated with Numic or Shoshonean occupation.

In the foothills, sites such as Graeber Cave (5JF8) (Nelson and Graeber 1966, 1984) and Dancing Pants Shelter (5DA29) (Liestman and Kranzush 1987) date to this period. Graeber Cave is a single-component sheltered camp overlooking North Turkey Creek in Jefferson County. More than 100 sherds from a flat bottomed, "flower pot" or truncated, cone-shaped vessel were recovered at the site. Classified as Intermountain Ware, the vessel has possible Shoshonean affiliation. Associated lithic artifacts include a small, corner-notched point with a straight stem and serrated blade edges, and a small, triangular, un-notched point. Recovered faunal remains include bird, possible squirrel, rabbit, and elk or bison, as well as a dog (*Canis* sp.) mandible. Charcoal (I-12530) from a slab-lined hearth produced a radiocarbon age estimate consistent with Middle Ceramic occupation 630±75 BP, 2-sigma cal range AD 1270-1436 (Nelson and Graeber 1966, 1984), as did Feature 3, a hearth found at Dancing Pants Shelter (Liestman and Kranzush 1987).

A few of the known Middle Ceramic components are from sites on the Ken-Caryl Ranch. Side-notched projectile points were recovered from the upper levels at Bradford House II (5JF51) and Bradford House III (Johnson 1997a). The Anniversary site (5JF209) contained both side-notched and small triangular projectile points (W. Tate 1997). At Crescent site, charcoal from a hearth returned a dendrocalibrated age range of AD 1383-1523 (Stone and Mendoza 1994).

On the Palmer Divide, investigations at Franktown Cave indicate three Middle Ceramic components. While the investigator (Gilmore 2005) considers the first component's age range, based on an AMS date from a single rim sherd, possibly too early (AD 780-980), age ranges for the other Middle Ceramic Components 6 and 7 are AD 890-1170 and AD 1035-1290, respectively. The numerous investigations at the site resulted in the recovery of many artifacts from the Middle Ceramic period. In addition to ceramics and small, side-notched projectile points, a complete moccasin, a fragment of a fringed legging, a small sinew and twig loop, and four corn cobs were found. The potsherds from the Middle Ceramic components are from globular cord-marked vessels with constricted necks (Gilmore 2005).

At Bayou Gulch, projectile points include the Avonlea type which is known from the Northern Plains and was found in both Early and Middle Ceramic components at the site. Some small side-notched specimens, which resemble the Plains and Prairie side-notched types, were also recovered (Gilmore 1999).

On the plains in Denver and Aurora, there are two multi-component open camps with Middle Ceramic components, Box Elder-Tate Hamlet (5DV3017) and the Moffit site (5AM631). Investigations at both of these sites revealed Upper Republican potsherds (Tucker et al. 1992; Tucker 1994). Also, investigations at the Senac site (5AH380) revealed a rim sherd of an unidentified Middle Ceramic pottery type (O'Neil et al. 1988).

Burials dating to the Middle Ceramic period are less common than the previous period. Gilmore (1999) reports only two, one at the Peavy Rockshelter in Logan County, and another at the Chubbuck Oman site (5CH3), the latter actually in the Arkansas River Basin.

Protohistoric Stage

The Protohistoric stage in eastern Colorado consists of a single period (Clark 1999) that replaces the Late Ceramic period (Eighmy 1984; Gunnerson 1987). The combination of ethnohistory, ethnography, and oral history with archaeology has enabled researchers to identify the cultural affiliation of Protohistoric period sites (Clark 1999). Identified sites are primarily Dismal River (Apache) and Ute, but Shoshone, Ute-Numic speakers, Kiowa-Apache, and Cheyenne/Arapaho have also been recognized. The early portion of the period coincides with the Dismal River complex (Clark 1999), while later the period is distinguished by the presence of Euro-American artifacts and the adaptation to the horse by Native Americans. Diagnostic point styles include small unnotched and side-notched, triangular arrow points and metal projectiles. Pottery for this period on the eastern plains of Colorado is usually associated with the Dismal River complex, believed to represent a Plains Apache occupation of the area (Gunnerson 1960), first defined from a group of sites in Nebraska located on the Dismal River (Strong 1935). Based on the available data, the presence of Dismal River in Colorado dates from AD 1525 to 1725. Brunswig (1995) has noted that very limited and circumstantial evidence supports an influx of Apachean groups at an earlier time, from approximately AD 1300-1550, based on various hypotheses. One is the possible association of the Avonlea culture of the Northern Plains with southward-migrating Athapaskans, a supposition that Gilmore (2004b) has recently championed. Avonlea projectile points have been posited to be possibly ancestral to the later Plains Apache side-notched points.

Gulley (2000) has argued that Dismal River is a poorly defined archaeological construct, and that its identification representing Athapaskan (Apache) presence on the plains in the 1500s-1700s results from misinterpretation of early Spanish documents. She has suggested that given the variation in Dismal River sites, these are actually representative of the mingling of many groups, possibly including but not limited to Apaches, over an undetermined time on the Central Plains.

Based upon ceramic types and geographical distribution, Brunswig (1995) hypothesized that the Colorado plains and Front Range mountains were home to at least two variants of Dismal River culture, one of which, Western Dismal River, is defined by nomadic to semi-nomadic hunter-foragers found in southeastern Wyoming and northeastern Colorado extending to a point south of the Arkansas River and to the mountains just west of the Continental Divide. Dismal River occupations in the Platte Basin are identified by the presence of ceramics, the vast majority of which are Lovitt Plain Ware, with only occasional examples of Lovitt Simple Stamped, both sub-types of Dismal River Gray Ware. Usually, the ceramics consist of the remains of jar-shaped vessels with straight to flaring necks and partially rounded bases. These vessels were formed by lump modeling or coiling and use of a grooved or thong-wrapped paddle and anvil, followed by surface scraping and smoothing. Temper is often a fine sand or grit; some sherds include mica particles in the paste. When decorated, the vessel is stamped on the neck and upper body (Clark 1999).

Dismal River components on the plains in northeastern Colorado include open camps, sheltered camps, and architectural sites. The Camp site (5WL1995), an example of a stone circle site of Dismal River affiliation (Brunswig 1994) and McEndaffer Rockshelter (5WL3) (J. Wood 1967) are both in the plains. Lehman Cave (5EL12) (Lyons and Johnson 1994) and Franktown Cave on the Palmer Divide are examples of rockshelters that contained Dismal River pottery. The latter site, Franktown Cave (5DA2005), had two Protohistoric components, one of which contained four corn cobs; AMS dating of the cobs provided an age range of AD 1450-1650 (Gilmore 2005).

In the mountains, open camps with Dismal River components include Devil's Thumb Trail site (5BL6904) (Kindig 2000), Eureka Ridge (5TL3296) (Gilmore and Larmore 2005), and Pinnacle site (5PA1764) (Tucker et al. 2005). Evidence for the use of the high country is seen at the Devil's Thumb Trail site (5BL6904) near the Continental Divide, investigation of which yielded potsherds identified as Lovitt Plain and Dismal River Gray Ware. Charcoal associated with the sherds yielded an AMS date (AA-22853) of 350±150 B. P. (2-sigma cal range AD1445-1650) for the occupation (Kindig 2000).

The Eureka Ridge site is situated on a ridge crest above Little Turkey Creek. Cultural materials found at the site include debitage, small, side-notched and triangular unnotched projectile points, bifaces, scrapers, ground stone, and ceramics. The side-notched projectile points have been identified as Plains Side-notched, Upper Republican/Plains Village, and Desert Side-notched. The triangular, unnotched point resembles Dismal River projectile points documented at the Lovitt site in southwestern Nebraska. With the exception of one specimen (identified as a partially obliterated cord-marked impressed sherd of Late Woodland affiliation), the majority of the nearly 300 sherds recovered were identified as Dismal River. Three crushed body sherds from the site returned radiocarbon age estimates (AMS technique) of 305±30 BP, 410±40 BP, and 460±40 BP, or dendrocalibrated age ranges of AD 1490-1650, AD 1430-1510, and AD 1410-1480, respectively (Gilmore and Larmore 2005).

Investigations at the nearby Pinnacle site (5PA1764), which overlooks Eleven Mile Reservoir, resulted in the identification of a concentration of heat-treated lithic flakes, a stone circle with an interior hearth, and a badly eroded exterior hearth. The first two features yielded radiocarbon and thermoluminescent age estimates that place site occupation(s) between AD 1400 and 1620. The recovery of several sherds of Western Dismal River variant pottery corroborates these chronometric estimates. A culturally scarred tree found at the north end of the site was peeled at approximately 1893, and thus reflects a later aboriginal use of the site. Obsidian flakes found on the site were sourced to Obsidian Cliff in Yellowstone National Park (Tucker et al. 2005).

Among the hallmarks of the latter part of the Protohistoric period are trade goods found at aboriginal sites and traditional tools fashioned of metal and glass. During this period, use of the horse was adopted also. Clark (1999) has noted that the Protohistoric was a culturally dynamic period.

Historically, when Coronado trekked from Mexico through New Mexico and the Oklahoma and Texas panhandles to Kansas in 1540-1541, he noted that the Plains Apache tribes inhabiting the southern Plains lived a nomadic life, following the buffalo with dogs pulling their hide tents on travois. In 1706, the Spanish explorer Ulibarri, while traveling to the Plains Apache villages known as El Cuartelejo in eastern Colorado, observed that the Plains Apaches lived in settled villages along the Purgatoire River and grew corn and beans. By 1730, however, the Plains Apaches were being driven south out of Colorado by the aggressive expansion of the Ute and Comanche tribes (Bolton 1908; Thomas 1935; see also Gilmore 1999) and Pawnee were apparently in the area also. In the early decades of the nineteenth century, the Arapahoe and Cheyenne tribes moved south and occupied the area between the Platte and Arkansas rivers. Other groups of Sioux and Kiowa visited Colorado's plains at times, and the Utes, who traditionally occupied Colorado's mountains, also ventured onto the plains frequently in search of game.

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4

Site Structure and Stratigraphy

Bill Hammond and Linda M. W. Groth

This chapter describes the structure and stratigraphy of the Swallow site, which serves as a framework for interpretations of materials and patterns observed at the site. The 2 x 2-m grid system and extent of excavations at the Swallow site are shown in Figure 4.1. Excavation was conducted in 10 cm levels within the excavation units.

The central area of the site, adjacent to the wall of its monolith, is nearly flat. Ground surface at either end of the site slopes up, to the sides of the monolith, while to the southwest, beginning about 5 m from the wall, the slope is downward to the meadow (Figure 4.1). Reflecting the shelter's relatively slight overhang of 5 to 6 degrees, the drip line varies from about 50 to 150 cm from the wall. Figure 4.1 also shows surface contour lines, the location of the site datum, and the location of two profiles, B-B' in Figure 4.2 and A-A' in Figure 4.3, parallel and perpendicular to the rockshelter wall. These profiles show the modern ground surface, depositional strata, blocks of a large rockfall, and bedrock.

Four strata were identified during the excavations: A, B, C, and D, with Strata C and D being divided into two sub-strata (Figures 4.2 and 4.3). The breaks between the "cow manure layer" (Stratum A), and the "gray layer" (Stratum B) as well as that between the "gray layer" and the "red layer" (Stratum C) were distinct. A large rockfall separates Stratum C from Stratum D; the latter is the dirt between the rockfall and bedrock (Figures 4.2 and 4.3). More precise and detailed profiles of or close to the final north, south and west walls of the excavation were made by geologists Elmer Baltz and Charlotte Bechtold, and were very useful, particularly in defining the Strata C-D transition (e.g., Figures 4.4 and 4.5). Additional detailed profiles are on file with the project records currently at History Colorado.

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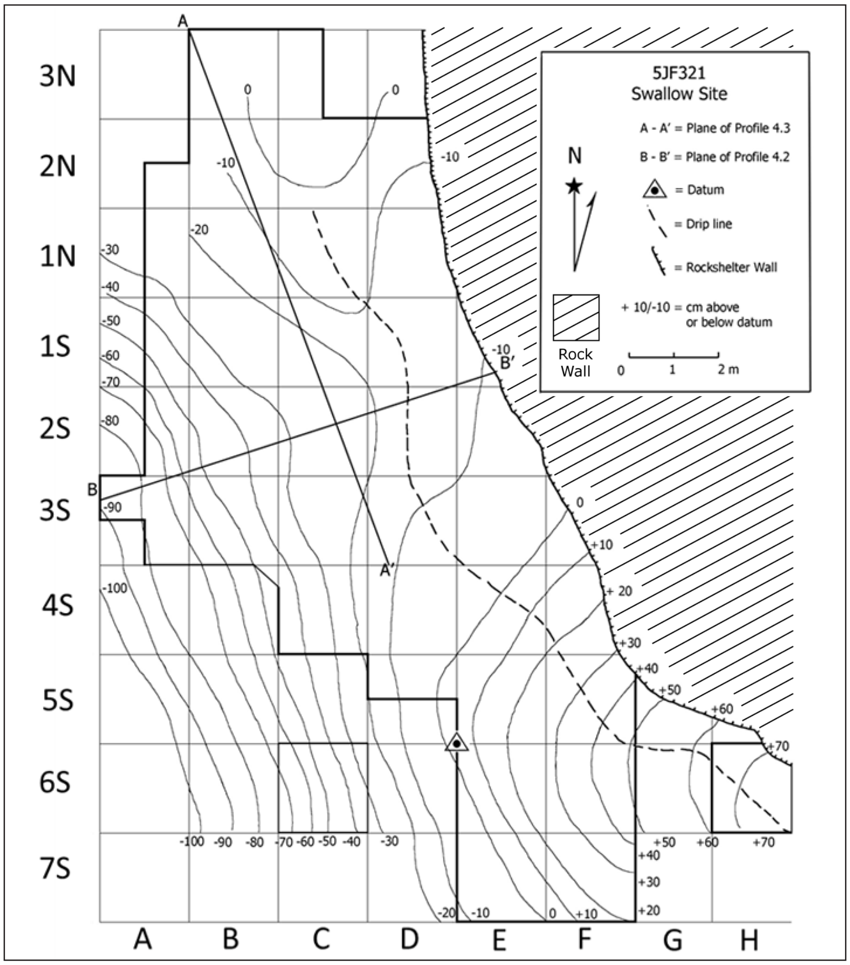

Figure 4.1. Topography and extent of excavation at the Swallow site.

Perpendicular to the shelter wall (Figure 4.2) strata slope only slightly for about 5 m from the shelter wall and then increase down to the meadow adjacent to Docmann Gulch. In contrast, the rockfall and bedrock are nearly flat in the areas where they were exposed during excavation. Parallel to the shelter wall (Figure 4.3) modern ground surface is nearly flat, while the underlying rockfall slopes down from northwest to southeast, and the bedrock slopes even more.

Stratum A

The uppermost 10 to 15 cm of the site, occupying much of Excavation Level 1 and often the upper part of Level 2, consist of coarse reddish-tan to tan sand; close to the shelter wall this sand is mixed with and underlain by a few centimeters of compacted and decomposing cow manure (Rathbun 1991). In the north-central portion of the site, below the cliff swallow nests that give the site its name, this "cow manure" layer is much harder and grayer than elsewhere; this is attributed

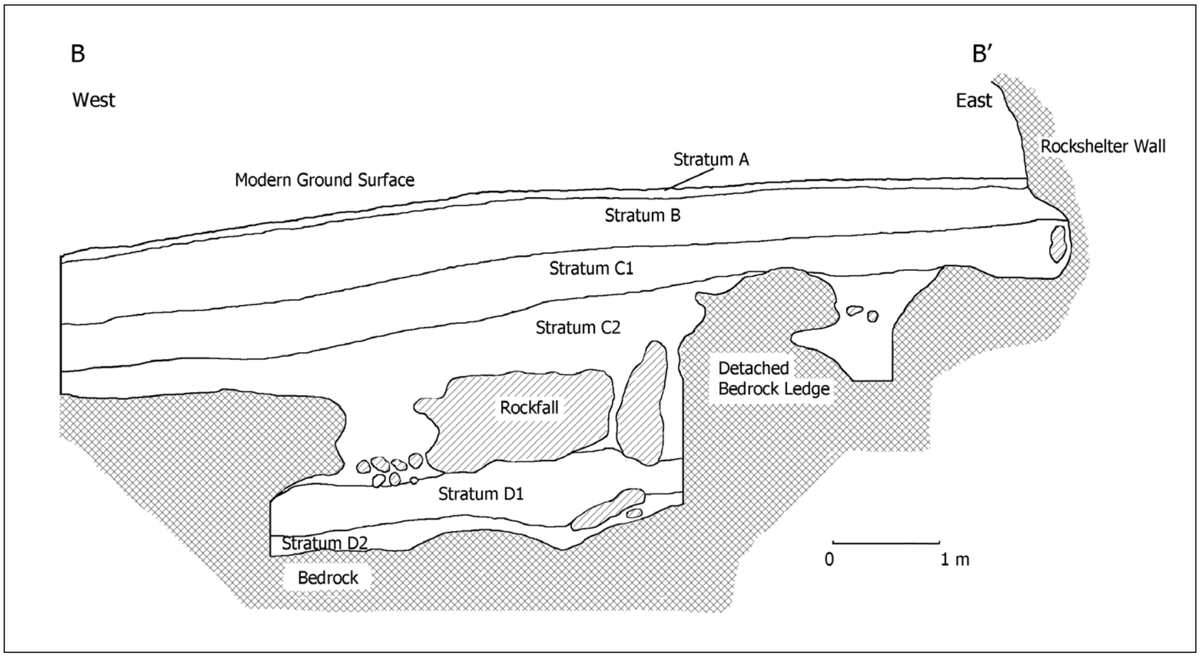

Figure 4.2. Site profile B-B', running through the center of the site from the shelter wall on the east to the furthest extent of excavation on the west. The location of this profile is shown on the site map in Figure 4.1.

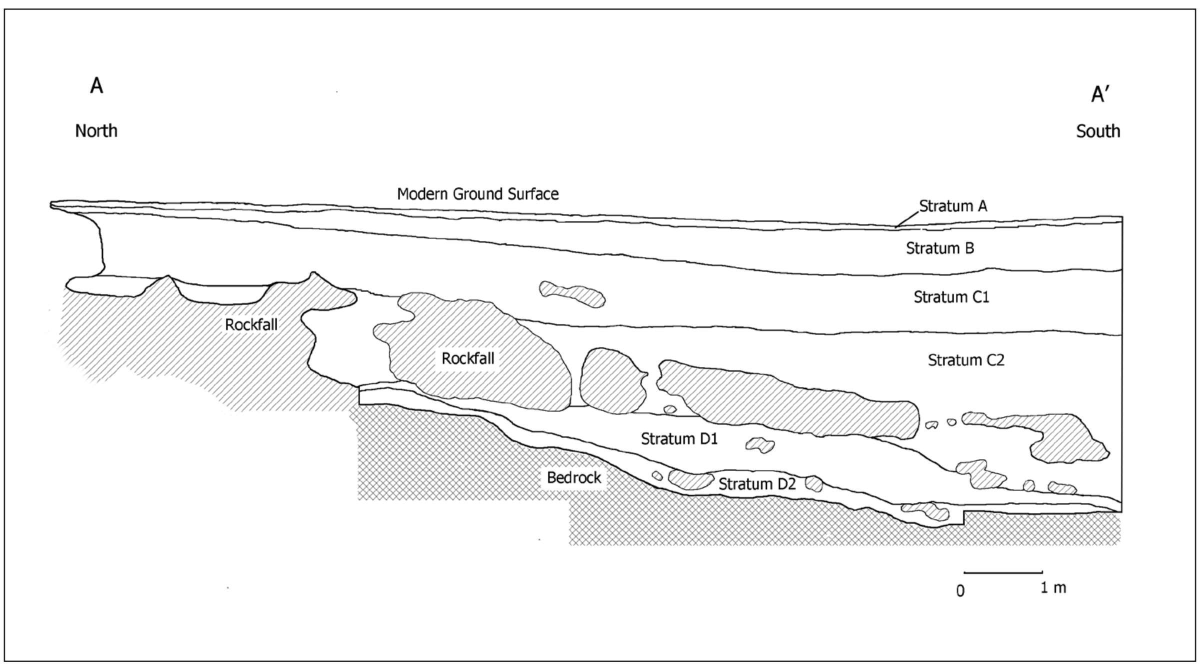

Figure 4.3. Site profile A-A' running south from the northern edge of the site, parallel to the shelter wall. The location of the profile in the site is shown in Figure 4.1.

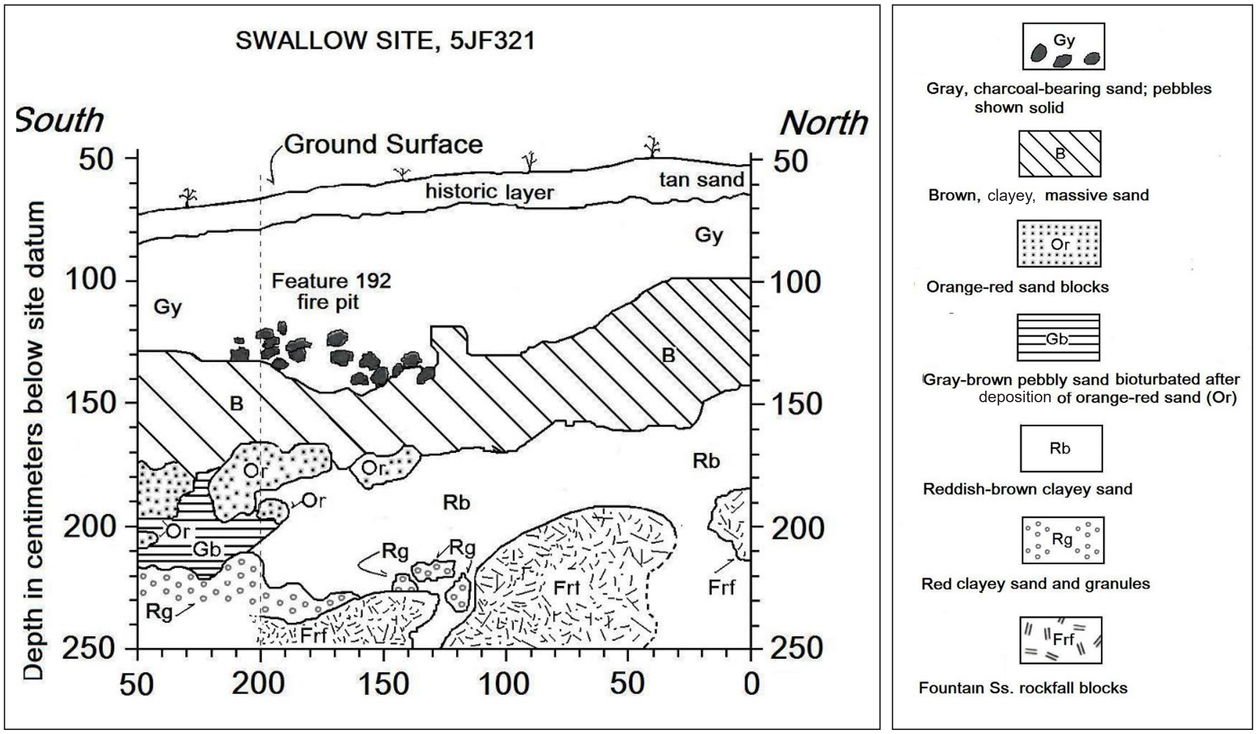

Figure 4.4. Profile N-S center wall of quad A2S and northern 50 cm of quad A3S. (Drawn by Elmer Baltz and Charlotte Bechtold.)

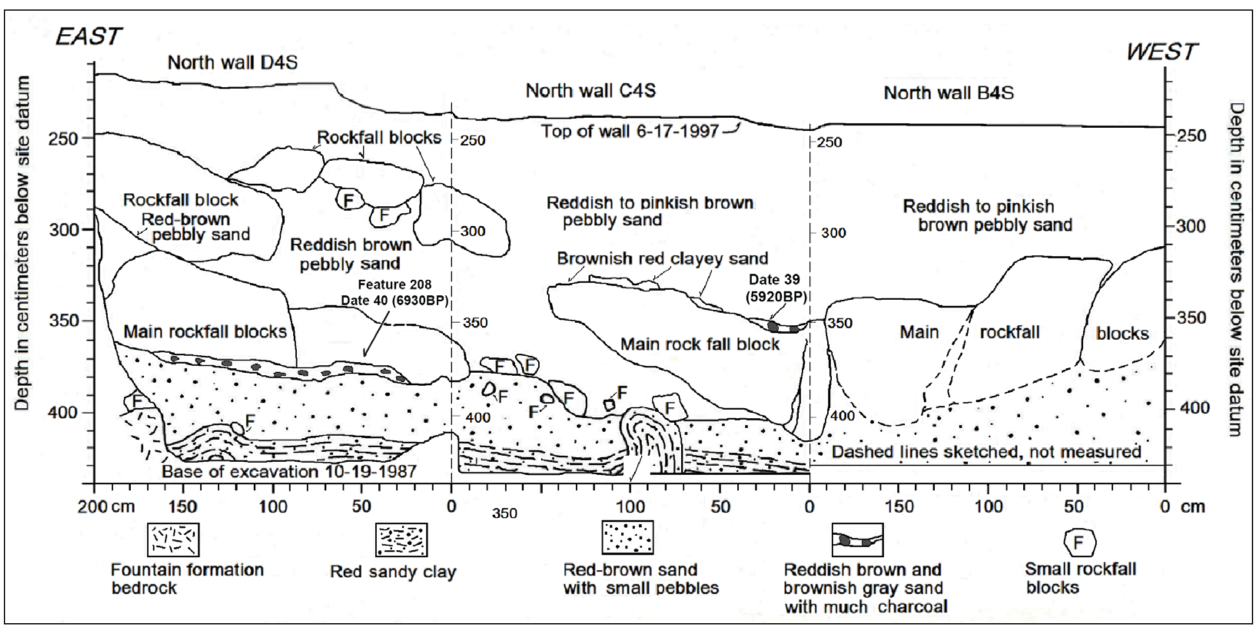

Figure 4.5. Profile E-W of N wall of D, C, B4S. (Drawn by Elmer Baltz and Charlotte Bechtold.)

to the color and cementing effect of many years of bird droppings. The sand layer that extends from the shelter wall to the western edge of the excavation is primarily derived from erosion of the sandstone shelter wall and appears to be an incipient A soil horizon. Together the sand and manure layers are designated Stratum A. The contact with the underlying Stratum B is distinct, suggesting an erosional unconformity (Rathbun 1991). Within Stratum A are scattered historic artifacts (mostly glass and bullet lead) and prehistoric cultural material from the underlying Stratum B. Little obvious evidence of bioturbation is present, but the prehistoric artifacts indicate there has been some mixing. The slope of the Stratum A – Stratum B interface is essentially the same as that of modern ground surface.

Stratum B

Stratum B is marked by an abrupt transition to dark gray dirt, made up of medium to coarse sand and small amounts of clay with intense charcoal staining and numerous charcoal particles. This dirt is finer and more ashy than in the overlying and underlying strata, and has a high organic content. Described as the "gray layer" by the excavators, Stratum B varies from about 20 to 70 cm in thickness, with an average thickness of about 40 cm. Its maximum depth is 150 cm below datum in the southwest corner of the site, where the slope down from the shelter is greatest. Otherwise, its slope generally follows that of the modern ground surface; it is thinnest at the north end of the site, where the rockfall blocks come closest to the surface. There it rests directly on the rock in several places. This stratum contains large numbers of rodent burrows, some filled with its own dark gray dirt and others with reddish tan sand presumably derived from Stratum A. Rather than being smooth and flat, profiles show that its interface with the underlying Stratum C is usually quite wavy and irregular, but usually quite distinct (Figure 4.6). In most areas the B/C interface lies within or just below Excavation Level 7. However, the stratum rises to Levels 3 and 4 to the north and drops down to Levels 9 and 10 to the southwest.

Stratum B contains a very dense concentration of cultural material. Diagnostic artifacts such as numerous Hogback corner-notched arrowheads and cord-marked ceramics as well as radiocarbon dates identify it as an Early Ceramic occupation zone. Chipped and ground stone tools and lithic debitage are present, as are bone tools and faunal remains. The stratum contains several firepits and numerous associated fire-cracked rocks. A distinct band of fire-cracked rock is present in Levels 4 and 5. The presence of a few earlier projectile points is indicative of bioturbation and mixing of materials from Stratum C.

Stratum C

Stratum C extends from the base of Stratum B to the top of the rockfall (Figures 4.2 and 4.3), and consists of two layers or sub-strata, designated Strata C1 and C2. Stratum C1, the upper layer, is gray-brown to reddish-brown, fine- to coarse-grained sand containing much silt and little clay. It is coarser grained than Stratum B, contains much less charcoal, and is highly bioturbated; some of the rodent holes are filled with gray sand characteristic of that of the overlying Stratum B. In

Figure 4.6. View east at Swallow excavation. Stratum B ("gray layer") visible in planview as exposed in grid units in foreground. Strata B and C visible in rear profile just in front of Fountain formation monolith. Rockfall exposed in center left.

profile it varies from 25 to 90 cm thick and has a maximum depth of 220 cm below datum in the southwest corner of the excavation. In its lower portion the layer is calcareous to varying degrees. Stratum C1 usually lies over Stratum C2, but in limited areas of the north end of the site it rests directly on the rockfall. In the profiles of the southwest margins of the site a frequently interrupted, red-orange, very coarse-grained sand layer that is culturally sterile lies between Strata C1 and C2. In the eastern part of the south wall these "orange blocks" no longer separate Strata C1 and C2, but dip into the upper part of C2. This highly calcareous layer is relatively thin (12 to 30 cm thick), and its bottom is 190 to 215 cm below datum. Stratum C2 is predominantly reddish to pinkish brown and is more complex than C1. This layer exhibits more variation in color, and in some profiles there is a sharp separation of these colors. Stratum C2 may, therefore, consist of more than one soil layer although, on the whole, it is composed of very coarse-grained sand with traces of silt and clay, is highly calcareous, and is somewhat harder than Stratum C1. Like C1, Stratum C2 is highly bioturbated; a few burrows are filled with gray sand similar to Stratum B, while others contain reddish to grayish brown sand, resembling Stratum C1. Stratum C2 covers most of the rockfall, as well as filling the cracks between blocks of the rockfall.

Numerous hearth features consisting of closely set fire-cracked rocks are present in both Strata B and C and are discussed in detail in Chapter 7. While Stratum B hearths contain relatively large amounts of charcoal, usually in small pieces, Stratum C hearths almost always contain little or no charcoal. Diagnostic artifacts and radiocarbon dates indicate that Stratum C contains mixed Late and Middle Archaic materials. An Early Archaic occupation is present in the lower part of Stratum C2.

Fire-Cracked Rock Layers

In addition to rocks within hearths, numerous pebbles and cobbles up to 30 cm or more in diameter are present in Strata B and C, while very few fire-cracked rocks were found in Strata A and D. In Strata B and C, over 20,000 rocks were plotted within and outside the hearths; and most are fire-cracked. Since these scattered rocks are of the same appearance and type as those in the numerous fire features, they are presumably scattered from dismantled or disturbed hearths.

Systematic recording of the material types of all these rocks was not performed; however, a sample of 1,005 rocks from Stratum B was analyzed (Table 4.1). While a sample was not drawn from Stratum C, no significant difference in materials was noted between the levels during excavation.

Table 4.1 Fire-cracked rock sample from Stratum B.

Material	Percent of Sample
Amphibolite	31.8
Biotite gneiss	21.8
Fountain sandstone	14.6
Granite	12.9
Vein quartz	8.9
Lyons/Dakota sandstone	6.8
Migmatite	3.0
Metaquartzite	1.0
Limestone	0.2

Notably, 70.5 percent of the assemblage is igneous or metamorphic rock and represents manuports from the pediments along the foothills and the bed of Deer Creek. These rocks were probably carried from a greater distance to the site because they performed better in cooking or heating than the sandstones readily available around the shelter. Fountain sandstone and quartz are presumably derived from the shelter wall, and the Dakota and Lyons sandstone from upslope, along the hogback ridges.

While fire-cracked rocks were scattered throughout Strata B and C, three distinct layers had high concentrations (Figures 4.7, 4.8, and 4.9). In their most dense areas, the first and second layers are up to 30 cm thick, while the third layer is only 10 cm thick in its densest areas. Fire-cracked rocks are rarely present within about 50 cm of the rockshelter wall, but otherwise they occupy most of the horizontal extent of the site in these layers. The uppermost layer is in Excavation Levels 3 through 7 in Stratum B. It is the largest and most extensive of the three layers, reaching the western edge of the excavation. In the trench described in Chapter 1 numerous fire-cracked rocks are present only where the trench comes closest to the main excavation. These trench rocks, at a depth of 165 to 185 cm below datum, appear to be the western edge of the first layer, and probably

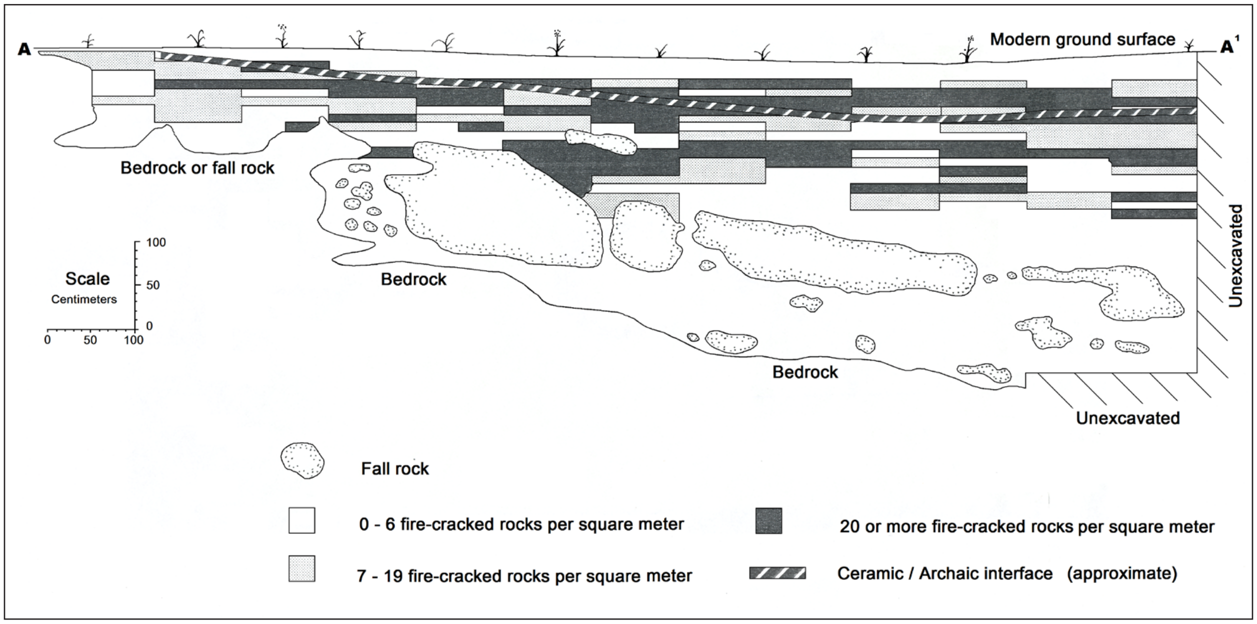

Figure 4.7. Fire-cracked rock distribution along the A profile.

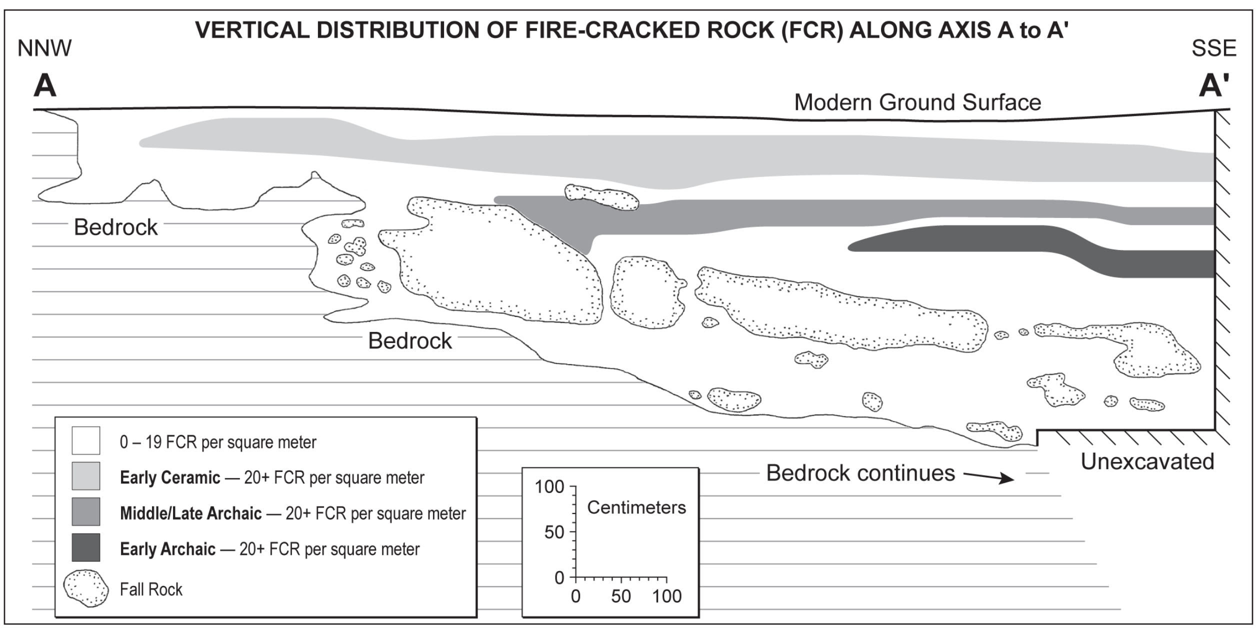

Figure 4.8. Fire-cracked rock distribution along the A profile.

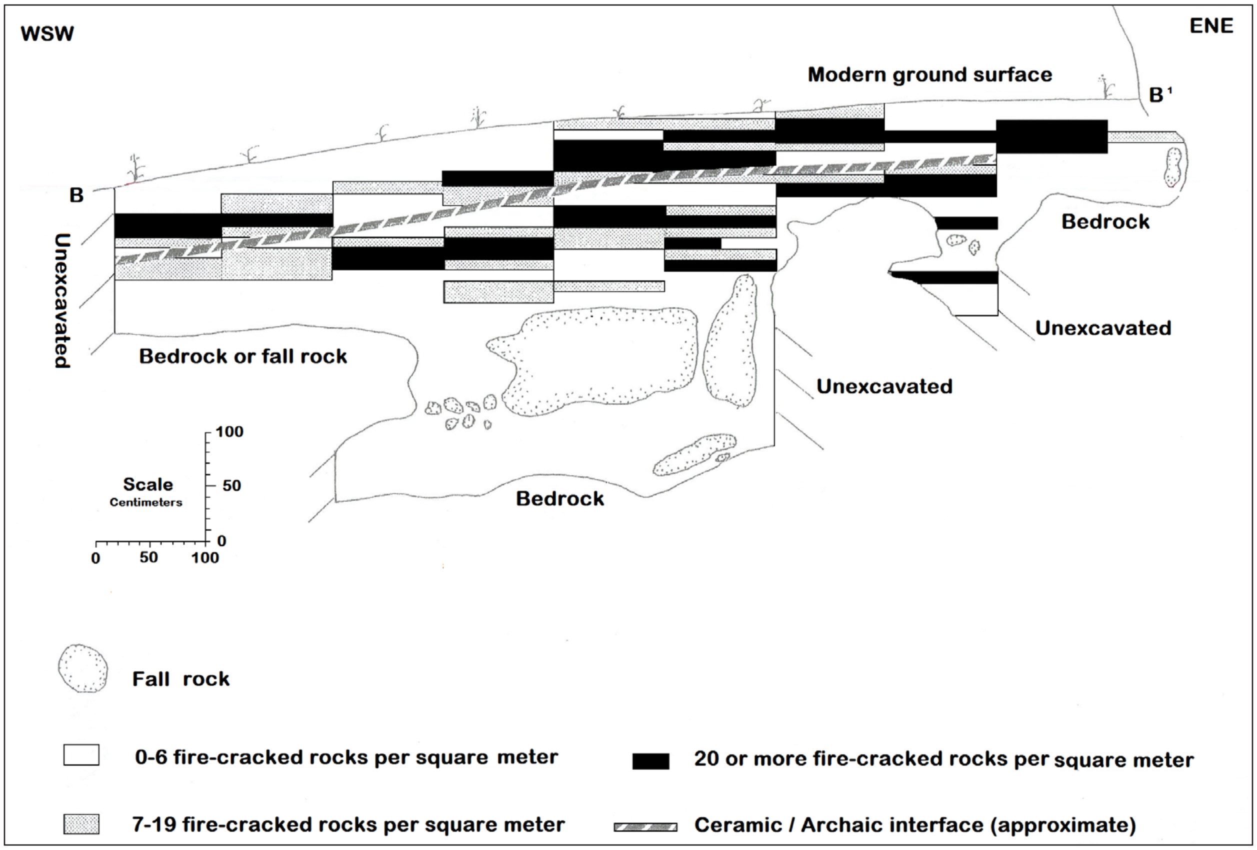

Figure 4.9. Fire-cracked rock distribution along the B profile. For profile locations, see Figure 4.1.

mark the western extent of the site. The second rock layer is in Stratum C1 and possibly the top of C2, from about Excavation Levels 11 through 14. The third layer, lower in Stratum C2, is smaller and less distinct, occupying Levels 18 through 21.

The Rockfall

Sometime during the Archaic, a massive slab of rock cleaved away from the overhanging monolith and onto the shelter floor where it fractured into large blocks on impact. The scar on the face of the rockshelter wall from which it fell is readily apparent (Figure 4.10). The rockfall significantly altered the topography of the shelter, which was occupied both before and after this rockfall event (Figures 4.2, 4.3, 4.5, 4.11, and 4.12). Subsequent to the rockfall, the site was not utilized for ca. 600 years before the shelter was again occupied. The rockfall boulders define the bottom of Stratum C. Within the excavation it measures about 15 m parallel to the rockshelter wall and extends at least 10 m outward from the wall and is up to 1.5 m thick. The bedding planes of the rockfall blocks are at nearly right angles to the planes in the parent rock. In contrast to modern ground surface and the interface between Strata B and C, the rockfall slopes quite sharply downward from northwest

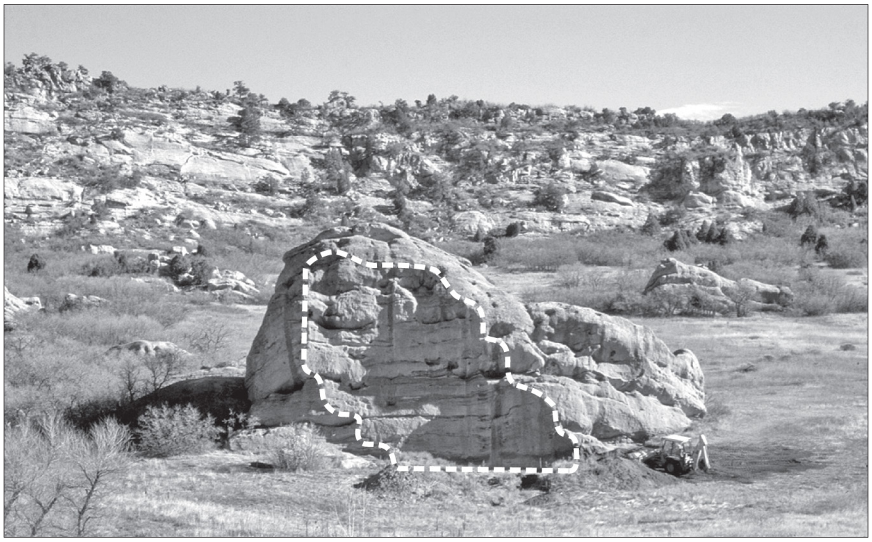

Figure 4.10. View east at Swallow site monolith, with rockfall scar indicated by dashed line. Lyons hogback in background.

to southeast; its top is above the modern ground surface a few meters north of the excavation and is 2.8 m below it at the extreme south end. The bottom of the rockfall slopes in a similar way, varying from Excavation Level 25 (270 cm below datum) in unit C1N, the northwesternmost place it was exposed, to Excavation Level 37 (370 cm below datum) at the southeastern end. This gradient presumably reflects that of the ground surface at the time the slab spalled off. The

Figure 4.11. View northeast at rockfall being exposed by excavation.

Figure 4.12. View north at rockfall.

rockfall was found in all excavation units of the site which were dug deep enough to expose it. The rockfall seals an occupation beneath it, although cracks between the rockfall blocks make the seal imperfect. Particularly in the south portion of the excavation, where the major rockfall is relatively thin, smaller blocks of Fountain sandstone are present above the major rockfall; they are presumably from one or more later falls from the rockshelter wall.

Because of the steeper downward slope of the rockfall than of the fire-cracked rock levels, the lower part of Stratum C2 is thinner at its northern end than at its southern end (Figure 4.3). In Stratum C2 in this southern part of the site, from about 20 cm below fire-cracked rock Layer 3 down to the top of the rockfall, there are no hearth features, only rare fire-cracked rocks, and little other cultural material.

Stratum D

Stratum D lies between the bottom of the rockfall and bedrock, and consists of two layers or sub-strata, denoted D1 and D2. Far fewer rodent burrows are evident below the rockfall in Strata D1 and D2, than in the strata above it. Bedrock slopes from the northwest to the southeast at a steeper angle from the horizontal than that of the rockfall. The thickness of Stratum D varies as the distance between the rockfall and bedrock increases from about 10 cm on the north to over 80 cm on the south. Consequently, Strata D1 and D2 also vary in thickness. Stratum D1, the upper layer, is made up of reddish brown, fine to coarse sand containing many small pebbles. Feature 208 was located at the top of Stratum D1, immediately below the main rockfall block. This feature consists of a distinct lens of brown-gray sand containing a concentration of carbonized hackberry (*Celtis reticulata*) seeds and abundant small fragments of charcoal, perhaps derived from the seeds. The lens is up to 8 cm thick and was noted in the north wall of excavation unit D4S and found to extend about 40 cm to the south, into unit D4S, and about 20 cm west into adjacent unit C4S (Figure 4.5). Feature 208 was radiocarbon dated to 6930±50 BP, cal 5880-5740 BC (see date 40, Table 5.3). The upper 10 to 15 cm of Stratum D1, immediately beneath the rockfall, contain a rather sparse accumulation of cultural material, including flaked and groundstone tools, deer bone, and five Early Archaic type projectile points. Four large corner-notched points are Early Archaic Point Type 2A (see Chapter 9). A basal fragment of a Stemmed-indented base point, Point Type 3D (Chapter 9), similar to Pinto Shouldered points from the Early to Middle Archaic was also recovered. The presumed ages of these Archaic points are consistent with two radiocarbon dates obtained from Stratum D1 (dates 37 and 40, Table 5.3).

Stratum D2 consists of red sandy clay and lies between Layer D1 and bedrock. Its sediments appear to have been derived by weathering of the red bedrock mudstone. The layer contains a few small pieces of lithic debitage, and rare, very small fragments of charcoal which yielded a Plano period date (see date 38, Table 5.3). The dated charcoal came from beneath a Folsom preform. Neither the Folsom preform nor the Plano period date below it demonstrates a definitive Paleoindian occupation at Swallow site. No definite hearths were identified in either Stratum D1 or D2.

The site was excavated to bedrock over an area of approximately 18 m^2, in all or parts of eight excavation units, all below the rockfall. The deepest point of excavation was 480 cm below datum.

The Rockshelter Wall

While the wall of the rockshelter above modern ground surface is nearly vertical, sloping gently and rather uniformly to produce a slight overhang to the west-southwest, below the surface the shape of the wall is more complex. Here the wall bulges out to the west in the northern portion of the site (Excavation Unit Rows 1 South through 3 North). In Excavation Unit D2N this bulge extends westward into the site by about 1 m at 50 cm below datum, and by 2 m at 100 cm below datum. By 150 cm below datum the bulge becomes an overhanging ledge and meets the closest blocks of the rockfall to obliterate the dirt floor of the site. In contrast, to the south (Excavation Unit Rows 2 South to 5 South) the shelter wall slopes inward to the east. In Excavation Unit Row 3 South this indentation is over 2 m deep, producing a cave-like structure. Below it, from about 200 to 300 cm below datum, a detached ledge of the rockshelter wall extends up to 3 m west into the site in Excavation Unit Rows 2, 3 and 4 South. This ledge is separate from the parent mass of the monolith, probably split off by the rockfall when it fell. It appears to rest on bedrock (Figures 4.13 -4.16).

Trench and Test Unit Excavation

The 12-m trench extending west of the main excavation block, described in Chapter 1, has surface elevations ranging from 117 cm below datum at the east end to 244 cm below datum downslope at

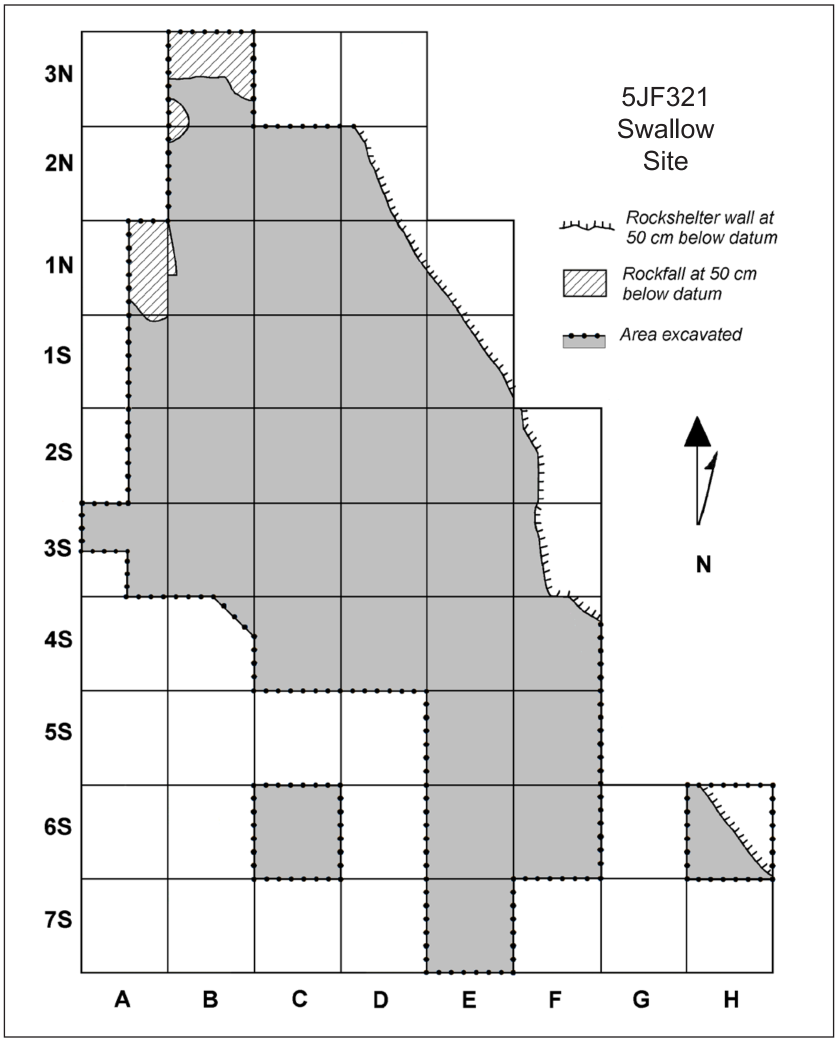

Figure 4.13. Rockshelter wall at 50 cm below datum.

the west. Cultural material (artifacts, processed bone and charcoal) is present in the trench, but in lesser amounts than in the body of the site. This cultural material is concentrated in the eastern part of the trench, and becomes increasingly sparse to the west, further away from the main site area. The trench was dug to different depths in each unit, from 4 to 10 excavation levels. At its western end the greatest depth of excavation was 285 cm below datum. Stratigraphic profiles were made of the north walls of the easternmost 4 m of the trench, but not of the western 8 m. Stratum A, the "historic layer," was present in only the easternmost 2 m, while Strata B and C are present to the western edge of the profiles. However, Stratum B becomes harder, progressively lighter gray, and more clayey and pebbly to the west. The stratum contains progressively much less charcoal. In its eastern part, a thin (3 to 11 cm) contorted layer of granular conglomerate is interpreted as pond sediments. Stratum C also changes from east to west. Stratum C1 is thinner than in the profiles of the main excavation, varying from 10 to 45 cm in thickness. It becomes grayer to the west,

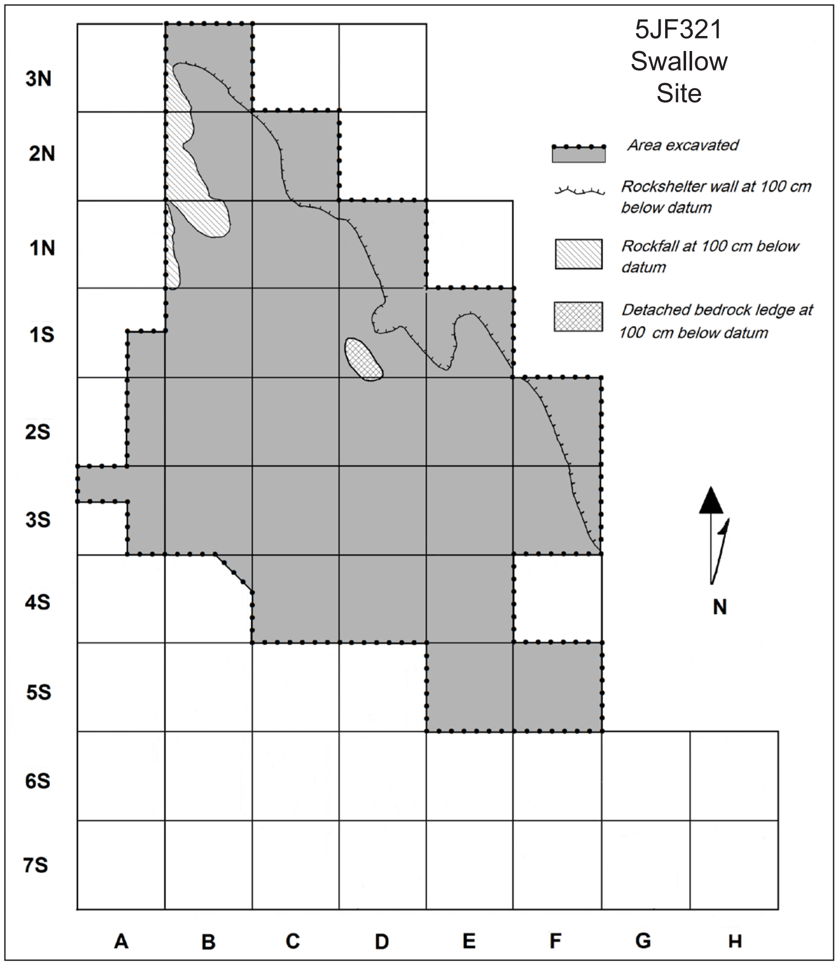

Figure 4.14. Rockshelter wall at 100 cm below datum.

and progressively more similar to Stratum B. Focally, the contact between Stratum B and C1 is indistinct. The thin, interrupted orange sand layer, described in the south and west site profiles, is present in only the easternmost portion of the trench. Stratum C2 lies at the bottom of the profiled area, so that its thickness is unknown. None of the strata in the trench are calcareous. In sharp contrast to the main excavation, very few rodent burrows were observed in the trench. As noted above, a block of Fountain sandstone, presumably the western edge of the rockfall, is present in the eastern edge of the trench, and a layer of fire-cracked rock in Stratum B is confined to the trench's eastern 2 m. In summary, the western edge of the site extends into the easternmost portion of the trench, while both site stratigraphy and the density of cultural material become attenuated and then nearly absent in the western part.

Test Unit A, to the northwest of the site, is 140 to 100 cm above datum at its surface. It was excavated from 6 to 16 cm, reaching the top of the rockfall over the eastern three-quarters of the unit. Its soil was light gray, silty to clayey sand, and very hard. Charcoal was absent. Test Unit

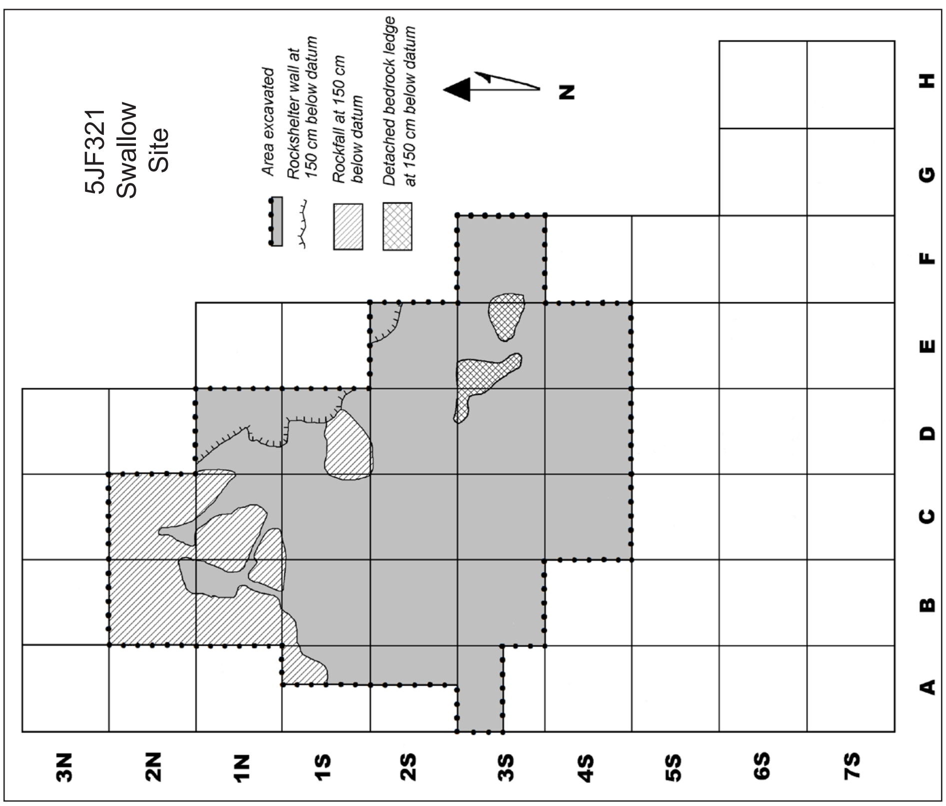

Figure 4.15. Rockshelter wall at 150 cm below datum.

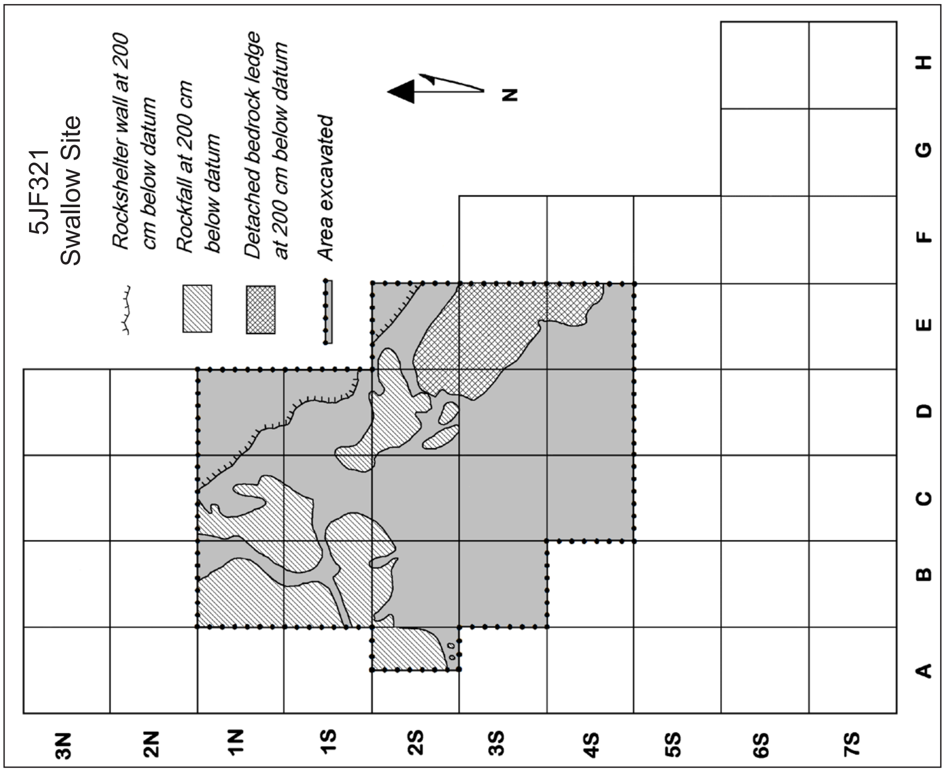

Figure 4.16. Rockshelter wall at 200 cm below datum.

B, in the meadow below the site, has a flat surface at 340 cm below datum. It was excavated to a maximum depth of 14 cm. The soil was similar to that of Test Unit A. No cultural material was found in either test unit.

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5

Radiocarbon Dates with Cultural Correlation

Bill Hammond and Jeannette L. Mobley-Tanaka

Forty radiocarbon dates were obtained from the Swallow site. When put in the context of the stratigraphic levels established in Chapter 4 and diagnostic artifacts, they provide additional data on the occupation sequence at the site. While the interfaces between strata are in places irregular and vertical mixing of materials has occurred, a moderate correlation exists between radiocarbon ages, strata, and cultural periods.

Overview of the Dates

Tables 5.1, 5.2, and 5.3 provide data on the 40 submitted samples. Provenience and sample type data are shown in Table 5.1. Dates are numbered by depth below ground surface. Horizontal distribution is given by excavation units. Depth below modern ground surface is also reflected by the excavation level, which represents 10-cm vertical excavation intervals, starting at the highest point in each excavation unit. Table 5.2 lists the measured radiocarbon ages and provides data on analysis type. Samples are ordered by increasing radiocarbon age. Laboratory numbers begin with either "Beta" or "CURL," indicating the samples were processed by Beta Analytic, Inc. or by the University of Colorado Radiocarbon Laboratory at INSTAAR. Table 5.3 summarizes the results by mean surface depth.

Nineteen of the 40 dated samples derive from hearth features (Table 5.1). Two others were associated with human remains, pit burials with the walls or outline of the pits definable in places. Two samples were associated with hard-packed surfaces. The remaining 17 samples come from excavation levels or, in two cases, from defined strata. Twenty-six samples consisted of wood charcoal, thirteen consisted of bison or deer bones, and one consisted of charred seeds.

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Table 5.1. Radiocarbon sample provenience and other data. Samples are sorted by increasing mean depth below the modern ground surface.

				Depth (cm)							
No.	Catalog/ Accession	Exc. Unit	Level	Datum Depth	Surface Depth	Mean Surface Depth	Context	Feature Type	Note	Material	Weight (g)
1	8663	C1S	2	29	14	14	Feature 41	Hearth		Ch.	5.9
2	F104.12002	E1S	3	35-45	20-30	25	Feature 104	Basin ashpit	From ashy fill	Ch.	9.0
3	F130.115	B1N	3	41-50	21-30	25	Feature 130	Rock hearth		Ch.	10.2
4	32307	C3N	3	16	25	25	Feature 193	Hearth		Ch.	21.9
5	7390	E3S	5	49-58	44-53	49	Feature 52	Hearth		Ch.	6.7
6	7200	E3S	5	51	46	46	Feature 48	Hearth		Ch.	5.7
7	F117.12536	F6S	6	12-21	50-59	55	Feature 117	Firepit	Lower portion of feature	Ch.	5.6
8	7726	E3S	6	60-70	55-65	60	Feature 53	Hearth		Ch.	28.8
9	7941	E3S	7	70-75	65-70	70	Feature 62	Packed surface		Ch.	10.5
10	9100	C1S	7	74	69	69	Feature 77	Hearth		Ch.	4.4
11	11309	E3S	8	70-80	70-80	75	Feature 93	Hearth		Ch.	4.0
12	F192.31440	A2S	8	131-140	71-80	76	Feature 192	Firepit	Lower part of gray sand	Ch.	5.8
13	9901	C1S	8	80-90	75-85	80	Feature 83	Hearth		Ch.	22.0
14	19677	C1N	9	98	88	88	Exc. Level	none		Bone	nd
15	19889	C1N	10	103	93	93	Feature 133	Surface		Bone	nd
16	8362	E3S	10	103	98	98	Feature 78A	Hearth		Bone	nd
17	8373	E3S	11	100-110	95-105	100	Feature 89	Hearth		Ch.	0.8
18	8364	E3S	11	100-110	95-105	100	Feature 78A	Hearth		Ch.	3.9
19	8369	E3S	11	100-110	95-105	100	Feature 78B	Hearth		Ch.	3.0
20	F12.12185	B2S	12	143-155	103-115	109	Feature 12	Human remains	Burial pit partially defined	Ch.	4.7
21	16528	C2S	13	152	122	122	Exc. Level	none		Bone	nd
22	38119	E2S	13	135	120-130	135	Exc. Level	none	Decorated bone fragment	Bone	nd
23	10242	E3S	14	140	135	135	Feature 94	Hearth		Ch.	2.0
24	F17.12225	D2S	16	160-170	146-156	151	Feature 17	Human remains	Burial pit partially defined	Ch.	3.2
25	21454	C1N	16	163	153	153	Exc. Level	none		Bone	nd
26	22650	F3S	16	160	160	160	Exc. Level	none	Deer long bone	Bone	nd
27	C1.18.16196	C1S	17	181-190	161-170	166	Exc. Level	none	10-cm interval, 3 m^2 area	Ch.	11.1
28	23092	E4S	17	165	165	165	Exc. Level	none	Deer long bone	Bone	nd
29	882	D4S	18	171	151	171	Exc. Level	none		Bone	nd
30	none	C1S	18-20	191-220	171-200	186	Feature 107	Slab-lined hearth	Taken from 40 cm interval	Ch.	nd

Table 5.1 (*continued*). Radiocarbon sample provenience and other data.

				Depth (cm)							
No.	Catalog/ Accession	Exc. Unit	Level	Datum Depth	Surface Depth	Mean Surface Depth	Context	Feature Type	Note	Material	Weight (g)
31	28135	D3S	19	190	181	181	Exc. Level	none	Deer long bone	Bone	nd
32	28228	D3S	19	193	182	182	Exc. Level	none		Bone	nd
33	1047	D4S	19	199	186	186	Exc. Level	none	Bison phalanx	Bone	nd
34	10462	E3S	21	200-216	195-211	203	Feature 95	Hearth		Ch.	2.2
35	1360	D4S	22	210-220	209-219	214	Exc. Level	none		Ch.	7.5
36	1376	D4S	23	223	222	222	Exc. Level	none	Deer long bone	Bone	nd
37	C1N.26.26120	C1N	27	270-278	260-268	264	Stratum (F179)	Ash and Ch.	Below rockfall; above Folsom	Ch.	2.0
38	C1.340.21335	C1S	33	321-340	321-330	326	Exc. Level	none	Below rockfall; below Folsom	Ch.	2.0
39	C4S.34598	C4S	33	355-360	325-330	328	Exc. Level	none	1-4 cm above rockfall	Ch.	1.04
40	D4S.35546	D4S	36	375-380	355-360	358	Stratum (F208)	Charred seeds	Immediately below rockfall	Seeds	6.0

Dating of 39 samples took place over a period of 14 years (Table 5.2). The first 12 were obtained between 1991 and 1998 on a variety of contexts, including hearths and excavation levels. Subsequently, hearth charcoal samples at various depths from two vertical excavation unit columns (C1S and E3S) and a single isolated charcoal sample from Unit D4S were obtained to provide an overall temporal picture of site occupation. When these dates did not define Stratum C adequately, and since there was so little charcoal in this stratum, AMS dates on collagen from deer and bison bones from this stratum were obtained. The initial 12 dates were funded by members and friends of the Denver Chapter of the Colorado Archaeological Society (DC-CAS). Subsequently, 15 dates on hearth charcoal and 12 dates on bone collagen were funded by Grant 2002 M2 009 from the Colorado State Historical Fund. INSTAAR (CU) acknowledges NSF Grant ATM-9809285 in support of the AMS bone collagen dates. A 40th date was obtained in 2018 on charred decorated bone, funded by DC-CAS. Among the charcoal samples, 7 were analyzed by accelerator mass spectrometry (AMS), while radiometric methods were used to analyze 20 samples. All of the bone samples were analyzed by AMS. Nine of the charcoal samples analyzed by radiometric methods were subjected to extended counting. 13C fractionation was not directly measured for the radiometric samples, apart from the Feature 192 sample (Beta-103238). In these cases, the assumed value for wood charcoal (-25‰) is reported. Measurement precision varies significantly, with reported standard deviations ranging from 15 to 110 years.

Conventional radiocarbon ages are given with 1-sigma standard deviation. Dendrocalibration was performed by Mark Mitchell, Research Director for Paleocultural Research Group, using OxCal 4.4 and the IntCal20 calibration curve (Reimer et al. 2020). Calibrated dates are presented at 1-sigma. Conventional radiocarbon dates are rounded to the nearest 10 years except for three AMS dates, which are rounded to the nearest 5 years; calibrated dates are rounded to the nearest 5 years. Assignment of dates to specific cultural periods is made from their conventional ages, not their calibrated dates.

These dates indicate Early Ceramic (AD 150 to 1150; 1800 to 800 BP), Late Archaic (1000 BC to AD 150; 3000 to 1800 BP), Middle Archaic (3000 BC to 1000 BC; 5000 to 3000 BP) and Early Archaic (5500 to 3000 BC; 7500 to 5000 BP) components at the Swallow site. No dates were obtained from the Middle Ceramic period, although Middle Ceramic period side-notched points, and unnotched points generally attributed to the Middle Ceramic period, occur at the site. Historical artifacts present in the uppermost stratum also indicate a much later Euro-American use of the site.

The oldest date, taken from sediment beneath a broken Folsom preform, is of Late Paleoindian age. This preform was found in the nearly sterile Stratum D2. The associated radiocarbon date, which is about 2000 radiocarbon years younger than the preform, indicates that an intact Folsom component is not present at Swallow.

When the samples are arranged according to depth below ground surface, there is a general trend that can be used to identify temporal units at the site (Figure 5.1). The Pearson product-moment

Table 5.2. Radiocarbon dating results. Samples are sorted by increasing conventional age.

No.	Catalog/ Accession	Report Date	Lab Number	Analysis Type	Material	Measured Age*	SD	$\delta^{13}C$	Conventional Age (^{14}C yr BP)	SD
7	F117.12536	10/10/1993	Beta-65275	Radiometric	Charred Material	1040	80	25**	1040	80
4	32307	4/20/2004	Beta-190709	Radiometric	Charred Material	1150	60	25**	1150	60
5	7390	4/20/2004	Beta-190697	Radiometric	Charred Material	1160	60	25**	1160	60
9	7941	4/20/2004	Beta-190699	Radiometric	Charred Material	1200	60	25**	1200	60
8	7726	4/20/2004	Beta-190698	Radiometric	Charred Material	1230	60	25**	1230	60
3	F130.115	9/21/1992	Beta-55583	Radiometric	Charred Material	1240	90	25**	1240	90
6	7200	4/20/2004	Beta-190696	Radiometric, extended count	Charred Material	1290	50	25**	1290	50
2	F104.12002	5/7/1991	Beta-44397	Radiometric	Charred Material	1370	70	25**	1370	70
25	21454	12/29/2005	CURL-8123	AMS	Bone	0.8399	0.0016	15.5	1400	20
1	8663	4/20/2004	Beta-190703	Radiometric, extended count	Charred Material	1410	70	25**	1410	70
13	9901	4/20/2004	Beta-190705	Radiometric	Charred Material	1480	60	25**	1480	60
11	11309	4/20/2004	Beta-190708	Radiometric	Charred Material	1560	60	25**	1560	60
12	F192.31440	4/7/1997	Beta-103238	Radiometric, extended count	Charred Material	1630	60	26.0	1620	60
17	8373	4/20/2004	Beta-190702	AMS	Charred Material	1630	40	23.6	1650	40
24	F17.12225	6/21/1991	Beta-45147	Radiometric, extended count	Charred Material	1880	90	25**	1880	90
10	9100	4/20/2004	Beta-190704	Radiometric, extended count	Charred Material	2060	80	25**	2060	80
27	C1.18.16196	9/21/1992	Beta-55584	Radiometric	Charred Material	2390	70	25**	2390	70
18	8364	4/20/2004	Beta-190700	Radiometric, extended count	Charred Material	2760	110	25**	2760	110
34	10462	4/20/2004	Beta-190707	Radiometric, extended count	Charred Material	2800	80	25**	2800	80
30	none	2/4/1991	Beta-42288	Radiometric, extended count	Charred Material	3150	100	25**	3150	100
20	F12.12185	5/7/1991	Beta-44398	Radiometric	Charred Material	3440	90	25**	3440	90
14	19677	12/29/2005	CURL-8121	AMS	Bone	0.6124	0.0013	16.1	3940	20
19	8369	4/20/2004	Beta-190701	AMS	Charred Material	3960	40	23.2	3990	40
23	10242	4/20/2004	Beta-190706	AMS	Charred Material	4040	40	23.5	4060	40
28	23092	12/29/2005	CURL-8125	AMS	Bone	0.5646	0.0012	9.1	4590	20
21	16528	12/29/2005	CURL-8120	AMS	Bone	0.5634	0.0014	14.0	4610	20
16	8362	12/29/2005	CURL-8119	AMS	Bone	0.5606	0.0011	12.6	4650	20
22	38119	7/1/2018	PRI-6018	AMS	Charred Bone	4760	60	-***	4760	60
26	22650	12/29/2005	CURL-8124	AMS	Bone	0.5147	0.001	17.7	5335	15
33	1047	12/29/2005	CURL-8117	AMS	Bone	0.4819	0.0009	20.6	5865	15
15	19889	12/29/2005	CURL-8122	AMS	Bone	0.4816	0.0009	20.9	5870	20
39	C4S.34598	3/5/1998	Beta-114460	AMS	Charred Material	5910	60	24.2	5920	60

Table 5.2 (*continued*). Radiocarbon dating results.

No.	Catalog/ Accession	Report Date	Lab Number	Analysis Type	Material	Measured Age*	SD	$\delta^{13}C$	Conventional Age (^{14}C yr BP)	SD
36	1376	12/29/2005	CURL-8118	AMS	Bone	0.4727	0.0011	13.3	6020	20
35	1360	4/20/2004	Beta-190695	Radiometric, extended count	Charred Material	6030	110	25**	6030	110
32	28228	12/29/2005	CURL-8127	AMS	Bone	0.4715	0.0009	14.1	6040	20
31	28135	12/29/2005	CURL-8126	AMS	Bone	0.4693	0.001	8.6	6080	20
29	882	12/29/2005	CURL-8116	AMS	Bone	0.4538	0.0012	27.2	6345	25
40	D4S.35546	4/28/1998	Beta-116395	AMS	Charred Material	6900	50	23.1	6930	50
37	C1N.26.26120	4/18/1995	Beta-81295	AMS	Charred Material	7130	60	22.9	7170	60
38	C1.340.21335	7/15/1994	Beta-73631	AMS	Charred Material	8290	60	22.9	8320	60

* Measured ages of charred material samples reported as ^{14}C yr B.P.; measured ages of bone samples reported as percent modern.
** δ ^{13}C values not measured.
*** δ ^{13}C values not reported.

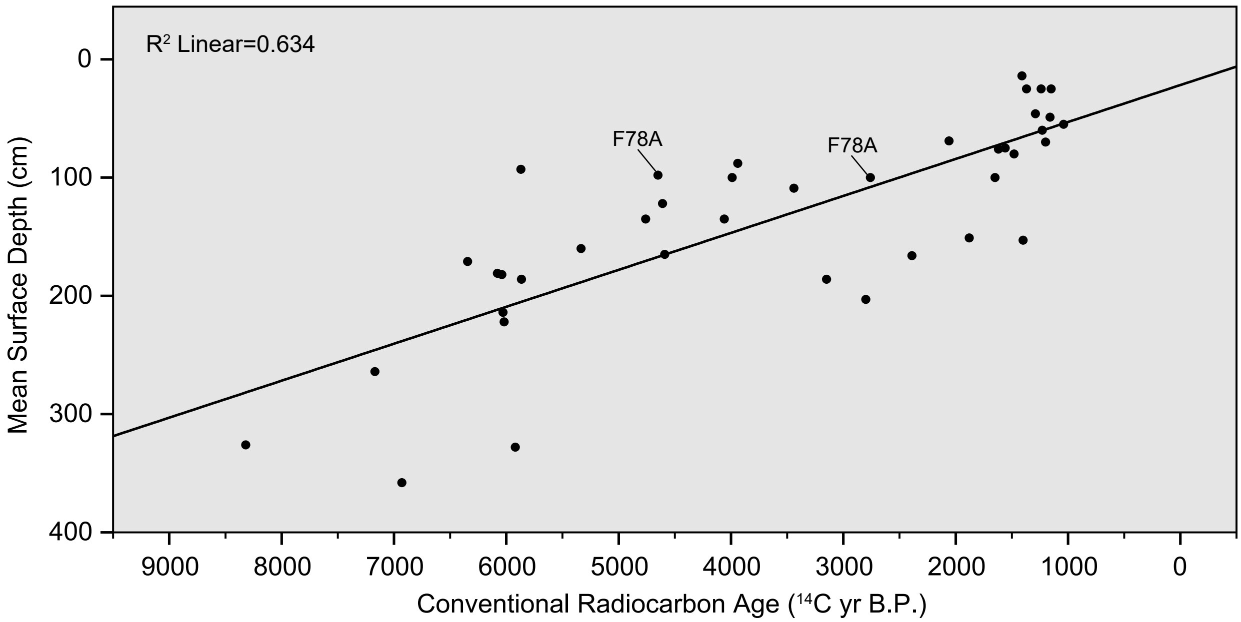

Figure 5.1. Scatterplot showing the relationship between median surface depth and conventional age for 40 radiocarbon assays. Line represents the linear correlation.

correlation coefficient for depth (by mean surface depth) and conventional age yields an r^2 value of 0.639; in other words, a moderate correlation exists between depth of sample and age of sample.

While the general trend is meaningful, there are some dates which are clearly out of sequence. The mixing of deposits and of datable material is not surprising, given the long occupation of the site and the evidence of rodent burrows frequently noted by excavators. Of the most dramatically out of sequence samples, several were recovered from Unit C1N and the neighboring C1S, suggesting that this area of the site may have experienced more dramatic bioturbation than other parts of the site.

The least disturbed sequence of dates is that occurring in Levels 2 through 8, representing the Early Ceramic period (800-1800 BP). The first nine dates fall within Stratum B. They range from 1040±80 BP to 1410±70 BP and are all closer to the surface than the next group of Early Ceramic dates.

Four additional dates fall within the Early Ceramic period, 3 occurring in Level 8 (Dates 11-13) and one in Level 11 (Date 17), somewhat deeper than Stratum B was generally found. Since the interface of Strata B and C is irregular, they may actually be in Stratum B; alternatively, these four samples are all derived from hearths, and it appears that at least 3 of the features were dug into the top of Stratum C from the overlying stratum. This positioning is documented for Feature 93 (Date 11) and Feature 83 (Date 13), the tops of which are in Level 7; and Feature 192 (Date 12), the top

Table 5.3. Radiocarbon data summary. Samples sorted by increasing mean surface depth.

No.	Catalog/ Accession	Lab Number	Exc. Unit	Level	Mean Surface Depth (cm)	Context	Conventional Age (^{14}C yr BP)	Calibrated Date (1-σ cal AD/BC)
1	8663	Beta-190703	C1S	2	14	Feature 41	1410±70	A.D. 570-675
2	F104.12002	Beta-44397	E1S	3	25	Feature 104	1370±70	A.D. 600-775
3	F130.115	Beta-55583	B1N	3	25	Feature 130	1240±90	A.D. 675-885
4	32307	Beta-190709	C3N	3	25	Feature 193	1150±60	A.D. 775-980
6	7200	Beta-190696	E3S	5	46	Feature 48	1290±50	A.D. 665-775
5	7390	Beta-190697	E3S	5	49	Feature 52	1160±60	A.D. 775-980
7	F117.12536	Beta-65275	F6S	6	55	Feature 117	1040±80	A.D. 890-1150
8	7726	Beta-190698	E3S	6	60	Feature 53	1230±60	A.D. 685-885
9	7941	Beta-190699	E3S	7	70	Feature 62	1200±60	A.D. 705-945
10	9100	Beta-190704	C1S	7	69	Feature 77	2060±80	175 B.C.-A.D. 60
11	11309	Beta-190708	E3S	8	75	Feature 93	1560±60	A.D. 430-565
12	F192.31440	Beta-103238	A2S	8	76	Feature 192	1620±60	A.D. 405-545
13	9901	Beta-190705	C1S	8	80	Feature 83	1480±60	A.D. 545-645
14	19677	CURL-8121	C1N	9	88	Exc. Level	3940±20	2475-2350 B.C.
15	19889	CURL-8122	C1N	10	93	Feature 133	5870±20	4785-4715 B.C.
16	8362	CURL-8119	E3S	10	98	Feature 78A	4650±20	3500-3370 B.C.
17	8373	Beta-190702	E3S	11	100	Feature 89	1650±40	A.D. 360-535
18	8364	Beta-190700	E3S	11	100	Feature 78A	2760±110	1050-805 B.C.
19	8369	Beta-190701	E3S	11	100	Feature 78B	3990±40	2575-2465 B.C.
20	F12.12185	Beta-44398	B2S	12	109	Feature 12	3440±90	1880-1625 B.C.
21	16528	CURL-8120	C2S	13	122	Exc. Level	4610±20	3490-3360 B.C.
22	38119	PRI-6018	E2S	13	135	Exc. Level	4760±60	3635-3386 B.C.
23	10242	Beta-190706	E3S	14	135	Feature 94	4060±40	2835-2490 B.C.
24	F17.12225	Beta-45147	D2S	16	151	Feature 17	1880±90	A.D. 25-250
25	21454	CURL-8123	C1N	16	153	Exc. Level	1400±20	A.D. 610-660
26	22650	CURL-8124	F3S	16	160	Feature 135	5335±15	4245-4065 B.C.
28	23092	CURL-8125	E4S	17	165	Exc. Level	4590±20	3485-3350 B.C.
27	C1.18.16196	Beta-55584	C1S	17	166	Exc. Level	2390±70	740-390 B.C.
29	882	CURL-8116	D4S	18	171	Exc. Level	6345±25	5360-5225 B.C.
31	28135	CURL-8126	D3S	19	181	Exc. Level	6080±20	5030-4945 B.C.
32	28228	CURL-8127	D3S	19	182	Exc. Level	6040±20	4990-4900 B.C.
33	1047	CURL-8117	D4S	19	186	Exc. Level	5865±15	4785-4710 B.C.
30	none	Beta-42288	C1S	18-20	186	Feature 107	3150±100	1515-1280 B.C.
34	10462	Beta-190707	E3S	21	203	Feature 95	2800±80	1050-830 B.C.
35	1360	Beta-190695	D4S	22	214	Exc. Level	6030±110	5205-4790 B.C.
36	1376	CURL-8118	D4S	23	222	Exc. Level	6020±20	4950-4845 B.C.
37	C1N.26.26120	Beta-81295	C1N	27	264	Stratum	7170±60	6080-5985 B.C.
38	C1.340.21335	Beta-73631	C1S	33	326	Exc. Level	8320±60	7490-7200 B.C.
39	C4S.34598	Beta-114460	C4S	33	328	Exc. Level	5920±60	4885-4715 B.C.
40	D4S.35546	Beta-116395	D4S	36	358	Stratum	6930±50	5880-5740 B.C.

of which is in Level 6. These four samples range from 1480±60 BP to 1650±40 BP and are all closer to the surface than the following Late Archaic dates. While Date 12 is 131 to 140 cm below datum, it is on the slope down from the flat portion of the site to the meadow, and its depth below surface is only 71 to 80 cm. Thus, its depth below datum is not comparable to that of the first nine dates.

From its age, Date 24 (1880±90 BP) could be from either the Early Ceramic or the Late Archaic period. It is from charcoal associated with human remains in Stratum C; while this charcoal could be either from the surface from which the pit was dug or from the dirt removed in digging the pit, so the correlation of date and depth is uncertain. However, the depth of the burial and the absence of grave goods both suggest that the burial is Late Archaic.

Twenty-three radiocarbon dates were obtained from samples in Levels 9-33, within Stratum C, which extends from the bottom of Stratum B to the top of the rockfall. As stated in the previous chapter, bioturbation has resulted in severe mixing of materials in this stratum, as exemplified by Early and Middle Archaic Dates 14, 15, and 16 in the upper levels; Date 25 from the Early Ceramic at Level 16; and Late Archaic Date 34 from Level 21.

Aside from the clearly displaced Date 25, the youngest five dates in Stratum C, Dates 10, 18, 24, 27, and 34, are consistent with the Late Archaic period (1800-3000 BP). As discussed above, Date 24 is thought to be from a Late Archaic burial. Date 34 (2800±80 BP) from Feature 95, a hearth, is problematic. There is conflicting information about the depth of the hearth. Level 21 is given on Tables 5.1 and 5.3. Some of the documentation regarding the feature give the top of the hearth at Level 17 or 18. The hearth from which Date 10 (2060±80 BP) was obtained lies at the top of Stratum C and was exposed as the bottom of Stratum B was stripped away. Date 18 (2760±110 BP) is from a hearth feature in Level 11. (Note that a bone sample from the same feature, Date 16, was dated at 4650±20 BP.) Date 27 (2390±70 BP) is from Level 17 of Unit C1S. Dates 10, 18, 24, and 27 range from 1880±90 BP to 2760±110 BP. They come from Excavation Levels 7, 11, 16, and 17.

Nine dates from Stratum C (numbers 14, 16, 19-23, 28, and 30) are all consistent with the Middle Archaic (3000-5000 BP). The dates range from 3150±100 BP to 4760±60 BP and in depth from Excavation Level 9 to Level 18.

There are nine Early Archaic dates above the rockfall, eight in the lower part of Stratum C. Date 15, in Level 10 of the upper part of Stratum C, is clearly displaced upward. Date 26, at 5335±15 BP and in Level 16, is considered a transitional date. The next six dates (29, 31-33, 35, 36) are tightly clustered at 5865±15 BP to 6345±25 BP and in Levels 18 through 23. The last date, Number 39 (5920±60 BP), is from a small fragment of charcoal found immediately on top of the rockfall. It is from Level 33, at 357 cm below datum. It falls within the age range of the six dates just discussed but is much deeper. It was probably displaced downward from the depth of the other dates.

Below the rockfall three radiocarbon dates were obtained. The first two, 6930±50 BP and 7170 ±60

BP, are from an older Early Archaic layer than the one above the rockfall. The first of these dates, Number 40, lies immediately below the rockfall, and must have been at the surface when the large slab fell from the face of the overhanging monolith. Thus, it identifies the date of the rockfall. The second date, Number 37, comes from only a few cm below the bottom of the rockfall. However, because the first comes from the south edge and the second from the north edge of the deep part of the excavation, and because the rockfall slopes so steeply from north to south, it is not a discrepancy that their depths below datum vary greatly (377 and 274 cm), and that their excavation levels are 36 and 27 respectively.

At 8320±60 BP, the third date from below the rockfall (Date 38), is from the Late Paleoindian period. It comes from deeper below the rockfall than the upper two dates and is from scattered, small charcoal fragments below a broken Folsom preform. It is from Stratum D2, which contains a few flakes and charcoal fragments, but no other cultural material. This date indicates that an intact Folsom component is not present. Whether a Late Paleoindian occupation occurs at Swallow is not known.

Examining the calibrated radiocarbon date record, several "time gaps" are apparent. All of these gaps are explained by sampling and by the small standard deviations of the bone dates. However, one gap is associated with more than 50 cm of nearly sterile sediment between the top of the rockfall and the bottom or the upper Early Archaic occupation in the south end of the site. This suggests that the site was not in use for ca. 600 radiocarbon years after the rockfall occurred.

Cultural Correlation

The following section correlates the site stratigraphy described in Chapter 4 and this chapter's radiocarbon dates with cultural periods and stages, primarily identified by diagnostic artifacts. The radiocarbon dates indicate regular occupation of Swallow site in the Early Ceramic period, and extensive but intermittent occupation throughout the Archaic Stage.

As stated, there is a moderate correlation between age of date, depth of date, and the strata described in the previous chapter. This correlation is considered below. It is emphasized here that materials at the site have been subject to significant mixing through bioturbation, both from burrowing animals and human agency. Use of the site for several millennia has clearly resulted in artifacts being displaced horizontally across the site and displaced vertically both upwards and downwards in the soft sandy-silty soil matrix. The displacement of artifacts is evidenced by the distribution of Early Ceramic period projectile points and ceramics, and the distribution of Late and Middle Archaic projectile points. Early Ceramic Hogback corner-notched projectile points and ceramic sherds are most numerous in Levels 1-7, but a few occur in Levels 8-23. Middle Archaic McKean Complex points are vertically present in Levels 1-18, and Level 23. Duncan points are most common in Levels 6-13. Other Middle to Late Archaic projectile point types are present from Levels 1-18, and in Levels 20, 23, and 24. Conjoinable artifacts are illustrative of the horizontal and vertical displacement of materials through bioturbation. One of the decorated bones is in three fragments with 6+ m of horizontal separation and over 1 m of vertical separation. One fragment (38119) is from Level 13 of E2S, one fragment (18890) is from Level 21 of C4S, and the third (36812) is from Level 24 of C4S. A Type 12 projectile point was in two pieces, the tip (29738) from Level 7 of E6S, and the base (12741) from Level 13 of E5S.

Historic Stage

The widespread presence of decaying cow manure identifies Stratum A as historic; this part of the Ken-Caryl Ranch was used for raising cattle beginning no earlier than 1914 (Johnson and Mobley-Tanaka 1997) and continuing, at least intermittently, until the late 1970s. Mixed throughout Stratum A and often extending into the upper levels of Stratum B are smashed bullets, shards of glass, smashed and intact cartridge cases and a few nails, staples and fragments of wire. The largest artifact is a rusted small animal trap in Excavation Unit E3S. Two round, red "targets" are painted on the shelter wall, together with numerous bullet pockmarks. These show no evidence of weathering. The historic component is discussed in Appendix F.

Although Stratum A is clearly of Historic period age, more prehistoric artifacts than historical ones were recovered from it, presumably the result of displacement from bioturbation. All of the diagnostic prehistoric artifacts in Stratum A are Early Ceramic except for a single small side-notched projectile point, from the Middle Ceramic period.

There are no artifacts or radiocarbon dates from the Protohistoric period at the Swallow site.

Late Prehistoric Stage

Middle Ceramic Period

No radiocarbon dates or diagnostic potsherds identify a Middle Ceramic period presence; the most surficial hearth features, one radiocarbon dated at 1410±70 BP, were found at the junction of Strata A and B. However, among the projectile point assemblage are 9 small side-notched and 20 un-notched points; these (Types 11a and b, and Type 12, described in Chapter 9) are characteristic of the Middle Ceramic period. In contrast to the historic artifacts, which are concentrated in Excavation Levels 1 and 2, these points were concentrated between Levels 4 through 9, with single outliers in Levels 1, 2, and 20. The presence of side-notched points at the site is indicative of use of the Swallow site by Middle Ceramic period bands. Small numbers of side-notched points have also been recovered at other Ken-Caryl sites, including Bradford House II and III (5JF51 and 5JF52), Anniversary site (5JF209), and Falcon's Nest (5JF211). On the other hand, the stratigraphic location and prevalence of small triangular unnotched points or bifaces in levels that are clearly Early Ceramic in date, may indicate that these tools are not solely diagnostic of the Middle Ceramic. It has been asserted that small triangular unnotched points or bifaces in Early Ceramic contexts at Swallow and other Ken Caryl sites indicate these tools were in use earlier in the Hogback valley than in other areas (Johnson et al. 1997:139, Hammond and Rhodes 2013).

Early Ceramic Period

The 12 radiocarbon dates from Stratum B, together with the predominance of Early Ceramic cord-marked potsherds and Hogback corner-notched projectile points in this stratum, clearly identify Stratum B with the Early Ceramic period. By far the densest concentration of cultural material - hearth features, artifacts, charcoal and processed bone - is in this layer, together with the uppermost fire-cracked rock layer, described in Chapter 4. The large number of scattered fire-cracked rocks are presumably from dismantled hearths and possibly roasting pits. Further supporting a very intense occupation, the dark gray color of the dirt reflects a high concentration of culturally introduced charcoal, turned to powder and mixed with other components of the dirt by the traffic of generations of people. Stratum B contains numerous rodent burrows and mixing of cultural materials is apparent, yet ceramic analysis indicates the stratum contains some integrity of stratigraphic deposits within the Early Ceramic period (Chapter 13). The radiocarbon dates from Stratum B suggest regular use of the site during this period. With the exception of relatively small areas in the north and southwest portions of the site, the interface between Strata B and C is in Excavation Levels 7 and 8.

Archaic Stage

Late and Middle Archaic Periods

Both radiocarbon dates and projectile point types confirm that Stratum C dates to the Archaic period.

Stratum C is divided into sub-strata C1 and C2, yet no distinct stratigraphic separation of the Late from the Middle Archaic occupations is apparent. While some McKean complex projectile point types are commonly associated with the Middle Archaic, and some types such as Besant are attributed to the Late Archaic, many of the point types recovered from Swallow are considered Middle to Late Archaic in age, thus not diagnostic of a single period. Strata C1 and C2 both contain numerous rodent burrows. The distribution of Middle to Late Archaic projectile points and the radiocarbon dates from the Middle and Late Archaic periods indicate extensive disturbance and mixing of deposits from these periods. Late Archaic, Middle Archaic, and Middle to Late Archaic point types were recovered from all levels from Level 1 to Level 18, and a few were recovered from levels below Level 18.

The Late and Middle Archaic occupations are considered together, occupying Excavation Levels 8-9 through 16-18, in the remainder of the analysis of the Swallow site.

Upper Early Archaic Period

In light of the above, it is perhaps surprising that the location of an Early Archaic occupation above the rockfall is somewhat well defined. One radiocarbon date from Level 16 and six of eight dates from Levels 18 through 23 are from the Early Archaic period. Date 26, of 5335±15, from Level 16, is more recent than the others, and may be a transitional date between the Middle and Early Archaic. Middle Archaic Date 30 from Levels 18-20, and Late Archaic Date 34 from Level 21 (discussed above) indicate there has been mixing in the lower levels above the rockfall. The lowest fire-cracked rock layer is in this Early Archaic zone, in Levels 17-21. Because of the slope of the rockfall from north to south, the soil of Stratum C below Levels 21 and 22 is between rockfall blocks in the north part of the site and between the lowest fire-cracked rock layer and the top of the rockfall in the south part. In neither of these locations is there much cultural material; the little that is present is most probably displaced downward from the Early Archaic occupation above. A corresponding gap in the calibrated radiocarbon date sequence confirms the likelihood of a period of site disuse of ca. 600 years after the rockfall happened.

The types of formal tools, the species of animal bone and the types of lithic materials used are remarkably constant through all the cultural periods above the rockfall, implying little change in basic lifestyle over this lengthy period.

Lower Early Archaic Period

In the 10 to 15 cm of Stratum D1 immediately below the rockfall is a second, earlier Early Archaic layer. Feature 208 was noted in the profile of the north wall of Excavation Unit D4S, immediately below the main rockfall block and at the top of Stratum D1 (Figure 4.5), This feature consists of a distinct lens of brown-gray sand containing a concentration of carbonized hackberry (*Celtis reticulata*) seeds and abundant small fragments of charcoal. As described in Chapter 4, Feature 208 extends about 40 cm to the south, into Unit D4S, and about 20 cm west into the adjacent Unit C4S. The radiocarbon date from Feature 208 dates to 6930±50 BP (Date 40). Feature 179 is an ash and charcoal lens a few centimeters below the bottom of the rockfall, with a date of 7170 ±60 BP. Feature 179 may be the remnants of a firepit.

Five projectile points from this layer are Early Archaic. Four mostly complete large corner-notched points are Early Archaic Point Type 2a (See Chapter 9). A basal fragment of a Stemmed-indented Base point, Point Type 3d (Chapter 9), similar to Pinto Shouldered points from the Early to Middle Archaic, was also recovered. Other formal artifacts in this layer are scanty but are of the same types as those found above the rockfall. The types of lithic material are much more limited, however.

Stratum D, the area below the rockfall, is the least disturbed or bioturbated layer of the site.

Paleoindian Stage

The underlying Stratum D2, immediately above bedrock, contains very little cultural material. The association between a broken Folsom point preform and small, widely scattered bits of charcoal yielding a radiocarbon date of 8320±60 BP indicates that an intact Folsom component is not present at the excavated portions of the site. Whether the charcoal dates a Late Paleoindian component is not known. Since Stratum D2 is just above bedrock, the main part of such an occupation would probably be further out from the rockshelter wall, where bedrock is deeper. The "trench" extending west from the main excavation block, described in Chapters 1 and 4, was not excavated deep enough to explore this possibility.

Summary

In summary, Stratum A is a thin, superficial layer containing a scattering of historical material, and Middle Ceramic and Early Ceramic artifacts, while Stratum B contains a rich Early Ceramic occupation. Stratum C1 and the upper part of Stratum C2 contain mixed Late and Middle Archaic occupations. An upper Early Archaic occupation in Stratum C2 is underlain by a culturally nearly sterile zone in the lower part of this stratum, indicative of a period of site disuse after the rockfall. A lower Early Archaic occupation is in the upper part of Stratum D1, immediately below the rockfall.

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6

Palynology

Linda M. W. Groth

Study Objectives

The study of Swallow site palynology sought to answer the following questions:

- What changes occurred in local/regional vegetation patterns to indicate climate changes?
- Does the vegetation show any optimum intervals for prehistoric habitation in the Hogback valley?
- Do the analyses show prehistoric use of specific flora?
- Can detailed databases of modern pollination and fossil pollen profiles be obtained for use in this project and in future Colorado foothill studies?

Study Design

The basic palynology study consisted of three phases:

- Sampling and studying the seasonal time-distribution patterns of modern airborne pollen assemblages within close proximity to the archaeology site.
- Sampling and studying the pollen assemblages from soil columns within the archaeology site grids.
- Statistical analyses and graphing of data to reach the above objectives.

Palynology at the Swallow site was conducted at the suggestion of Ivol Hagar, Site Director at the time (1986). Soil sampling occurred in August and September 1986, air sampling through

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1987, and processing and study occurred in 1989. The statistical analysis and report writing were completed and submitted in the 1990s. Some slight updating was done in the early 2000s. The chapter was not subsequently updated. The author apologizes for not referencing recent studies.

The Modern Pollen Study Framework

Collecting Equipment

Three collecting devices were constructed. One consisted of a plastic pipe 10 ft high, and the other two pipes were each approximately 1 ft high. A collecting cup was attached to the upper end of each pipe, and the pipes were then stuck into the ground at the locations described below. The cups were padlocked to the pipes to reduce the possibility of vandalism.

The collecting cups were plastic containers with a diameter of 3.25 in. The inside bottom and sides of each cup were smeared with a mixture of gelatin, glycerin, and phenol which made a sufficiently soft, somewhat sticky medium on which to "capture and hold" the pollen grains and prevent mold growth. A copper scrubber (Chore Boy) was then placed over the cup to act as a wind-baffle, rain-splash deterrent, and insect barrier (so that pollen-laden insects would not contaminate the sample). At replacement time, the cups were removed, dated, and closed with a snap-on lid. A new, previously prepared cup and copper scrubber were then bolted into place on each pipe for the next collecting interval.

Sampling Locations and Intervals

Two sites were chosen for the three collection pipes/cups. Both were in open terrain and were far enough away from the Swallow site and dirt roads that they would not be directly contaminated by excavation and other human activities at and near the site. The first location was about 250 yd east, uphill from the Swallow site. The 10-ft collection pipe and a 1-ft pipe were stuck into the ground about 3 ft away from each other. The low pipe was included to see if its sample cup received a greater number and more variety of nonarboreal pollen than the high pipe. The remaining 1-ft pipe was located approximately 60 yd north of the Swallow site.

The three pipes were emplaced November 28, 1986. Samples were collected approximately every two to four weeks, beginning December 14, 1986, and ending January 28, 1988. Sixty-six cups were collected during this time period.

Sample Processing

The cups were frozen until processing time to prevent the growth of mold. The samples were processed using the widely accepted acetolysis method. No problems were associated with macerating this type of sample since there was little or no extraneous organic or inorganic material that had to be eliminated. Sixty-six slides were made of the modern pollen samples.

The Swallow Site Soil Pollen Framework

Collecting Equipment

The basic sampling tool was a sharpened uncontaminated teaspoon. A soil-sampling probe was tried initially, but it could not easily penetrate the dry soil as well as the spoon could. The samples were put into sterile bags and then frozen to prevent the growth of mold until processing time.

Sampling Locations

Sampling was conducted at two locations at the rock shelter: (1) outside the drip line, and (2) inside the drip line.

Outside the Drip Line

A soil column was sampled down the south wall of the north half of grid B2S (N 100 cm, W 175 cm). The south half of B2S had not been excavated. Site Director Ivol Hagar selected this grid for sampling because it was the deepest one excavated at that time, and it had a straight wall.

The exposed grid wall was scraped back several centimeters to remove eroded/oxidized surface material and modern contamination. Then horizontal holes (at surveyed depths) were dug approximately 10 cm into the wall. Subsequently, an uncontaminated soil sample was taken at the back end of each hole with the sharpened teaspoon and put into a numbered sterile bag.

Sampling was conducted August 9-10, 1986. Twenty-nine samples were collected approximately every 5 or 10 cm from -50 cm (L2) down to -230 cm (cm below datum; L22). These intervals included a sample from each visually obvious sediment layer. The 230-cm depth (L22) was the bottom of the grid at this time. Subsequent digging revealed mostly rockfall below this depth. Soil from -30 cm (surface) to -50 cm (L2) was not sampled due to excavator disturbance, crumbling soil structure, and probable contamination.

Inside the Drip Line

This area was chosen for sampling by Ivol Hagar because it was within the habitation section of the site. Grids E3S and E2S were sampled because at the time it was determined that their excavated depths went through the Early Ceramic period and into the Archaic. Two soil columns were sampled September 10 and 21, 1986. The highest column was sampled down the east wall (N 110 cm) of Grid E3S from -30 cm (L3) to -80 cm (L8). Nine samples were collected approximately every 5 cm. Collecting (and excavation) stopped at -80 cm (L8) at an alluvial flow containing thin layers of interbedded charcoal and coarse sediments which appeared to wash toward a fire pit to the west. This flow was considered to be the base of the Early Ceramic period as of August 23, 1986.

There was no collecting through the alluvial flow between -80 cm (L8) and -100 cm (L10). Sampling below the alluvial flow was continued down a second column on the south wall of Grid E2S (W 170 cm). Thirteen samples were collected approximately every 5 cm from a depth of -100 cm (L10) to -170 cm (L17). This column was considered to be in the Upper Archaic as of August 23, 1986.

Total analyzed samples were 9 from E3S and 13 from E2S. Added to the 29 from B2S, this resulted in a total of 51 soil samples. Additional samples were taken to experiment with processing procedures for eliminating charcoal.

Sample Processing

Since the pollen study was going to be dependent on frequency statistics, the raw data had to be obtained with a minimum of variations induced by the diverse collecting, laboratory, and identification processes. Therefore, to ensure procedural uniformity, the author collected the samples, the laboratory processed them within a short time frame, prepared the microscope slides, and identified and counted the pollen grains.

Processing samples with low pollen densities and abundant charcoal is difficult. The charcoal tends to dilute and mask the pollen, making the subsequent microscopic study very tedious, and ultimately skewing the statistics away from the small pollen grains which are easily masked. Various techniques were used on the surplus samples in order to arrive at an efficient procedure. The final method used a combination of ultrasound, microsieving, and a modified Schultz acetolysis solution. The decanted residues were stained with saffron, and a five percent solution of zepharin chloride fungicide was added before storing them in vials until slides could be made.

Analytical Procedures

A Leitz microscope with transmitted light and phase contrast was used to study the pollen grains. For the modern samples, the standard procedure was to identify and try to count 200 arboreal pollen grains per slide. During this 200-count, the encountered nonarboreal grains were also identified and counted separately. This standard industry procedure helps to find more nonarboreal pollen samples when they are diluted by large amounts of arboreal pollen (i.e., pine and oak). Winter samples had few pollen grains of either type to record.

In the soil samples, 100 arboreals were counted, as well as additionally counting the nonarboreals. In some of the coarser sediment samples, the pollen density was too low to count the planned 100 arboreals. Then, 25 traverses were read per slide; this was considered “covering the slide.” This avoided scanning the slide edges where differential settling in the mounting medium can skew the pollen statistics. Pollen grains were identified to family or genus. Corroded, ruptured, and deformed pollen grains were counted as “Unidentified.” Spores were noted, but not counted.

In general, there was a low volume of pollen grains on the soil slides compared to the modern pollen slides, but it was usually possible to count 100 arboreals with corresponding nonarboreals. The exceptions were the five slides from B2S soil samples from -130 cm (L10) to -150 cm (L14). These samples had much higher densities of arboreal and nonarboreal pollen compared to those of the other levels.

After the pollen counts were recorded, the data were compiled and graphed using TriMetrix Axum Data Analyses software. The results were used to construct the sawgraph diagram for the modern study (Figure 6.1), the bar graphs for grids B2S and E3/E2S (Figures 6.2 and 6.5), and the additional statistical studies (Figure 6.4) used in the interpretations. Pearson Correlation (bell-curved data assumption) analysis of genera was not definitive; there were too many pollen genera which had very low occurrences in many of the samples.

Elements Influencing Palynology History Determinations

The palynology history of this area has been influenced by the geology, soil characteristics, and changing landscapes in and around Docmann meadow. Many of the details are discussed in the Environment section.

Geology and Soil Characteristics

The local geological formations, mainly the Pennsylvanian Fountain formation, contributed much of the soil material to the site. Additional materials originated from winds blowing across unconsolidated Holocene and Pleistocene deposits to the west. The vegetation landscape centering on Docmann meadow was altered by climate as well as by man, especially during historic ranching times.

Soil origins and characteristics at the sampling sites are important because they influence pollen densities and preservation. Different sediment layers within the Swallow site contained very different pollen densities. Coarse-grained soils are not good material for pollen preservation. The coarser soils allow faster meteoric-water infiltration and oxidation of the pollen exines. Very coarse-grained soils can result in groundwater percolation which can carry the pollen into lower levels, depositing it when encountering less-pervious layers. Some of the red/orange layers had the coarsest textures, and thus the lowest concentrations of pollen. Many of the soils in Grids E3/E2S were relatively coarse, mainly from the mass wasting of the adjacent rock face, and therefore lacked good pollen counts. The finer-grained brown sediments had the highest pollen densities. These were composed of clays, fine sands, and silts, and were found mainly in Grid B2S. Pollen is very resistant to common soil chemicals, but charcoal and ash in the soils portend poor pollen preservation. High heat destroys the pollen grains completely or can damage the exines to such an extent that the pollen cannot be identified. Grids E3/E2S had several layers with very low pollen densities probably due to the relatively large number of nearby hearths within the habitation area.

Changing Local Landscapes

As Nelson and colleagues point out, our perspective for describing past environments is almost certainly skewed by our observations of the environment today (2008:46). In attempting to reconstruct past landscapes, the local changes made in the historical period must be recognized so as not to unknowingly include them within reconstructions of prehistoric times. Modern hydrologic changes and ranching activities have altered the local landscape of Docmann meadow, and therefore also the nature of the present local vegetation. The historical drainage alterations can be deduced from field observations and aerial photo study.

Downslope and south-southwest of the Swallow site excavation there is a relatively deep gulch advancing upslope by headward erosion into the meadow. During wetter times of the year, several small shallow tributaries flow across the meadow, down this headwall, and into the gulch. This steep erosion head of Docmann Gulch was a geomorphic feature useful for constructing an earthen dam site for a ranch pond. Metal and clay pipes attest to historic construction.

The damming of the water allowed sediments to back up in the pond and raise the base level of the tributary mouths. The dam has been breached, and at the present time there is slow, flow-through water from the meadow rivulets. The remains of this pond are now filled with cattails and reeds, and edged with willow thickets and cottonwood trees. During prehistoric times there probably was no eroding gulch, but there may have been a natural depression here, and perhaps other small shallow depressions scattered across the meadow.

There is now another wetland area, demarcated by more cattails and willows, on the west side of the pond on the slope near the road. This wetland probably did not exist prior to 1971 when Johns Manville Corporation constructed its office here. Road building created a long berm ditch that concentrates small water flows and diverts them down the valley. The engineers must have predicted heavy water runoff because they built a hydraulic jump box near the old Falcon House homestead site. The water goes through a culvert under the road and flows down the slope, resulting in enough water to enable the cattails and willows to prosper.

Two additional water diversion projects changed the meadow. Mann Reservoir was constructed upslope on the northwest edge of Docmann meadow. The slopes around the north and east-northeast side of the meadow have traces of canals that used to direct water for irrigation. These projects could effectively catch much of the meteoric water that should flow down toward and through the meadow, but they actually diverted the water around the edge of the valley. The effect from all this drainage alteration is that the meadow gets less water than it naturally (prehistorically) did, and the current flora are a response to increased dryness.

Ken-Caryl Ranch cattle grazing and other ranch activities in this area from about 1913 until 1980 (and grazing beyond) also eventually altered the native vegetation. Cattle selectively eat the taller grasses and forbs, resulting in a cover of shorter grass species that can tolerate trampling. Over-grazed areas become somewhat barren, and dry weedy plants (such as yucca, rabbitbrush, cacti) expand while some of the native perennial grasses are replaced by introduced annual grasses. Cattle grazing and earthen dam building disturbed the local soils, and weeds proliferated. Therefore, the modern weed pollen collected in the cups may not be indicative of prehistoric weed distributions.

There is evidence that the area immediately downslope from the Swallow site and east of the pond had been scraped in historical times. There is an old cattle feed/salt box located in an unnatural-looking depression which slopes uphill when it should naturally slope down toward the pond. This could be from milling cattle killing the vegetation which allowed the wind to blow away the soil. But from the depression's curved configuration, it also appears that a dredger may have scraped out the dirt to use in the earthen pond dam. A cubic, out-of-place probable stone marker is near the margin of this depression. It may have been placed to demarcate between hard rocky soils and the easier-to-scrape soils. Either scenario would produce the poor surface soils upon which the present weed assemblages grow. And all activities would stir up the pollen grains, with the winds blowing them toward the archaeological site. Therefore, the modern weed pollen collected in the cups is probably not indicative of prehistoric weed distributions.

As far as Jefferson County Open Space personnel know, the area has never been tilled. However, the section now within South Valley Park has been hayed, perhaps three or four times in the past ten years (Alichia Doran, Jefferson County Open Space Weed and Pest Manager, personal communication, 2009), further altering the natural vegetation. Comparisons of photographs taken in 1987 with those taken in 2009 show very obvious increases in the growth of riparian flora, such as cattails, sedges, willows, and cottonwoods, in the immediate vicinity of the breached stock pond just west of the Swallow site. The remainder of the area shows little obvious change in genera, but some of the scrub oak thickets appear to be expanding.

Modern Pollen Analyses

Tables 6.1 and 6.2 provide a summation of the identified pollen from the air-sampling cups. The variety identified represents various local and regional environments that are discussed below. Environmental characteristics were abstracted mainly from Mutel and Emerick (1992), Ells (2006), and Weber (1976).

The assumption is that the modern pollen spectra are significant indicators of local and perhaps regional flora growth and environments, and therefore useful for prehistoric interpretations. The modern pollen samples were collected as described under "The Modern Pollen Study Framework" above. Figure 6.1 is the graphed counts for the samples collected from the 10-ft pole. A specific plant has a dominant time to pollinate, and this time period is relatively short compared to the plant's flowering period. Thus, the collected pollen record is fairly indicative of the pollination season. Pollen quantities may vary from year to year for various reasons, but what is important is the overall pattern of change, not individual numbers.

Table 6.1. Identified arboreal pollen – Swallow site area.

Family	Genus	Common Name(s)	Environmental Signature	Prehistoric Potential Use	Comments
Aceraceae	*Acer*	box elder mountain maple	High Plains, Foothills; box elder along streams & in gulches; mt. maple in canyons & scattered on north-facing slopes.	fuel	Some species in area have been introduced as shade trees.
Betulaceae	*Alnus Betula*	alder birch	Foothills, Montane; abundant along stream banks, pond borders; moist soils.	fuel, food, medicine	River birch is the common *Betula* in Rocky Mt. region.
Fagaceae	*Quercus*	oak	Foothills; dense thicket of shrubs & small trees; cool protected crevices of rocky outcrops, dry slopes.	food, attracts wildlife, fuel, medicine	Now only one native species, *Quercus gambelii* (scrub oak); shade trees are introduced.
Oleaceae	*Fraxinus*	ash	Foothills; moist woodsy places & rocky soils, cool ravines, along streams.		Not native to Colorado; escapes from cultivation & often exists as if native.
Pineaceae	*Abies*	fir	Montane, dominates Subalpine; cool NE-facing, well-drained slopes, usually above 9,000 ft.		
	Juniperus	juniper	Plains, Foothills; hot dry open rocky SW-facing slopes & ridges, common in canyons & draws in porous soils, rocky bluffs.	tea, medicine, fiber, fuel	Often grows in clumps with scrub oaks & serviceberry.
	Picea	spruce	Montane, dominates Subalpine; cool NE-facing slopes; groves along streamsides in sheltered canyons of Foothills, rocky soils.		
	Pinus	pine	Dominates Foothills, Montane; warm S & SW- facing slopes, wide variety of soils.	fuel, medicine, pitch	Mainly Ponderosa from the Foothills; Limber or Lodgepole from Montane.
	Pseudotsuga	Douglas fir	Foothills, dominates in Montane; cool moist N & NE-facing slopes and in moist ravines.		
	Tsuga	hemlock	Moist, well-drained soils, rich in organic matter; in areas protected from the wind.		Introduced to Colorado; native to Pacific NW & Appalachians.
Salicaceae	*Populus*	cottonwood	Plains, Foothills; streambanks, flood plains, ditches lower canyons, moist soils.	fuel, dye, medicine	Rooted in subsurface water; grown as a shade tree.
		aspen	Montane to Subalpine; usually needs moisture.		
	Salix	willow	Plains, Foothills, Montane; wet sandy places, streambanks, ditches, canyons, makes thickets	basketry, medicine	Ranges from very tall down to creeping shrubs; may be insect and wind pollinated.
Ulmaceae	*Celtis*	hackberry	Foothills; dry hillsides & rocky places, canyons; often with junipers.	fuel	A native very hardy tree that is often stunted, scrawny, or misshapen.
	Ulmus	elm	Cultivated as a shade tree, wide variety of soils.		Not native to Colorado, but is hardy.

Table 6.2. Identified nonarboreal pollen – Swallow site area.

Family	Genus	Common Name(s)	Environmental Signature	Prehistoric Potential Use	Comments
Apiaceae	various Umbellifers	umbels wild carrot parsley parsnip cowbane, etc.	Plains, Foothills, Montane; widespread weeds of cultivated ground, ditches, streamsides, roadsides, dry shale outcrops.	food, medicine	Some are introduced weeds or have escaped from gardens.
Asteraceae/ Compositae	*Artemisia*	sagebrush	Plains, Foothills, Montane; widespread in arid areas, disturbed soils, over-grazed land, gravelly hillsides.	tea medicine ceremonial	All considered common weeds in late summer, but some are ever present.
	<u>Low-spine</u> *Ambrosia* *Xanthium*	 ragweed cocklebur	Plains, Foothills; roadsides, cultivated ground, vacant lots, disturbed/neglected ground.	food, medicine	
	<u>High-spine</u> *Helianthus* *Chrysothamnus* *Gutierrezia* Liguliflora	 sunflower rabbitbush snakeweed dandelion chicory	Plains, Foothills, Montane; drier areas of meadows, hillsides, over-grazed land, pastures, roadsides.	food, oil, dye, fiber, medicine	
Brassicaceae (Cruciferae)	*Brassica*	wild mustard	Plains, Lower Foothills; marshy places to dry sites, fields, roadsides, waste areas, particularly on shale outcrops.	food, medicine	Common weed of field and roadsides.
Cactaceae	*Opuntia*	cactus (prickly pear)	Plains, Lower Foothills; dry areas, sandy soils, sunny rocky slopes.	food, medicine	Usually pollinated by bees.
Cheno-Ams (Chenopodiaceae Amaranthaceae)	*Chenopodia*	goosefoot R. thistle poverty weed burning bush	Plains, Foothills; gravelly roadsides, disturbed soils, waste/fallow ground, trampled sites, dry areas, or drying mud; quick establishment in barren and waste grounds.	food, medicine, dye	Often an important part of the landscape to help interpret the condition of the land; burning bush may be most abundant weed in Colorado esp. along roads & in waste areas.
	Amaranthus	pigweeds	Plains, Foothills; waste and fallow grounds, disturbed soils.	food, medicine	Common weeds of late summer
Commelinaceae	*Tradescantia*	spiderwort	Lower Foothills; dry rocky slopes.		Very common in spring & early summer.
Cyperaceae	*Carex* *Scirpus* *Eleocharis*	sedge bulrush spike-rush	Plains, Foothills, Montane; moist areas, willow bogs, thickets, streamsides, snowmelt areas, ravines, wet meadows.	food	Grass-like plants, sometimes hard to distinguish from the true grasses.

Table 6.2 (*continued*). Identified nonarboreal pollen – Swallow site area.

Ephedraceae	*Ephedra*	Mormon tea	Foothills; dry areas, rocky hillsides, often with sagebrush and junipers.	food	Mainly in SW Colo., but some seen near site.
Euphorbiaceae	*Euphorbia*	spurge	Plains, Foothills, Montane; rocky hillsides, dry open waste areas, roadsides, pastures.		Very common weed; considered noxious; some introduced.
Leguminosae (Fabaceae)	various genera of beans, peas, legumes	clovers alfalfa, vetch loco-weed liquorice	Plains, Foothills, Montane, Alpine; wide range, along irrigation ditches, sandy streambanks, sand hills, stony alpine meadows, open gravelly hilltops, cultivated fields, pine forests.	food, medicine	Alfalfa & clover can be cultivated, but escape to natural areas and along roadsides.
Gramineae (Poaceae)	various genera	grasses	All ranges and conditions, but especially areas of low rainfall.	food, weaving, attract wildlife	Wild, introduced, & cultivated; cultivated grasses can escape to roadsides and natural areas.
Malvaceae	*Malva*	mallow cheeseweed	Plains, Lower Foothills; dry sandy soils of prairies and sagebrush lands, abundant along roads.	Medicine, ceremonial	Common weeds in lawns and gardens, and in natural areas.
	Sphaeralcea	copper mallow			
Polygonaceae	*Polygonum*	knotweed smartweed	Plains, Foothills, Montane, Subalpine-wide range; wet marshy places, pond borders, mud or wet sand in seepage areas, streamsides, disturbed soils, roads.	food, medicine, tea	Large genera, widely distributed, considered common weeds.
	Rumex	dock sorrel	Sandy areas of roadsides, pond borders, waste and disturbed grounds.		
	Eriogonum	buckwheat	Dry rocky hillsides, rocky meadows, open slopes, sandy plains.		
Primulaceae	*Primula*	Primrose	Plains, Foothills, Alpine; wet meadows, streambanks, bogs, grassy sunny slopes, some in waste lands.	Food	

Table 6.2 (*continued*). Identified nonarboreal pollen – Swallow site area.

Rosaceae	*Cercocarpus*	mountain mahogany	Plains, Foothills, Montane; open dry grassy or rocky slopes, oak stand edges; can form thickets.	medicine, attract wildlife	*Cercocarpus* - wind pollinated
	Prunus	wild plum chokecherry	Plains to Montane; dense thickets in gulches, canyons, along streams, open hillsides, woodland edges, roadsides.	food, medicine	*Prunus* & *Rosa* - insect pollinated
	Rosa	wild rose	Common throughout many environments, in thickets and sunny open areas of woods, meadows, hillsides.	food, medicine	Can grow from plains up to 10,000 ft. elevation
Sparganiaceae	*Sparganium*	bur-reed	Plains, Foothills; borders of ponds and bogs.	attracts animals	
Typhaceae	*Typha*	cat-tails	Plains, Foothills; standing water, pond and lake margins, marshes, swamps, sloughs, irrigation ditches, often in dense colonies.	food, fiber, medicine, attracts wildlife	Important nesting grounds
Urticaceae	*Urtica*	nettle	Plains, Foothills, Montane; wet waste areas, along streams & irrigation ditches, in shade of trees & rocks.	food	

The microscope slides made from the two 1-ft pole samples were studied, but the data were not graphed because the slides were flooded with low-spine Asteraceae and other common weeds for several weeks; these results would indicate that nothing but weeds, especially ragweed, was growing there. The 10-ft pole samples also had significant amounts of ragweed, but not to the same extent. On September 11, 1987, the weeds were very high and draped over the low traps. Also, the low pole to the north had a rattlesnake living under the adjacent rock, making sample collecting problematical for several weeks. In spite of this, attempts were made to statistically compare the short-pole and high-pole data sets. The objective was to determine which genera statistically grouped together, and therefore might be useful in determining environmental changes in the prehistoric record. The high-pole and the low-pole cups empirically have the same pollen genera present. Also, the annual pollen ratios are very close for the "wet to dry" pollen groups, 0.420 for the high pole and 0.385 for the low pole.

Pearson parametric (bell-shaped curves) correlations between genera were made but were not convincing. They lacked tight coefficients for the more common expected pairings and genera having very low counts resulted in correlations with low confidence limits; therefore, the analyses were terminated. Perhaps more definitive evaluations could be made using Spearman nonparametric analyses since the annual genera frequency curves are strongly asymmetrical.

If a vegetation survey of the Swallow site area is undertaken, many more plant species will be observed than those identified in the modern pollen samples. The majority of collected pollen grains are relatively small and light and have been carried by the wind (anemophilous) and thus can be disseminated over a wide area. High arboreals, especially those growing in thick stands of the same species (i.e., ponderosa pine in the Foothills), and nonarboreals growing in large open areas (i.e., sagebrush) are the most efficient with wind pollination. The pollen of plants pollinated by insects (entomophilous) or by birds and animals (zoophilous) is not usually common in the collected samples unless physically dropped in there by these vectors, or the plant is growing extremely close to the collecting cups. Thus, wildflowers and many flowering shrubs and bushes are not usually represented. Plants having flowers with bright colors, a scent, and nectar attract insects for pollination, but flora with none of these characteristics are likely wind pollinated. Because wind pollination is not as efficient as animal and insect pollination, large amounts of pollen must be produced by anemophilous species.

The Flora Environment Zones

The Swallow site, at 5,838 ft (1,780 m) elevation, is located in a vegetation transition zone between the lower (under 6,000 ft) drier Plains and the wetter higher (approx. 6,000-8,000 ft) Foothills zone (Pesman 1975; Nelson 1969). The modern pollen assemblages reflect this intermediary area as well as show some influence from the montane zone (8,000-10,000 ft) beginning approximately 5 mi (8.3 km) to the west. Altitudes are approximate because vegetation growth varies with the topography, aspect of the slope, and soil depths. Thus, there is much overlapping and interfingering of the vegetation. Adding to the vegetation complexity are various genera having species that grow in more than one zone. In addition to the large regional zones, there are several local environments, all of which influence the total composition of the collected pollen.

Modern Pollen Spectra

The modern pollen spectra are diagramed as continuous sampling sawgraphs to show continuity from one collecting period to another; there are no time gaps. Collecting continued during the winter months to show that some pollen is always in the air. The record generally coincides with the wind-pollinated vegetation growing locally and regionally around the Swallow site.

Arboreals

In 1987, arboreal pollination occurred from late winter through early summer with the major peaks in April and May. Identified arboreals were both deciduous (*Acer, Alnus, Betula, Quercus, Fraxinus, Populus, Salix, Celtis, Ulmus*) and coniferous (*Abies, Juniperus, Picea, Pinus, Pseudotsuga, Tsuga*), and all are wind-pollinated. The dominant pollen genera identified are *Pinus* (pine) and *Quercus* (oak). In Figure 6.1, notice the difference in scales of the pine and oak compared to the other arboreal genera.

In the Swallow site area, a few woody species are more similar to shrubs than to trees, but by convention are included under "Arboreals." Willows (*Salix*) and alders (*Alnus*) are actually more like high bushes here in the semi-arid West, and *Betula* is river birch, a bush with many thin main stems (Weber 1976) or it may grow as high as 20 ft (Ells 2006). Growth depends upon receiving sufficient permanent moisture. Likewise, some flora such as *Prunus* (wild plum, wild cherry) often appear tree-like, but conventionally are included as nonarboreals.

Nonarboreals

In 1987, nonarboreals began pollinating in March, with the cool-season grasses (Poaceae), and continued through November, reaching their peak in September. Grass pollination peaked in the summer months, while the other nonarboreals (mainly common weeds) reached their maximum in the fall. As with the pine and oak, some of the nonarboreals have different scales on Figure 6.1 because *Artemisia*, low-spine Asteraceae, Cheno-ams, and Poaceae at times flood the samples.

Local Vegetation Environments

The present environments must be identified and understood in order to understand changes in past environments. The following are the local environments and accompanying vegetation identified by their collected pollen.

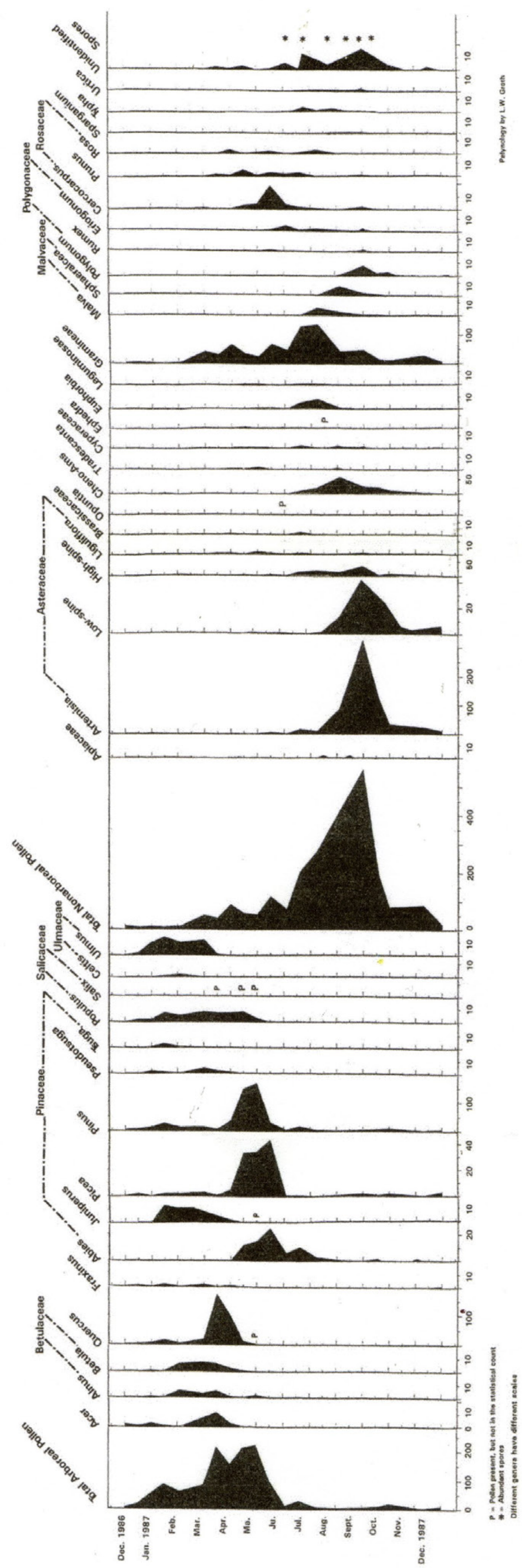

Figure 6.1. Modern pollen spectra from Swallow site (5JF321) vicinity. Data collected from December 1986 through December 1987.

Lyons Sandstone Ridge and Slopes

The west side of the ridge descends toward the Swallow site. The ridge is up to 190 ft high with 15-100% slopes (Price and Amen 1983) and is dry and open with sparse vegetation growing in cracks where shallow soils and water collect. The only arboreals are scrub oaks growing in thickets along the base, scattered junipers on the slopes, and pines on the top. These ponderosa pines have a tap root that can grow 35-40 ft into the rock fissures, and can easily tolerate drought (Mutel and Emerick 1992). A few hackberry trees occur with the junipers, and mountain maple and box elder grow on north-facing slopes of the ravines cutting through the Lyons ridge and the Hogback farther east. Nonarboreals at the base and on the dry slopes include mountain mahogany, cacti, spiderwort, buckwheat, grasses, sage, and various unidentified herbaceous plants growing in rock crevices.

The Meadows

Nonarboreal vegetation dominates the broad open meadows that generally surround the Swallow site area. Significant herbaceous plants are wild grasses, sagebrush, rabbitbrush, Cheno-ams, umbells, sunflowers, low- and high-spine Asteraceae, mallows, buckwheat, and wild mustard. Grasses identified by Price and Amen (1983) are wheatgrass, needlegrass, switchgrass, bluestem, buffalo grass, and blue grama. Blue grama is profuse and is an important component of the meadow environment (Mutel and Emerick 1992). Many nonarboreals release pollen relatively close to the ground, and thus their pollen does not usually blow long distances.

Significant *Artemisia* (sagebrush) pollen was collected in 1987. However, there seems little obvious sagebrush growing in the surrounding area. Alichia Doran (personal communication, 2009) said there had been no sage eradication program for the Open Space area, but that the common sage growing here is *A. frigida* (fringed). This sage is common on the dry sandy/gravelly flats and hillsides but has shoots that are seldom more than a few inches tall, and thus not very noticeable. Two other species (*A. cana* and *A. ludoviciana*) are shrubs that can grow to 3 ft, more characteristic of what we think sage should look like. They are growing somewhat farther away in the foothills, but still can contribute significant windborne pollen to the Swallow site area.

More woody types found here include scrub oak, mountain mahogany, wild plum, wild rose, and chokecherry growing in thickets around the Fountain outcrops in the meadow. The grasses, forbs, and shrubs are important food sources for game animals. The plum, rose, and chokecherry bushes are insect pollinated, but a nominal amount of their pollen was identified in the collection cups. It is suggested that birds sat in these bushes, rubbed pollen onto their feathers, and then alighted on the enticing 10 ft-high pole where the pollen was shaken into the sampling cups. None was identified in the low-cup samples.

Precipitation here is 13 to 16 in (33-41 cm) annually, mainly in the spring, with thunderstorms in the summer sufficient to sustain grasses and forbs, but not enough throughout the growing season to support trees (Price and Amen 1983). Many of the soils surrounding the Swallow site are deep, 60+ in, allowing deep rooting for grasses and forbs to survive seasonal droughts, fires, and grazing animals, all of which can prevent trees and larger shrubs from growing. Local strong winds cause high evaporation rates.

Riparian Areas

Within the meadow and about 90 m downslope from the Swallow site is a very local riparian area consisting of a small pond with an exit ravine extending south-southeast toward Deer Creek (discussed previously under "Changing Local Landscapes"). Shallow ephemeral tributaries flow slowly across the meadow to this pond, resulting in an "island" of riparian vegetation within the dry meadow. Photographs of this area taken in 1987 (when the air samples were collected) show an intact dam, standing water in the pond, one small group of emerging cottonwoods (*Populus*) at the north margin, some scattered cattails (*Typha*), and a few shrubby willows (*Salix*). A variety of riparian nonarboreals, knotweeds (*Polygonum*), reeds (*Sparganium*), sedges and rushes (Cyperaceae), dock (*Rumex*), and various umbells (Apiaceae) was identified.

Photographs taken in 2009 show a raised road and a breached dam. The pond is now a marsh with an extensive cattail community, and another group is growing between the pond and the road. Willow thickets proliferate, and relatively tall cottonwood trees are growing both north and south along the pond margins and in the gulch. Thus, if pollen air samples were collected at present, they should show a change in the numbers and patterns of some local riparian vegetation from those collected in 1987. A relatively large grove of cottonwoods, about 0.4 km northwest of the Swallow site, exists in a wet low area created by the ephemeral tributaries. The water table is probably close to the surface, allowing the large trees to survive during dry months.

Another riparian area is located 0.6 km south of the Swallow site along perennial Deer Creek. Arboreals growing here in the gravelly soils are a mixture of pine, cottonwood, box elder, alder, willow, and a few spruce. Nonarboreals are various grasses and forbs growing sparsely in bunches under the trees and along the creek banks.

Disturbed Soil Areas

Common weeds such as goosefoot, burning bush, thistle (*Chenopodia*), dandelion (*Liguliflora*), pigweed (*Amaranthus*), ragweed (*Ambrosia*), knotweed (*Polygonum*), nettle (*Urtica*), and cocklebur (low-spine Asteraceae) dominate the dry disturbed-soil areas around the excavation site, along the roadsides, and often in areas where cattle have heavily trod and selectively grazed. Their pollen and seeds can be redistributed by grazing livestock and carried on human clothing.

Spores

Spores were observed, but not counted. An asterisk was placed in the sample column of Figure 6.1 when spores were very abundant. Most of these spores appeared in late summer through early fall.

The very small smooth spheroid ones were thought to be from puffballs or other fungi. Some of the trilete spores probably belong to mosses that are growing at the water edges.

Regional Vegetation Environments

As indicated in Figure 6.1, regional vegetation also has an influence on the collected pollen.

Higher Foothills

Still within the Foothills zone, and within sight a few miles to the west, are large stands of Ponderosa pines (*Pinus*) which are contributing significant pollen rain to the Swallow site area. Cooler temperatures and more moisture result in larger and taller trees that are growing closer together than those at lower elevations. Precipitation is higher than down in the meadow area, with 17-22 in common (Watts 1972). On the cooler, more moist north-facing slopes grow spruce (*Picea*) and Douglas fir (*Pseudotsuga*). Alder, willows, cottonwoods, birch, and Colorado blue spruce grow in the riparian environments here. There is an herbaceous understory of forbs, grasses, sedges, and rushes. Other than sagebrush, it is unlikely that many nonarboreals contributed pollen to the collected samples.

Montane Zone

Also contributing to the pollen record are trees growing higher and farther away in the montane zone, out of sight to the west. Precipitation ranges up to 30 in annually (Watts 1972). Douglas fir (*Pseudotsuga*) and Lodgepole pines (*Pinus*) grow here, with spruce (*Picea*) and fir (*Abies*) existing on the coldest slopes.

When assessing pollen significance from local and regional sources, it is important to understand that some genera contribute proportionately more pollen than others. *Pinus* produces enormous amounts of pollen, with their counts being overrepresented in the samples. Therefore, on Figure 6.1, there is a different scale for the *Pinus* (and *Quercus* which also produces large amounts). Their high numbers do not mean the area is covered with a pine-oak forest. Pine pollen has two attached air bladders (bisaccate), making it easily carried great distances by the wind. It is common to see cars, gutters, and pond surfaces in Denver that are yellow with mountain-derived pine pollen. The high mountain and foothills winds are easily responsible for the large numbers of pine pollen at the site. Fir and spruce also have bisaccate morphology and can easily blow in from the Montane zone. Thus, the arboreal pattern shows the regionality of the pollen record at the Swallow site.

Introduced Vegetation

This study is concerned only with native vegetation in order to understand the prehistoric environment. Three arboreal genera identified on the slides are not native to Colorado: *Fraxinus* (ash), *Tsuga* (hemlock), and *Ulmus* (elm). These non-native pollen grains are probably blowing in from the surrounding developed areas, especially during times of frequent strong winds. Only one species of oak, *Quercus gambelii* (scrub oak), is native to Colorado, but other species of oak as well as some species of *Acer* (maple) have been introduced as shade trees. Introduced nonarboreal plants include various species of umbels and spurges. Grasses can be wild, or introduced and cultivated, with some escaping to natural areas; they are all included under Poaceae.

Pollen Records from the Swallow Site Sediments

The pollen counts from the soil samples are found in Figure 6.2 (grid B2S) and Figure 6.5 (grids E3S/E2S). These bar graphs show the sampling was not continuous, but at intervals. See “The Swallow Site Soil Pollen Framework” for the details. The interpretations and conclusions come from the B2S grid data.

Grid B2S - South Wall of the North Half

Soil samples were taken in this grid because it was outside the dripline, and therefore considered to be outside the habitation area, with perhaps less human disturbance of the soil.

Figure 6.2 shows: (a) general soil characteristics, (b) dashed boundary lines between cultural periods, (c) the depth for each sample and its level number, (d) C-14 dates, and (e) the pollen flora identified and counted in each sample.

(a) The samples with the best preservation and highest density of pollen were the fine-grained brown soils. These soils probably accumulated slowly, most likely by eolian processes. In particular, soil samples from -130 cm to -150 cm (L10-L14) were relatively uniform in nature and had comparatively high pollen densities. There was little washing-in of coarse-grained sediments during this time.

The samples with the lowest densities of pollen grains were the medium- to coarse-grained, mainly red/orange soils originating from weathering and erosion of the Fountain formation and from slope wash. These coarse erosion sediments can often build up rapidly with little time for pollen accumulation. Soils with high concentrations of ash and charcoal had few pollen grains to identify. These samples were in close proximity to hearths, and the heat may have destroyed the pollen. Low pollen counts found in some layers could also be attributed to drought which causes plant stress, resulting in decreased pollen production for that time period.

(b) The dashed lines between cultural periods are located at the most probable depths as determined by artifact characteristics. There is no distinct interface between Late Archaic and Middle Archaic. Sampling occurred only into the Upper Early Archaic. The Lower Early Archaic soil was below the rockfall and had not been exposed when sampling took place.

(c) Each sample was surveyed as to its depth (cm) below datum. The level numbers were determined

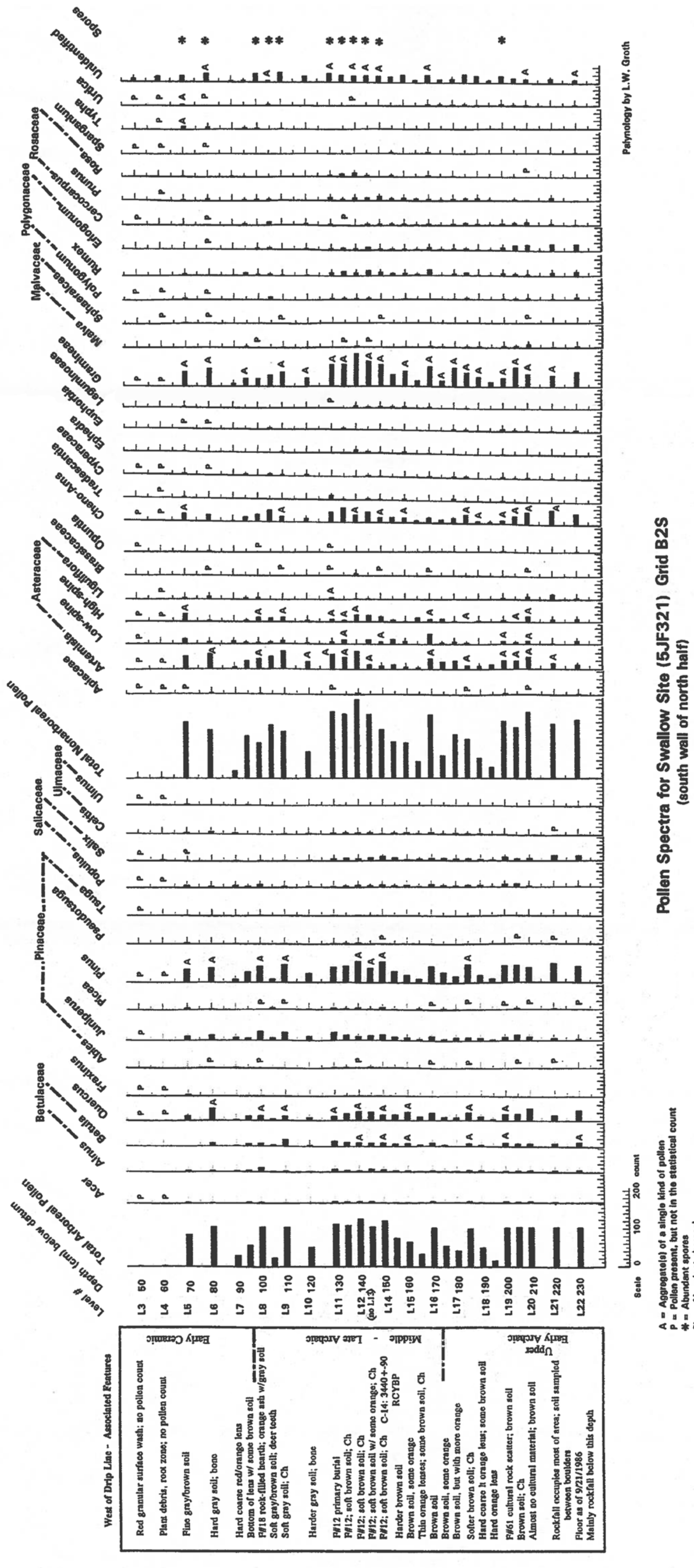

Figure 6.2. Pollen spectra for Swallow site (5JF321) Grid B2S (south wall of north half).

from a master list for the B2S grid. These level numbers do not specifically coincide with the even-numbered sampling depths (i.e., L3 is 57-67 cm; L4 is 67-77 cm, etc.), but were placed as accurately as possible on the diagrams. There is no Level 13 because the burial found at this location was not dug in 10-cm intervals.

(d) The closest C-14 date to the soil sampling column was obtained from charcoal in the primary burial pit in grid B1S and the north half of grid B2S. The date obtained was 3440 ± 90 YBP.

(e) The most noticeable observation is that the flora varieties identified in the modern pollen record also occur in the sediment samples. Since the variety is similar, then the changes or anomalous concentrations of specific genera through the soil column can be studied to interpret changes in past environments and possible prehistoric usage. All identified soil pollen can be put within a local or regional environment, as in the modern study. The identified pollen reflects major vegetation units as well as smaller local communities.

Arboreals

As in the modern samples, *Pinus* (pine) and *Quercus* (oak) dominate the arboreals. As with modern observations, this does not mean that a pine/oak forest covered the Swallow site area. Pine's large pollen production and long-distance transport via airsack suspension make counts high even if the trees grow far away. Oak occurs consistently throughout the section and in numbers only slightly less than those for pine. Oak also tends to be overrepresented in the samples, but the pollen is not transported as far; oak is considered a local tree. Juniper (*Juniperus*), the third dominant in numbers of pollen, occurs consistently throughout the section. It needs the dry conditions of rocky slopes and is probably growing close by. Spruce (*Picea*) occurs in low numbers fairly consistently throughout the section, while fir (*Abies*) is represented sporadically. Both spruce and fir characteristically require higher, colder, and more moist slopes. Douglas fir (*Pseudotsuga*) occurs infrequently throughout the section and also prefers higher cooler slopes. Therefore, spruce, fir, and Douglas fir should be considered regional vegetation from the west, while oak and juniper are local. The pine is mainly regional, but some pollen also represents local scattered trees like those observed today.

Arboreals growing in riparian areas are well represented. Box elder (*Acer*) and cottonwood (*Populus*) pollen are low in numbers but are consistent throughout the section. River birch (*Betula*) is more consistent and in higher numbers from -130 cm (L10) to -230 cm (L22). Box elder and cottonwoods grow along the margins of both quiet and flowing water, while birch is more characteristic of flowing water (Weber 1976). If there was no permanent flowing water in the meadow, then the birch pollen probably came from trees growing along a more distant creek flowing from the foothills. Cottonwoods and birch occurring throughout the section show there has always been sufficient water somewhere in the area. The woody shrub-like trees, willow and alder, also require a riparian environment. Their pollen numbers are also higher and more consistent from -130 cm (L10) to -230 cm (L22).

Three arboreal genera were identified that are not native to Colorado. *Fraxinus* (ash), *Ulmus* (elm), and *Tsuga* (hemlock) were introduced in historic times. The few pollen grains observed are considered lab or site contamination and were not included in the study.

Nonarboreals

Most of the non-arboreal pollen that was identified belong to flora that grow here today under semi-dry to dry conditions. Poaceae (grasses) and *Artemisia* (sage) dominated, and Cheno-ams and low- and high-spine Asteraceae were also prolific. Other dry-land flora were *Opuntia* (cactus), *Tradescantia* (spiderwort), *Euphorbia* (spurge), mallows, *Eriogonum* (buckwheat), and *Cercocarpus* (mountain mahogany). Many grasses and forbs grow low to the ground and release their pollen low to the ground. Therefore, their pollen may not be carried very far by the wind. An example from Figure 6.2 is *Eriogonum*. Some species grow almost flat along the ground (Ells 2006); their pollen is carried only short distances, and thus the plant was growing very close to the Swallow site. However, many grasses, weeds, and sagebrush can grow tall, produce large amounts of pollen, grow in large open areas, and their pollen can be blown easily and relatively far.

Identified plants requiring moist-soil areas were Cyperaceae (sedges), *Polygonum* (knotweeds), *Rumex* (dock), and *Sparganium* (bur-reeds). They did not occur in every horizon but were fairly consistent throughout the column. *Typha* (cattail), occurring only toward the column top, indicates there was not enough standing water or boggy areas in the earlier times to support a dense community of this plant. Other identified nonarboreals, such as the wild mustards, umbels, legumes, and nettles, can often grow in a wide range of conditions. In order for their pollen to be significant in the Swallow site soil, their growing areas were probably close by.

Pollen Data Transformations and Interpretive Plots

The grid B2S raw pollen data were empirically evaluated to determine which data were robust enough to use in prehistoric reconstructions. Pollen counts from the -50 cm (L2) and -60 cm (L3) depths were incomplete and therefore unreliable. Data from -70 cm (L4) to -230 cm (L22) were judged to be usable because of low counts. Count numbers were converted to percentages because total counts varied among the levels.

Although the graphs of Figures 6.2 and 6.5 are the conventional way of showing the pollen history, changes and trends are sometimes difficult to comprehend for so many flora using this format. Statistical-graphic displays of certain genera or groups of like genera present the data in more comprehensible ways. Since *Pinus* pollen tends to overwhelm the statistics, it is more illustrative to compare ratios of other genus pairs so that a more accurate picture of vegetational conditions emerges. Figure 6.3 illustrates a few of the pollen groups and ratios that were studied to summarize trends and changing conditions.

Depth-cumulative-frequency plots were made for each comparison group, the total being the sum

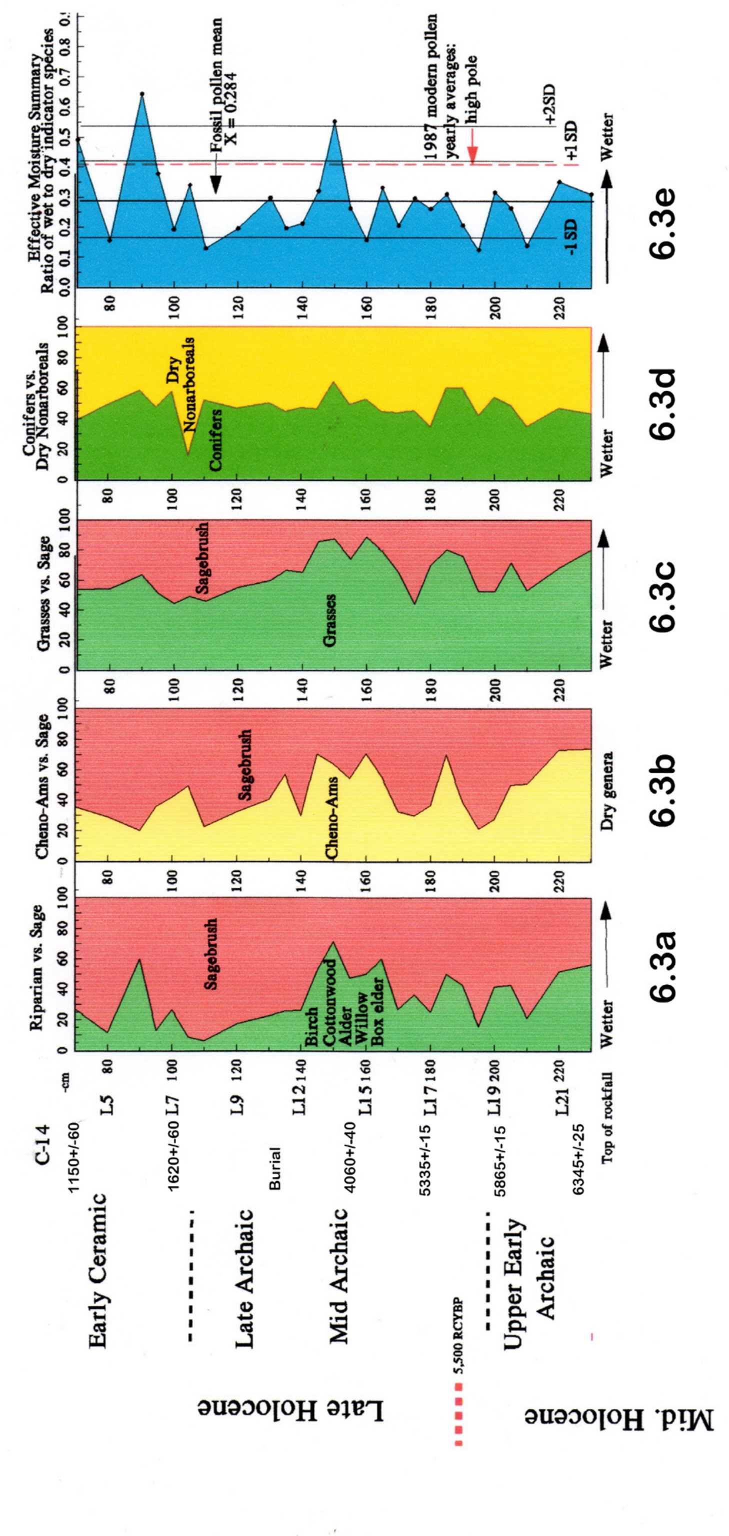

Figure 6.3. Summary of pollen environmental indicators of the Swallow site (5JF321) Grid B2S.

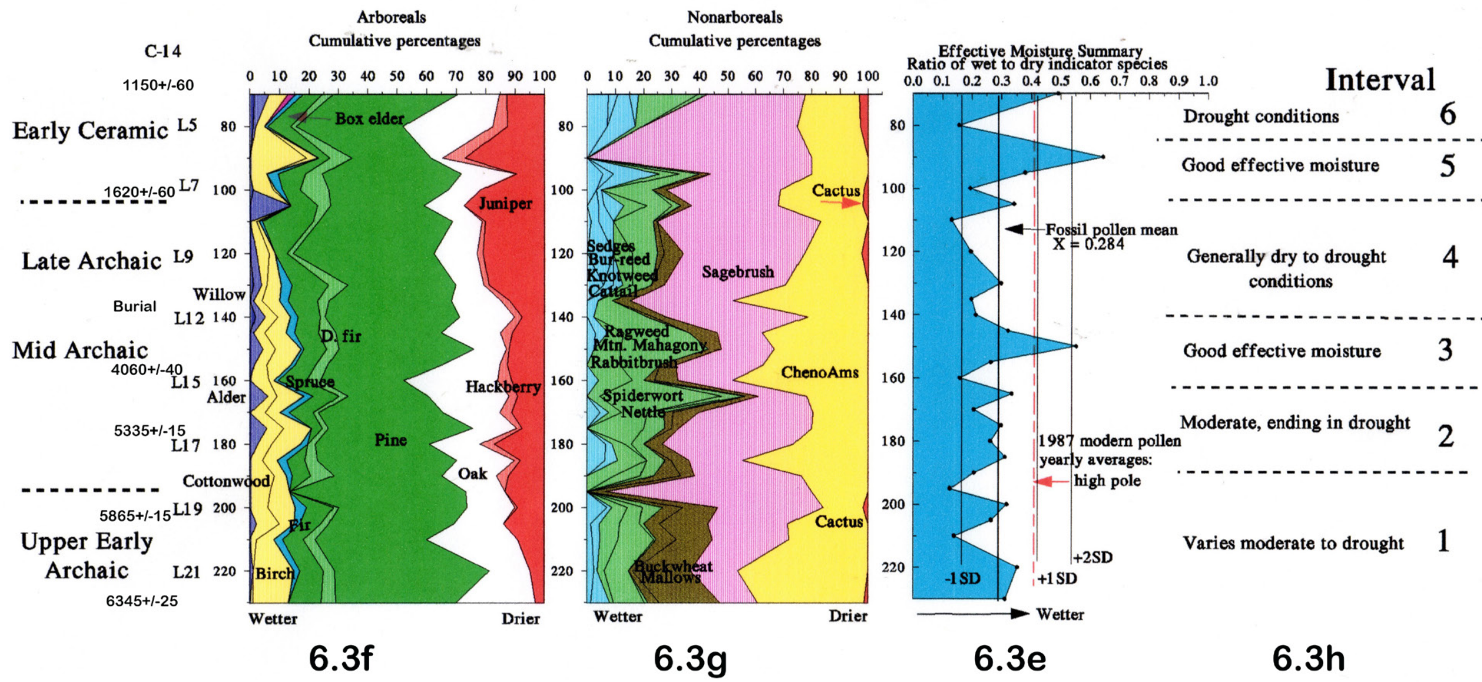

Figure 6.3 (continued). *Summary of pollen environmental indicators of the Swallow site (5JF321) Grid B2S.*

of percentages for individual genera included in the plot. This type of ratio plot eliminates the confusion caused by varying pollen recovery. Ratios are unaffected by changes in the relative frequencies of pollen types that are not included in the ratios. Some of the trends have multi-point curves, suggesting the data are not random.

Pollen Ratio Selections

A large number of dual comparisons were possible, so the pairing of data had to be on a selective basis. Pollen representing flora requiring different moisture conditions were used since they would most likely disclose environmental trends through time. The selected comparisons are summarized in Figure 6.3. All interpretations are only from B2S data, and not from the site as a whole.

Figure 6.3a is a ratio of riparian arboreals to sagebrush. There were large areas of open dry land with sagebrush, but there were nearby riparian environments throughout the time span. From -230 cm (L22) to approximately -140 cm (L12) there was significant stream water as well as shallow or boggy areas for a community of riparian arboreals. From -140 cm (L12) upwards, this community retreated as sagebrush greatly expanded (with one retreat around -90 cm, L6).

Figure 6.3b is a ratio of Cheno-Ams to sagebrush. Both are dry-climate flora, but the Cheno-Ams are considered very local, probably representing weeds in the disturbed soils within the immediate area of the Swallow site, while farther from the site was a large community of sagebrush. The expansion of Cheno-Ams from -170 cm (L16) to -130 cm (L10) perhaps occurred during a time of increased occupancy of the site, representing human soil disturbances and the availability of nutritional plants close to the habitation area.

Figure 6.3c is a ratio of grasses to sagebrush. Grasses require more effective moisture than sage, especially in summer. As grass expands, sage contracts, indicating there is more effective summer moisture (Miller 2004), which also benefits other local nonarboreals. The grass community expanded and contracted irregularly from -230 cm (L22) to -170 cm (L16), and then grasses dominated from -170 cm (L16) to -130 cm (L10). After that a more uniform drying trend began with sagebrush and grasses sharing approximately 50 percent of the pollen rain.

Figure 6.3d is a ratio of conifers to dry nonarboreals. Expanding conifers indicate cooler and more moist conditions. They may grow farther downslope, even growing into the meadow edges. Expanding dry nonarboreals show there was meadow flora requiring warmer temperatures and less effective moisture as the conifers retreated to higher, cooler, wetter elevations. This ratio shows few significant trends, as the mean stays close to the 50 percent line. However, the increasing/decreasing conifer pattern between -210 cm (L20) and -180 cm (L17) somewhat mirrors the grass pattern (Figure 6.3c) and the riparian arboreal pattern (Figure 6.3a) at the same depths, both indicating more effective moisture.

Figure 6.3e is a conclusion wet-dry ratio plot (using count data from Figures 6.3a - 6.3g) designed to summarize the effective soil wetness (and thus indirectly the climate) of the Hogback valley through prehistory. The curve is the ratios of select wet and dry groups of fossil pollen. It has been duplicated on both Figure 6.3 pages for easier comparisons and comprehension.

The selected "wet" genera needing more effective moisture are *Acer* (box elder), *Alnus* (alder), *Betula* (birch), *Salix* (willow), Cyperaceae (sedges and rushes), *Sparganum* (bur-reed), *Typha* (cattail), and *Polygonium* (knotweeds). The selected "dry" genera needing less effective moisture, genera considered to have a wide latitude of edaphic/moisture variations, were not included. Spruce and fir, growing mainly in the higher foothills and mountains, were not included because they do not represent local conditions. Pine, ragweed, and sagebrush were not used because their prolific pollen production would mask subtle changes by the other less-prodigious genera.

Statistical Evaluation of the Wet/Dry Ratio

What is the statistical data robustness of the fossil wet-dry ratios? The following diagrams show the standard deviations of the wet/dry ratio that were used to justify the major proposed paleoenvironmental oscillations. In Figure 6.4a, the heavier black line is the mean (X = 0.284) of all the Swallow site soil pollen ratios. Thinner black lines show -1, +1, and +2 degrees of standard deviation (SD) from the mean. Two oscillations reach or exceed +2SD. These excursions are judged to be quite significant major environmental effective-moisture events, especially since the data event trends have multiple points incrementally continuing in the progression and regression of the data excursions. Another less conclusive event at 20 cm depth is partial and based on one sample. Unfortunately, shallower samples were not taken (disturbed soil) so that the trend might be confirmed. Data positioned near +1SD are also considered the reliable indicators of more effective wetness. Data points falling to -1SD are considered to be drier, or drought, indicators.

How do the pollen-suggested environments compare to present day conditions? Figure 6.4b compares the mean modern annual pollen wet/dry genera data ratios for the high and low collection poles. It is apparent that the climate proxy by fossil pollen was generally significantly drier, yet intermittently, wetter through sampled history than the modern pollen collection year 1987. Note: these very local conditions should not be extrapolated to the regional climate. (More than the 28 data points would permit better confidence determination.)

Overall, Figures 6.3e and 6.3h are judged to be reasonably valid to interpret changing wet-dry conditions in the local area. At the least, they are a reasonably good non-empiric evaluation and comparison for deciphering past local conditions relative to current moisture conditions.

Figures 6.3f and 6.3g are depth/cumulative percentage plots that have the pollen genera arranged in a generalized order of increasing need for effective moisture by the parent plants. This format is a schematic way of showing expanding and contracting relationships among various flora. The ordering is somewhat subjective because different species of a genus can adapt to different conditions, but the ordering is based upon present situations. The Figure 6.3f plot compares

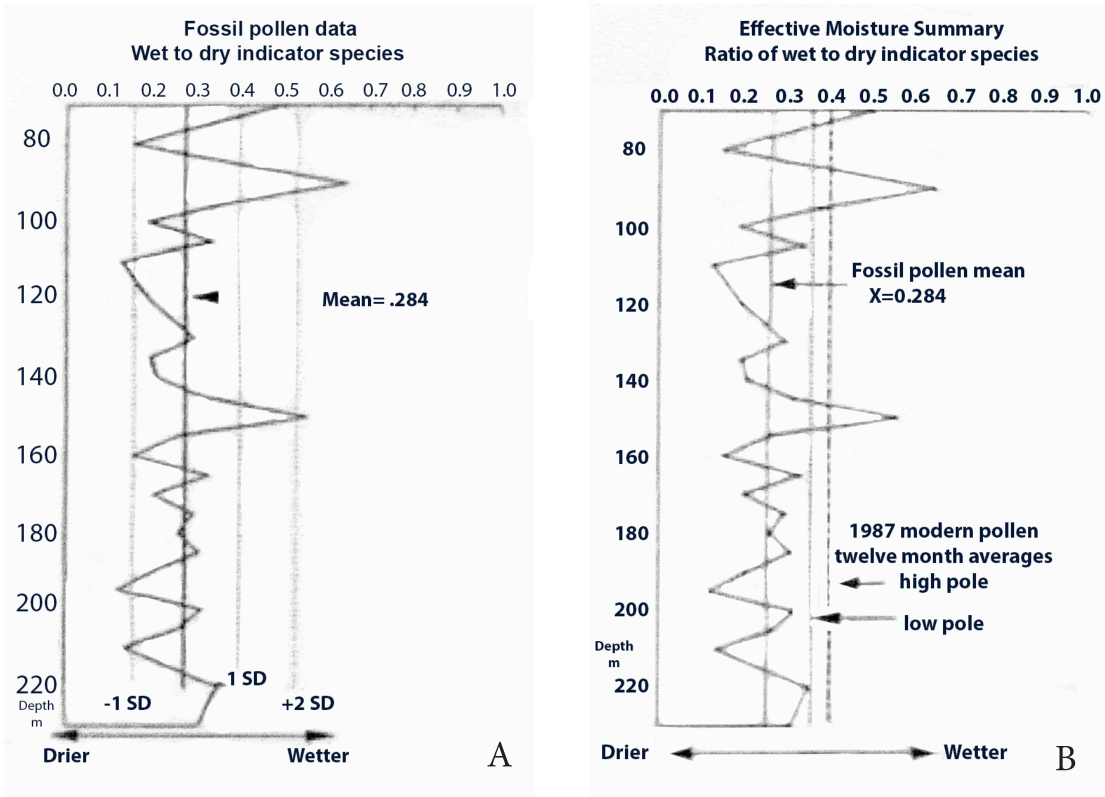

Figure 6.4. Diagrams showing the standard deviations of the wet/dry ratio that were used to justify the major proposed paleoenvironmental oscillations.

arboreals. Trees representing the riparian environment are on the far left and those representing the dry slopes are on the far right. This graphic plot generally indicates the expansion and contraction of streams, marshes, and ponds, and/or the rising and lowering of the water table. The Figure 6.3g plot compares the nonarboreals. The driest genera on the right need the least amount of effective moisture. The nonarboreals requiring standing water or boggy areas are on the left.

Statistical Environmental Deductions

Next, the prehistory data are compared to the vegetation of the present; 1987 is assumed to be representative of "the present." Figure 6.3h is the graph of the fossil wet-dry genera ratios, a summarized indication of environmental trends inferred from the preceding plots in Figures 6.3a -6.3 g. The median fossil ratio is augmented with the medians for the 1987 yearly ratio means of the high and low pollen traps. The modern pollen collection year of 1987 was considered an average to slightly above average year for moisture (Climate-Charts.com 2024). The Swallow site fossil pollen mean falls below the modern pollen yearly mean. If 1987 rainfall data generally represent recent times, then the studied prehistoric interval appears overall to be relatively drier than the present. However, several points come close to or significantly surpass the 1987 yearly averages, indicating wetter period exceptions to the overall drier prehistoric. Keep in mind that these data represent just a small section of sediment, probably penetrating only into the latter part of the Middle Holocene.

The Hogback valley is a relatively small transitional protected area in the Rocky Mountain foothills. The following speculations are constructed mainly within the context of the immediate Docmann meadow/Swallow site area. Local past conditions should not be extrapolated to regional environmental/climatic changes. Conifers of the montane region are described only if they aid in substantiating details for the Swallow site area. Little is said about *Pinus* because it does not occupy a selective place in the immediate area; it grows in a variety of soils and can survive in a range of effective moisture regimes.

There are several ways to interpret the same data set. There is no one criterion to use, and thus data obtain significance only in context with other data. The "whole flora picture" must be taken into account, not just isolated genera. The Figure 6.3h commentary summarizes the pollen trends seen in Figures 6.3a-6.3g. These statistical trends permit comparisons to present (1987) conditions by using the mean and standard deviations. This method eliminates guessing about which data points are significant. Based on this procedure, Figures 6.3a - 6.3h suggest several environmental trends. Many detailed changes among genera could be discussed, but the overall picture is one of longer drier intervals (moderate to very dry) separated by two shorter wetter intervals. Points scattered around the mean are interpreted as moderate conditions, perhaps somewhat drier than today when compared to the line indicating 1987 yearly averages. The Figure 6.3e points trending toward -1 degree SD indicate drier conditions, and points trending toward +1 degree SD are wetter, and up to +2 degrees SD are considered quite wet, a condition that does not frequently occur here. Environments with increased effective moisture result in landscape stability and increased soil development due to denser vegetation cover, and by the trapping and retention of sediments by the denser plant cover. Low effective moisture results in sparse vegetative cover and blowing topsoil.

Interval #1

Alternating drier/wetter stages are indicated. This interval (-230 cm to -190 cm; L22 - L18) began with an average amount of effective moisture (points above the mean) and then progressed to increasing dryness, except with a wetter interval around -200 cm (L19). There are two points that drop to -1 degree SD indicating a significant drying trend. These Interval #1 conditions are speculative because there are no data below -230 cm (L22) to permit observing a longer trend, and the lowest sample was taken from a soil pocket in the top of the rockfall and may not be legitimate.

There were substantial grasses, but sage expanded as well as other drier nonarboreals such as buckwheat, mallows, and the Cheno-ams. Local arboreals show juniper was on a rising trend, and oak began a general expansion. There was a sufficient riparian environment for the growth of cottonwood, birch, and willow, indicating adequate stream flow, or the water table was close to the surface in certain areas.

Interval #1 generally corresponds to part of the Upper Early Archaic which is within the Middle Holocene. The Middle Holocene is often called the Altithermal, a time of significantly warmer and drier conditions than in the Early or Late Holocene in western North America. Doerner (2007) contradicts this scenario, indicating the Early Holocene was actually warmer. Sage, the drier grasses, and the Cheno-am communities expanded. The two low points at -210 cm (L20) and -195 cm (L18) appear to represent very dry times, but the wet spike between them at -200 cm (L19) is more difficult to explain. Benedict and Olson (1978) published data supporting a two-drought model for the Altithermal in the foothills and mountain areas of the Rocky Mountain region. Their earliest dry time was 7000-6500 RCYBP; the later dry time was 6000-5500 RCYBP. They thought the 500 years in between represented environmental conditions much like the present (see also Benedict 1979). This might be similar to Figure 6.3e which shows the wet data spike, at -200 cm (L19), as approaching the 1987 yearly pollen averages. Carbon-14 dating at Swallow site confirms that a late Altithermal period is present from approximately 6345 to 5865 RCYBP. However, without more closely spaced sampling from -190 cm (L18) down through -220 cm (L21) and lower, it is only speculation to believe the 6 samples represent conclusive Altithermal changes and conditions. At the Dutch Creek site 3 mi (4.8 km) north-northwest of the Swallow site, Gilmore (1989) found a fine-grained deposit he identified as dating from the Altithermal period. His time boundaries for it were 7300 to 5300 RCYBP, but no palynology was conducted on this deposit.

The Altithermal seems to be a generalized concept for a wide geographic area. Locally there should have been considerable plant variations due to elevation, slope aspect, wind direction, and permanent water. This is especially true for a relatively small, protected locale such as the Hogback valley. It is possible that the Upper Early Archaic Swallow site pollen interval represents a local deviation of the regional Altithermal.

Doerner (2007: Figure 1.6, p. 30) published a figure showing cultural-chronological periods correlated with paleoenvironmental reconstructions for the Colorado Front Range. It may be possible to project the Swallow site's local vegetational intervals into Doerner's regional reconstructions to look for commonality. His interval from 8000 to 5000 RCYBP (Middle Holocene) indicates warmer and drier conditions than the present, and these conditions continue through the Late Early Archaic. This generally corresponds to Swallow site's pollen record up to -160 cm (up to L15; Intervals #1 and #2) which shows warmer and drier conditions than the present and includes the Upper Early Archaic into the Middle Archaic.

Interval #2

After the alternating wetter/drier stages of Interval #1, there began an interval from -190 cm (L18) up to -160 cm (L15) of more uniform effective moisture, but still dry compared to the present. This correlates well with Doerner's continuing warmer/dry period to 5000 RCYBP. Interval #2 is defined by two end points at -1 SD. There are 6 points that are close to or just above the mean. Grasses expanded while sage and many other dry nonarboreals, such as mallows, buckwheat, mountain mahogany, and rabbitbrush, declined. In contrast to this decline, dry Cheno-ams expanded. This may have been in response to the better (moister) environment, resulting in more people, and therefore more soil disturbance immediately around the Swallow site. Increasing effective moisture is signaled by increasing percentages of arboreal cottonwood, willow, and birch, and nonarboreal sedges, bur-reed, knotweed, and cattails, indicating greater stream flow and expanding marshy areas. In the montane zone, spruce and fir were more in evidence, perhaps signaling increased snowpack and therefore higher stream flow near Swallow site that allowed the expansion of the riparian arboreals. On dry slopes, hackberry became more established. By the end of this time, there was a short-interval dry period with a SD of -1 during which oak peaked.

Interval #2 began during the early part of the Middle Archaic cultural stage and close to the Middle Holocene - Late Holocene boundary (accepted variously as 5500-4500 RCYBP) and continued into the later part of the Middle Archaic.

Interval #3

This appears to be a shorter interval (-160 cm, L15 to -145 cm, L12) but with multi-points, making it a legitimate environmental change. The wet/dry ratio goes from -1 degree SD at -160 cm (L15) and extends up to +2 degrees SD at -150 cm (L14), and then falls just below the mean at -145 cm (L12). This was a period of decidedly more effective moisture. Grasses expanded with sustained high counts, while sage communities retreated further. Riparian arboreal and nonarboreal flora thrived. Scrub oak, although usually considered a drier species, increased with increasing precipitation. Some of the drier nonarboreals did well with more moisture, the dry Cheno-ams flourishing perhaps due to increased human use of the area and thus more soil disturbances.

There were high pollen densities, indicating good environmental conditions and vegetation that was not under stress. A stable landscape with little erosion is indicated by brown fine-grained soil development and insignificant coarse sediments. The fields were probably covered with grasses and forbs. There was significant permanent water for riparian growth. Thus, it seems like an ideal period for winter (and summer) large elk and deer herds, concomitant with increased use of the area by prehistoric peoples. More charcoal observed in the palynology soil samples at these horizons may also indicate more frequent human occupation of the Hogback valley sites because of the beneficial floral and faunal conditions. This time of high effective moisture may correspond to the Middle Archaic, although the Middle Archaic-Late Archaic boundary has not been differentiated at the Swallow site.

Doerner's (2007) interval from 5000 to 3000 RCYBP shows a cooling period with the treeline extending downward throughout the Middle Archaic. This may correspond to Swallow site's interpreted wetter period, Interval #3, from -160 cm (L15) to -140 cm (L12) of the Middle Archaic.

Interval #4

A relatively long period of dryness began as the curve descends below the mean in the interval between -140 cm (L12) and -100 cm (L7). In the beginning, a moderate climate continued from the optimum environment in Interval #3, but then became much drier. The wet-dry ratio is commonly below the mean, and at -110 cm (L8) drops below -1 SD before beginning to rise again. As conditions became drier, juniper and sagebrush made substantial comebacks at the expense of grass cover and other more moisture-dependent nonarboreals. Grasses made a long, steady decline. Junipers steadily rose to a high point at -105 cm (L7). Riparian arboreals declined dramatically, indicating low stream flow and/or a drop in the water table. Montane conifers, especially spruce, either declined in numbers or became stressed enough to produce less pollen. Fir changed very little which may indicate the higher colder slopes had adequate moisture/snowpack, but this moisture apparently did not extend to lower elevations as suggested by the reduced riparian pollen. This interval may be wholly in the Late Archaic.

Doerner's (2007) time period from 3100 to 1500 RCYBP of the Late Archaic was warmer and drier again. Swallow site's interval of generally dry conditions (#4) from -140 cm (L12) to -110 cm (L8) may be in the Late Archaic also.

Interval #5

Statistics suggest another wet interval (-100 cm to -80 cm; L7-L5) between drought periods. Multi-plot points show the wet-dry ratio surpasses +2 degrees SD. This period had some fine-grained brown soil development, but there were also some hard coarse red lenses which indicate erosion from the Fountain outcrop due to intermittent heavy precipitation. (This may represent a time hiatus created by major erosion.) Grasses made a moderate spike as more effective moisture became available. Riparian willow, birch, and cottonwood showed resurgence as stream flows increased and the water table rose. Fir tree counts indicate adequate moisture in the montane, and spruce tree counts had already begun rising at the end of Interval #4. It appears likely that Interval #5 began at the Late Archaic/Early Ceramic transition.

Doerner (2007) interprets relatively modern conditions prevailing from 1500 RCYBP onward through the Late Ceramic, indicating cooling and forest thinning followed by warming and tree invasion. Swallow site records a wetter interval (#5) during Doerner's cooling time. This is similar to the wetter Interval #3 at Swallow site when it apparently corresponded to Doerner's cooler period.

Interval #6

In this period from -80 cm (L5) to -70 cm (L4), the SD drops to -1. Conditions again became very dry. Sage expanded with respect to riparian flora and grasses, and then was replaced by mountain mahogany and rabbitbrush. Grasses declined. Riparian arboreals declined, but riparian nonarboreals expanded. This suggests low stream flows for the trees, but perhaps the existence of springs with natural water-collecting small depressions in the nearby meadow led to the increased growth of sedges, bur-reeds, and other riparian nonarboreals.

Interval #6 ends with a wet spike beginning at about -75 cm (L4) and extending to almost +2 degrees SD. This spike is only one point with no data above it to indicate a legitimate long-term change. But Interval #6 had to be set off from Interval #5 because of the -1 SD at -80 cm (L5) but may not be an adequately interpreted interval. Doerner (2007) shows a regional warming time but not drought.

The interval of -70 cm (L4) to -30 cm (surface; L1) was not sampled. Clean proper sampling in the crumbling wall was not possible; any data would probably be compromised by contamination from previous excavation activities.

In intervals #1-6 there is a significant amount of riparian pollen throughout the soil samples. Although there is no geomorphic evidence that a substantial stream channel ever existed in the meadow around the Swallow site, there still could have been a riparian area nearby. Cottonwoods and other riparian arboreals just need a water table close enough to the surface for their roots to reach. There may have been some natural depressions in the meadow that collected melting snow in spring and rainwater from thunderstorms in summer, consistent enough to keep riparian-type flora alive. This appears to be the present condition, with water just below the surface resulting in some soggy grass and forb areas, and in the grove of cottonwoods and willows just to the northwest of the Swallow site. Water disappears underground at some places, indicating the porous nature of the sediments.

Grids E3/E2S

Physical Characteristics

The soil was sampled from -30 cm (L3) to -80 cm (L8) in Grid E3S, and then from -100 cm (L10) to -170 cm (L17) in Grid E2S in order to get a continuous section (Figure 6.5). The bottom E3S sample was separated from the top E2S sample by 20 cm of a small coarse alluvial flow which appeared to wash toward a fire pit. These grids were within the habitation area under the outcrop overhang (east of the dripline). It was suggested that this would be a good area to look for prehistoric plant usage, and to perhaps place some features (such as hearths) within the pollen spectra intervals.

In retrospect, this was not a good location to sample because of physical factors that resulted in low pollen densities. The sampling columns were too close to the Fountain outcrop. Weathering and erosion from the rock face resulted in adjacent soil horizons that were often unsorted coarse red/orange sediments, and there was also unsorted sheetwash flowing in from upslope. This location resulted in too many coarse porous layers subject to descending meteoric waters intermixing the various horizons. There was also a significant amount of ash and charcoal from many nearby hearths and ash pits, the heat from which oxidized the pollen grains making them impossible to identify. In this environment, differential preservation of the pollen grains probably occurred. Also, rodents burrowed near the rock face because of looser and warmer soils. Human activities

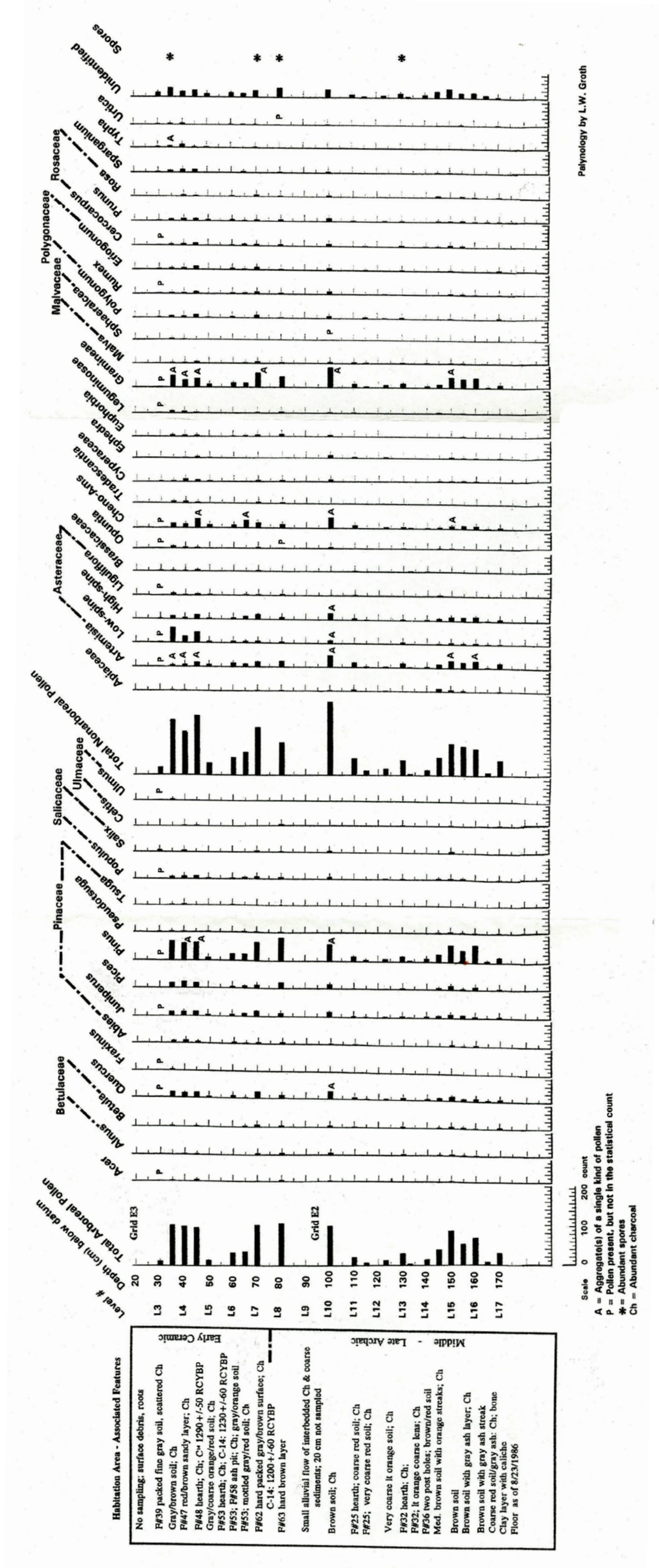

Figure 6.5. Pollen spectra for Swallow site (5JF321) Grids E3/E2S.

also would have intermixed the soil horizons. As of July 11, 2006, five occupation loci had been identified in various levels in E3/E2S. Because of these factors, the three C-14 dates available for charcoal in E3/E2S are inverted and cannot be confidently used with the pollen profile, although they collectively give a general date:

- L5 = Feature #48 (hearth): 1290 +/- 50 RCYBP (calibrated 665-775 AD), 46 cm deep
- L6 = Feature #53 (hearth): 1230 +/- 60 RCYBP (calibrated 685-885 AD), 55-65 cm deep
- L7 = Feature #62 (charcoal in hard-packed surface): 1200 +/- 60 RCYBP (calibrated 705-945 AD), 65-70 cm deep

Artifact characteristics indicate the pollen soil sampling began in the Early Ceramic and ended in the Middle-Late Archaic period.

Figure 6.5 Discussion

In spite of poor preservation in some soils, there were several horizons having adequate pollen counts. As in grid B2S, the pollen rain was dominated by *Pinus* (pine), with local *Quercus* (oak) and *Juniperus* (juniper) also significant. Lower percentages of *Picea* (spruce) and *Abies* (fir) represent the higher cooler montane forests. Riparian arboreal pollen from *Alnus* (alder), *Betula* (birch), and *Populus* (cottonwood) are low in number, but generally consistent throughout the section. The dominant nonarboreals, Poaceae (grasses), Cheno-ams, *Artemesia* (sagebrush), and Asteraceae, are generally steady throughout the sampling. Riparian nonarboreals, Cyperaceae (sedges, rushes), *Polygonum* (knotweeds), *Rumex* (dock), and *Sparganium* (bur-reeds), are in higher and more consistent numbers only from -100 cm (L10) to -35 cm (L3), and *Typha* (cattails) is only in obvious numbers at the very top of the column. The upper samples show a larger percentage of weeds (members of sunflower and mustard families, *Erodium*, Cheno-ams, and dandelion), perhaps indicating greater human soil disturbance in this very localized area.

No attempt was made to study Grids E3/E2S with ratio interpretative plots because too much of the collected data signified a stratigraphically disturbed, biased picture of the natural pollen rain, as discussed previously. However, pollen percentages from -160 cm (L16) to -145 cm (L14) in grid E2S compare favorably with those from similar depths below datum in grid B2S. These samples occur in the interval of the postulated favorable environment which had significant moisture and a denser vegetative cover.

Plant Usage

The pollen genera identified in the soil samples indicate there were ample local plant foods available (Tables 6.1 and 6.2), as well as many other flora that could be useful for crafts, medicines, dyes, and construction. The grasses, forbs, and riparian nonarboreals attracted game animals. For a comprehensive review of local prehistoric plant usage, see Cummings and Moutoux (1997) and Lyons (1997). The Swallow site pollen record shows no anomalous counts which might indicate specific plants were definitely utilized here. Remember that some plants frequently used by prehistoric people are not wind pollinated. Common examples in this area are yucca, pollinated by moths; gourd family, pollinated by bees; and skunkbrush, pollinated by small mammals. This archaeological site is very small when considering the areal extent of the vegetation producing the pollen rain, and thus it is difficult to identify changes in the pollen record that are specifically caused by humans.

Pollen from some nonarboreals have short transport distances, and thus either grow very locally or are carried onto the site by humans, birds, or animals. There were some significant occurrences of *Prunus* and *Rosa* pollen in both Grids B2S and E3/E2S. This seems somewhat unusual because wild plum, chokecherry, and rose are pollinated by insects. These genera were also identified in the modern samples with their occurrences attributed to birds. *Prunus* and *Rosa* pollen would have had to be transported to the Swallow site by something other than the wind. *Opuntia* (cactus), also insect-pollinated and recorded in the data, could have been accidentally carried to the site by animal fur and human feet, or intentionally for food.

Comparisons with Nearby Sites

Palynology reports have been published for two nearby sites, Massey Draw (Cummings 1994) and Crescent Site (Cummings and Moutoux 1997).

Massey Draw Site

The Massey Draw site is approximately 1.5 mi (2.4 km) north-northeast of the Swallow site and is located on the east side of the Dakota Hogback. The site has a soil column dating from Paleoindian (8620±120 RCYBP) to the present, and another column beginning in the Early Archaic (6440±110 RCYBP). The Swallow site soil samples are within the Massey Draw site cultural intervals.

The Massey Draw samples are dominated by nonarboreals, especially high frequencies of Cheno-ams in the lower levels, and *Artemisia* and high-spine Asteraceae in the upper levels. The only significant arboreal is *Pinus*. The climate was interpreted as very warm and dry in the Early Archaic, probably representing Altithermal conditions. More mesic conditions occurred in the upper levels. In comparison, the Swallow site did not have such dominant Cheno-ams and Asteraceae in the lower levels but had higher percentages of grasses (Poaceae). Although *Pinus* pollen was highest in numbers, there was a much more varied population of arboreal vegetation recorded.

These contrasts are probably because the Massey Draw site has an eastern and more arid (prairie) aspect and was protected from the west by the Dakota Hogback. The Swallow site has a western and less arid aspect (meadows, foothills, and mountains) and is exposed to winds blowing pollen from higher elevations as well as from a more varied local environment.

At the Massey Draw site, Anderson and others (1994) concluded that there were two primary periods of occupation: from 6440-6150 RCYBP during the Early Archaic, and from 2930-1960 RCYBP during the Late Archaic. The latter interval was the most intensely occupied. At the Swallow site, this interval would probably fall somewhere between -140 cm (L12) and -100 cm (L7) depths, apparently a time of a generally drier environment. The conditions for the Early Archaic interval varied but were often moderate to very dry. It is logical that both people and animals would congregate near a water source such as Massey Draw site during dry times.

Crescent Site

The Crescent site is 250 yd (230 m) south of the Swallow site. Environmentally, its close location and its western aspect should make it a more valid site to compare the pollen spectra.

The Crescent samples were recorded as beginning in the Altithermal during the Early Archaic and continuing through historic times (Cummings and Moutoux 1997). Thus, the Swallow site interval (from grid B2S) can be reasonably placed within the Crescent interval. The vertical succession of the pollen record should be the same, assuming soil horizons were not grossly disturbed, removed, or if meteoric water oxidation differentially removed various genera. However, there were several differences in sampling, analyses, and data recording between the two sites. These differences precluded a valid inter-site statistical comparison of most individual and grouped pollen data.

Review, Conclusions, Speculations, Recommendations

Both the modern pollen rain and the prehistoric soil pollen reflect the transitional nature of the local vegetation at the Swallow site between the Plains and Foothills climatic zones. There is also regional influence from genera wind-carried from the montane zone.

Comparison of the 1987 modern pollen spectra with those of the soil columns indicates that the vegetation of prehistoric times was very similar to the vegetation of today. Swallow site samples show the same variety as the modern pollen assemblages, but percentages changed through time. The climate did not change enough to cause any of the major taxa to completely disappear, or to completely dominate.

The past and present local flora genera are comparable, but historic hydraulic/diversion projects, cattle grazing, and haying may have changed the species growing there, and introduced non-native species. However, in this study the pollen was identified only to the genus level.

The B2S grid was outside of the rock overhang (outside the habitation area); the E3/E2S grids were under the overhang (within the habitation area), and close to the rock face. The B2S pollen record was used for interpretation because it had fewer human/animal activity disturbances (i.e., hearth, ash pits, rodent holes), less charcoal, more horizons of brown fine-grained soils, less coarse red soils, and thus had higher pollen densities and better preservation.

The E3/E2S soil profile yielded pollen data unacceptable for environmental reconstruction. Few samples had sufficient numbers of preserved pollen, obfuscating charcoal was common, soils were often oxidized, and there was more disturbance by rodents and humans.

Comparing ratios of selected indicator taxa from B2S determined if they were expanding or contracting as the available moisture varied. An "Effective Moisture Summary" index was devised. It shows that the soil pollen assemblages generally represent drier overall conditions than the 1987 modern pollen base case.

The nonarboreals were more significant in determining environmental changes than the arboreals. The expansion and contraction of grasses, with respect to sage, was significant and was indicative of increasing effective moisture.

The B2S pollen data show trends through time. Six periods of local environmental conditions are proposed. These local periods correspond in a general way to Doerner's (2007) regional climate reconstructions for the Colorado Front Range from the Later Early Archaic into the Early Ceramic periods.

Most vegetation changes were probably small scale in the Hogback valley vicinity. However, the statistical studies show two major intervals with significant effective moisture increases among the several longer and drier intervals. One wetter interval was in the Middle Archaic, and the other apparently at the Late Archaic/Early Ceramic transition.

There is no geomorphic evidence indicating that a permanent stream cut a major channel through the meadow with enough water to keep genera such as *Betula* (river birch) and *Populus* (cottonwood) continually alive over the valley bottom. However, the pollen of riparian vegetation occurs throughout the soil section. It is suggested that shallow depressions often had sufficient water to keep nonarboreals flourishing. Permanent flowing water may have been located farther away for the arboreals, or a large depression had a high water table as can be seen nearby today.

There were plenty of plant resources available for prehistoric use. There were no anomalously high counts of pollen from any one taxum to indicate the plant might have been gathered, brought to the site, and extensively used by prehistoric peoples. However, some plants were obviously carried onto the site by some agent because their pollen is not distributed by the wind.

A Swallow site to Crescent site correlation might be possible using grass versus sagebrush ratios with close interval sampling and is proposed for future study.

A prehistoric/historic climate record for the Hogback valley would be more valid and of longer record if a continuous sediment core was drilled (not augered) somewhere in the meadow, far from human disturbances, in a location with deep sediment deposits, and in a location that has had little chance of significant erosion. The fossil pollen results should then be studied in combination with other methods such as dendrochronology, hydrology, and sedimentology which can influence and strengthen the pollen record.

Future excavations in the area should include detailed study and recording of geologic stratigraphic clues for correlating time between grids. These might be traceable area-wide charcoal levels (forest fires), ash falls (volcanism), and oxidation rimes (areal exposure).

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7 Features

Jeannette L. Mobley-Tanaka

A total of 135 features was recorded at Swallow site, associated with all levels of occupation. Features included a variety of hearths, pits, artifact concentrations, and surfaces, as well as two burials and a possible structure.

Changes in both the frequency and types of features were observed in the Middle Archaic and again in the Early Ceramic levels, suggesting a change in subsistence practices and/or technologies. In addition, two primary activity loci were evident throughout the Archaic occupation, in the northern and southern portions of the site. Differences in the types of features in each area and in the associated artifacts and debris indicate a long-term use of the southern area for food preparation while the northern area was likely a shelter or sleeping area.

In this chapter, the types of features found will be discussed, followed by an analysis of change through time at the site. Finally, the two major feature clusters and the activities represented by the features within those clusters will be discussed.

Feature Types

Eight major types of features were recorded at the site. These are hearths, surfaces, pits, artifact concentrations, postholes, burials, a storage bin, and an enigmatic feature that may represent the remains of a structure (Table 7.1). In addition, there were a number of rock scatters, which are not discrete features *per se*, and will be included with hearths in the descriptions and discussion that follows. Details of individual features can be found in Appendix A.

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Table 7.1. Features

Type	Number
Hearths	61
Rock Scatters	21
Surfaces	32
Pits	7
Artifact Concentrations	7
Postholes	3
Burials	2
Storage Bin	1
Possible Structure	1

Hearths

Hearths are the most common type of feature found at Swallow site and are present in every time period. Sixty-one clearly definable hearths were found, accounting for 45 percent of all features. An additional 21 scatters of rock, charcoal, and stained soil probably represent destroyed or displaced hearths. Taken together, these two categories constitute almost 61 percent of all features at the site and attest to their importance in the activities of Swallow site residents.

Most of the intact hearths at the site are roughly circular. The mean diameter for all hearths is around 63 cm, but they vary widely in size, ranging from around 20 to 120 cm in diameter.

Efforts to categorize hearth features by shape or depth proved ineffective, in part due to preservation factors. The majority of hearths consist of clusters of fire-cracked rock that suggest the features were originally either rock-filled pits or rock piles built up from a surface (Figure 7.1). Because the features were not profiled during excavation, the shape, depth, and in some cases presence of a pit is uncertain.

Rock-filled hearths and other fire-cracked rock features are usually interpreted as cooking features and are relatively common in Archaic and later sites throughout much of North America (Black and Thoms 2014). Because stone retains heat well, such features were used as ovens to prepare a variety of plant foods that required long, slow cooking to make them palatable. The reuse of these features over time required the removal and replacement of stones that had become too fractured by heat to function well in retaining heat (Black and Thoms 2014). This kind of ongoing maintenance of the rock-filled hearths at Swallow is undoubtedly responsible for much of the fire-cracked rock found in Strata B and C at the site.

Pit features filled with fire-cracked rock have been associated with the preparation of the starchy roots of a variety of plants throughout North America. Wild plant foods associated with such features in various regions include yucca (Hixson 2001), agave (Van Buren et al. 1992), camas and other wild lilies (Thoms 2009), and a variety of nuts, including acorns (Jackson 1986: 394).

Figure 7.1. Feature 96, rock-filled hearth.

Jackson (1986: 394) also reports evidence for the roasting of meat from medium to large mammals in the same hearths used to process nuts.

Macrobotanical materials recovered from seven hearths at the Swallow site (Chapter 18) included several edible plant remains. The hearths yielded carbonized *Juniperus* (juniper) berries, and seeds of *Celtis* (hackberry), *Helianthus* (sunflower), various Poaceae (grasses), *Chenopodium* (goosefoot), and *Portulaca* (purslane). In addition, *Pinus edulis* (pinon pine) needles and cone scales were recovered, which may indicate that pinon nuts were being used; however, nuts themselves were not recovered. Substantial quantities of bone at the site also indicate that large animals such as deer and bison were being processed and consumed as well (Chapter 14), and larger hearths may have been used to roast large portions of meat, or to smoke meat for preservation.

Dense levels of fire-cracked rock in the midden suggest that such activities may have occurred repeatedly at the hearths, and that the rock that was used for heat retention within them was periodically replaced when it became too fractured to function well. The vast majority of fire-cracked rock at the site (79.4 percent) (see Site Structure and Stratigraphy, Chapter 4) was igneous or metamorphic rock, which would have been more difficult to obtain than the sandstone that outcrops widely in the valley. Ahler (2002) has argued that igneous rock has greater heat retention qualities and durability under heat stress and was therefore more effective for such cooking. It is likely that metamorphic rock performs similarly. The domination of non-sedimentary rock in the Swallow assemblage demonstrates ample planning by Swallow site residents in preparation and cooking of foods.

A second, less common type of hearth found at Swallow contains a slab lining on the sides and/or the base of the feature (Figure 7.2). Like most of the other hearths at the site, slab-lined hearths are also filled with fire-cracked rock. These hearths are unique to the northern portion of the site, which suggests their use may have been different, possibly as heating features for sleeping or shelter areas rather than for cooking. This activity area is discussed more fully in the section on Spatial Analysis of Features.

Figure 7.2. Feature 165, slab-lined rock-filled hearth.

Rock scatters are loose concentrations of rock, usually fire cracked, that are thought to be the remnants of destroyed or disturbed hearths, which do not retain a recognizable shape. These features may also represent dump localities from the removal of rocks from hearths that were refurbished. They are not included in the analysis of hearths but are a reminder that more hearth features existed in the past than could be clearly recognized during the excavation of the site.

Pits

Two types of pits were recorded at Swallow site. Both are fire features and could be classified with hearths; however, their dramatically different construction and fill suggest a significantly different use from rock-filled hearths, and so they are discussed separately here. The most common pit type is the ash pit. Five ash pits were recorded. These are shallow features, ranging in depth from 15-30 cm (Figure 7.3). As suggested by the name, ash pits typically contain ash and some charcoal, but do not contain rocks. All five of the ash pits recorded were filled with fine ash, indicating that the fuel within them was burned until completely reduced. This most likely indicates a different type of cooking technology from the rock-filled hearths. Ash pits were found only in the Early Ceramic levels at the site, suggesting that the different cooking technology may be associated with the use

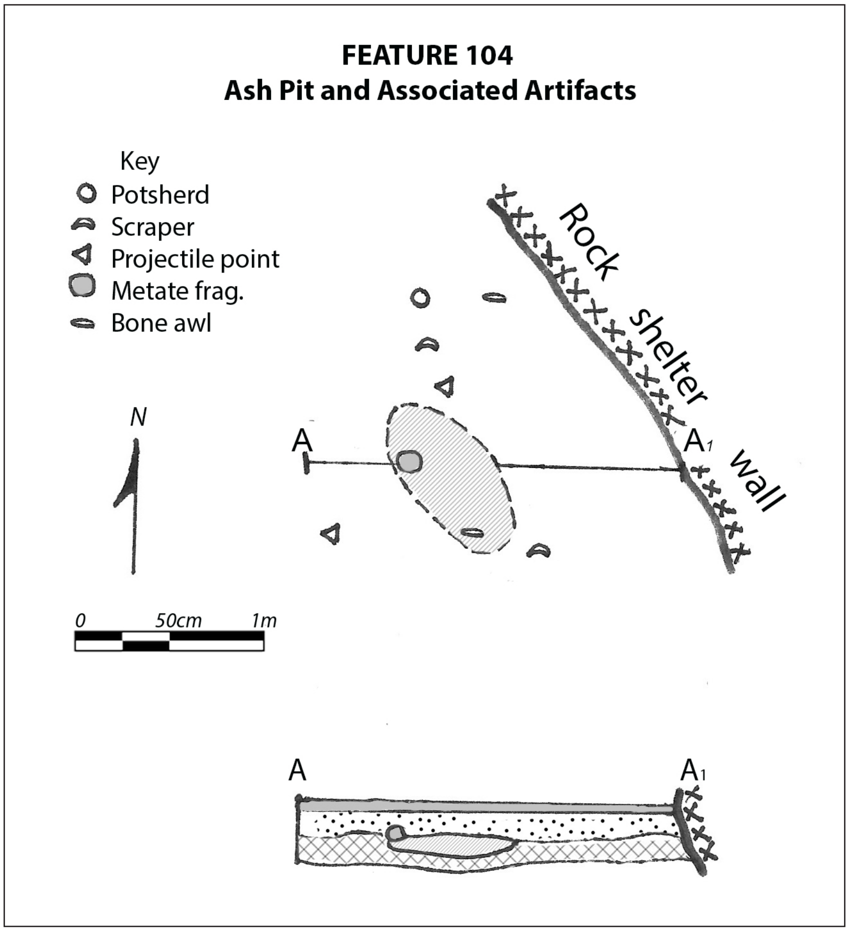

Figure 7.3. Feature 104, ash pit.

of pottery in cooking. Alternately, the fires in these pits may not have been used for cooking, but for heat or light.

The remaining two pits, Features 188 and 191, are unlined and did not contain a distinctive fill. They both showed signs of burning on the sides and the bottom of the pit and charcoal staining on the bottom, which suggest that they too were hearths. Both were shallow and fairly ephemeral, making their interpretation uncertain. Like the ash pits, the pit hearths were also associated with the Early Ceramic level, indicating a change in activities in the later time periods at the site.

Surfaces

Thirty-two surface fragments or lenses were recorded at Swallow site and were subsequently determined to be living surfaces or culturally significant levels. These surfaces were generally well-packed and sometimes discolored by use. In some cases, surfaces were noted to correspond with other features or to artifacts.

Only surfaces that appear to represent use levels are included in the analyses; however, a number of other "possible surfaces" were recorded that were later determined to be natural lenses or ponding sediments. These phenomena, while not of human origin, in some cases do represent a prehistoric surface, and they have been used in reconstructions of prehistoric surface topography at the site. Use surfaces, while found throughout the site, are most common in the northern portion.

Artifact Concentrations

Seven artifact concentrations were recorded as features. Six of these consisted mainly of groundstone and suggest that groundstone may have been cached or stored away for use at later times or later visits to the site. At least one concentration (Feature 178) was clearly a cache, tucked into a crack between large sandstone rock fall blocks on the floor of the shelter.

Both manos and metates, broken and whole, were found in these concentrations. Given the number of broken groundstone fragments found in hearths and fire-cracked rock scatters, the caching of groundstone might have been done to prevent it being used inadvertently in hearths. It may also have been stored away during times of the year when plant foods were not being prepared but the shelter was still in use. The one remaining artifact concentration consisted of several bifacial flaked tools in association with animal bone. Artifact concentrations were associated with all time periods at Swallow site.

Postholes

Three postholes were recorded at Swallow site, at different levels. None of the postholes are in association with each other, although one (Feature 125) may be associated with Feature 44, an alignment that may be evidence of a lean-to structure. The use of the other posts held by the postholes is uncertain, but they do not appear to be architectural in nature. Three additional "possible postholes" were recorded, but the proximity of rodent activity around these features makes their authenticity questionable.

Burials

Two burials were found at Swallow site. Both were tightly flexed, primary burials. One (Feature 12) was that of an adult female, the other (Feature 17) an adult male (Chapter 19). Both burials were found in Stratum C, suggesting an Archaic age; however the top of the burial pit was not defined in either case, making their ages uncertain. Charcoal found near each burial was submitted for radiocarbon dates, giving a date of 3440±90 RCYBP (Middle Archaic) for Feature 12, and 1880±90 RCYBP (Late Archaic/Early Ceramic) for Feature 17. Again, as burial pits were not clearly defined, the relationship of these dates to the burials themselves is somewhat tenuous. Both burials lacked any grave goods whatsoever, which is more consistent with Archaic burial practices, but not unheard of in Early Ceramic burials.

Storage Bin

One feature at Swallow site (Feature 197) was identified as a storage bin and is associated with the Early Ceramic levels. This feature utilized a natural boulder that had fallen from the shelter wall to form the top and back of the bin. Additional slabs were placed to create floor and wall sections to complete the enclosure measuring 40 cm deep, approximately 1 m wide, about 40 cm tall. The only artifacts found in association with it were one hammerstone and a metate fragment. The space was large enough, however, that a good store of foodstuffs or implements could have been kept there and would have been well protected from the elements.

Possible Structure

The final feature on the site, Feature 44, is enigmatic (Figure 7.4). It consisted of a linear, sand-filled trough, approximately 50 cm wide and 6.5 m long, stretching from the northwest corner of Unit B1N to the southeast corner of Unit C2S, at an angle roughly parallel to the monolith. Beneath the sand, which was approximately 5 to 10 cm thick, the underlying sediment had been deformed into a series of dents and ridges, irregular in size and shape. On the east side of the feature, between the rock shelter wall and the feature, the soil was stained with charcoal, while no such staining was found on the west side of the feature.

Excavators interpreted this feature as evidence of the edge of a lean-to shelter, with the bases of poles braced against the ground and deforming it during times of moisture. The poles would have leaned against the rock face and hides or brush could have been spread over them to form a seasonal structure. The sand filling the feature may be an alluvial deposit from drainage off the rock of the shelter, which drained across the lean-to and settled around its base. Perhaps the most compelling piece of evidence in favor of this interpretation is the difference in staining on either side of the feature. The charcoal staining, noted as a "stained surface" by excavators, suggests the high traffic area expected of a shelter floor.

Several additional features have been argued to be associated with Feature 44. The first is a posthole (Feature 125), which is located within the deformed zone near the northern end of the feature. The second is a radially fractured metate (Feature 45) which had been fractured by pressure to its center sufficient to drive fragments of stone into the underlying soil. The metate is in line with the south end of Feature 44 but was found approximately 80 cm further south than the end of the sand and deformed sediment associated with Feature 44.

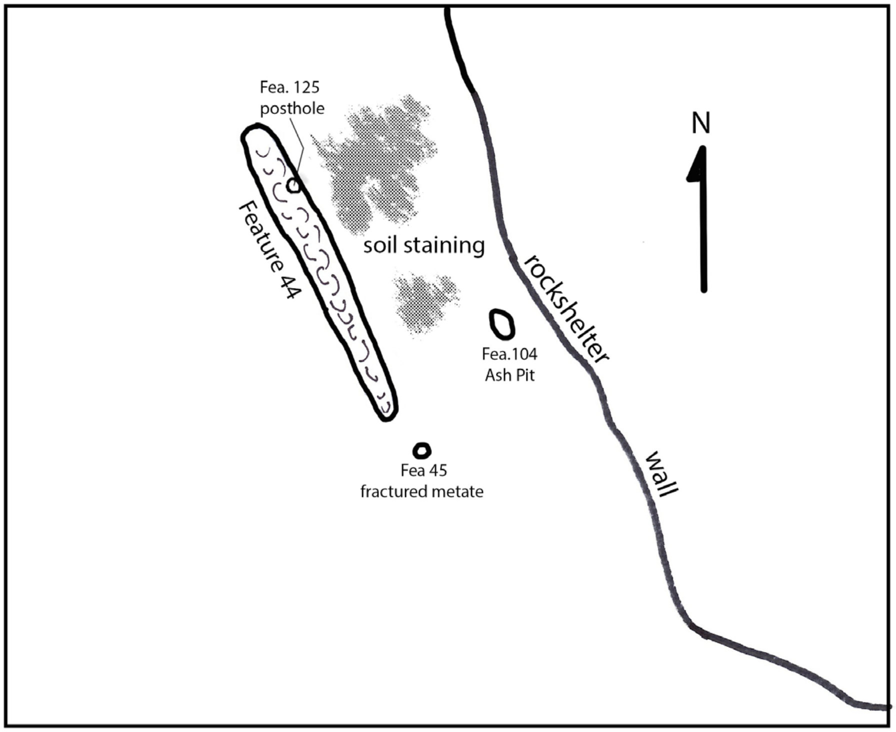

Figure 7.4. Map of Feature 44.

Finally, Feature 104 is a shallow ash pit, located near the rock face of the shelter that would have been inside the lean-to. It is found at the same level as the stained floor and Feature 44. This feature may have provided light, heat, or a cooking area inside the structure.

Feature 44 dates to Early Ceramic times and is on the northern end of the site. Interestingly, earlier occupations at the site appear to have used this portion of the site for shelter while using portions farther south for more intensive cooking activities. Whether the location of Feature 44 in the same general area reflects a continuation of that tradition or merely a coincidence is not known.

Temporal Variation in Features

In order to evaluate trends through time, features were assigned period designations based on their stratigraphic position and the analysis of artifacts and radiocarbon dates associated with the stratigraphy. This is a finer-grained temporal breakdown than that established for the site as a whole in Chapter 5. Substantial bioturbation has moved diagnostic artifacts and datable materials in the site, but has had less impact on features, which may be disrupted by rodent activity, but are not dramatically relocated. Therefore, the levels of features along with the added information available from diagnostic materials in direct association with them is used here to propose a finer temporal breakdown for this analysis. The designations used in the remainder of this chapter are:

Levels 1-8	Early Ceramic (EC)
Levels 9-11	Late to Middle Archaic (L/MA)
Levels 12-14	Middle Archaic (MA)
Levels 15-18	Middle to Early Archaic (E/MA)
Levels 19-22	Early Archaic (EA)

The Early Ceramic period accounts for both the greatest frequency and the greatest diversity of features at the site. Forty-eight percent of all features found at the site were associated with the Early Ceramic levels, which, even when accounting for the potential of better preservation, suggest a more intensive use of the site at this time (see Table 7.2). This interpretation is corroborated by artifact frequencies as well.

Table 7.2. Distribution of feature types by time designations.

Feature	EC	L/MA	MA	E/MA	EA	Total
Hearth	23	15	8	8	7	61
Surface/Lens	19	3	0	7	3	32
Rock Scatter	9	3	4	3	2	21
Artifact Concentration	2	0	1	3	1	7
Posthole	2	0	0	1	0	3
Ash Pit	5	0	0	0	0	5
Pit/Unlined Hearth	2	0	0	0	0	2
Possible Structure	1	0	0	0	0	1
Total	63	21	13	22	13	132

All types of features were present in the Early Ceramic levels, including several types of features (pits and ash pits) that were not associated with Archaic levels.

The most common features in all time periods were hearths, followed by surfaces and rock scatters. Hearths are the only features that occur with great enough frequency to make temporal comparisons. Hearth form did not vary significantly through the thousands of years Swallow site was occupied. All levels were dominated by the same style of hearth, consisting of a basin filled with rocks and containing charcoal or other evidence of burning. The mean size of hearths varied some through time, but only moderately (Table 7.3).

While the means are not dramatically different, an analysis of the range suggests a trend toward larger hearths in the Early/Middle Archaic and in the Early Ceramic, with fewer large hearths used in the Middle Archaic (Figure 7.5). Larger hearths in these periods do not replace the smaller hearths seen in other periods but occur along with smaller hearths—in other words, a wider variety

Table 7.3. Hearth size statistics by time period.

Temporal Designation	Mean	Standard Deviation	Range	Number
Early Ceramic	65.6	24.3	80	17
Late/Middle Archaic	61.0	18.8	59	14
Middle Archaic	56.4	17.3	50	7
Early/Middle Archaic	66.6	29.0	90	8
Early Archaic	67.0	21.1	50	5
Total	63.4	22.0	90	51

of features, including both small and large hearths, was used in greater frequency in the Early Ceramic and Early/Middle Archaic times than in other times.

This observation is borne out by a K-Means Cluster Analysis, an exploratory data analysis technique designed to differentiate meaningful clusters within a data set (Baxter 1994:148). The K-Means Cluster Analysis differentiated two groups of hearths based on the maximum dimensions both north-south and east-west. The main cluster of features is those clustered around the mean, and when the north-south and east-west measurements are plotted against each other, these show a general diagonal line, indicating a correlation between these measurements (they are roughly the

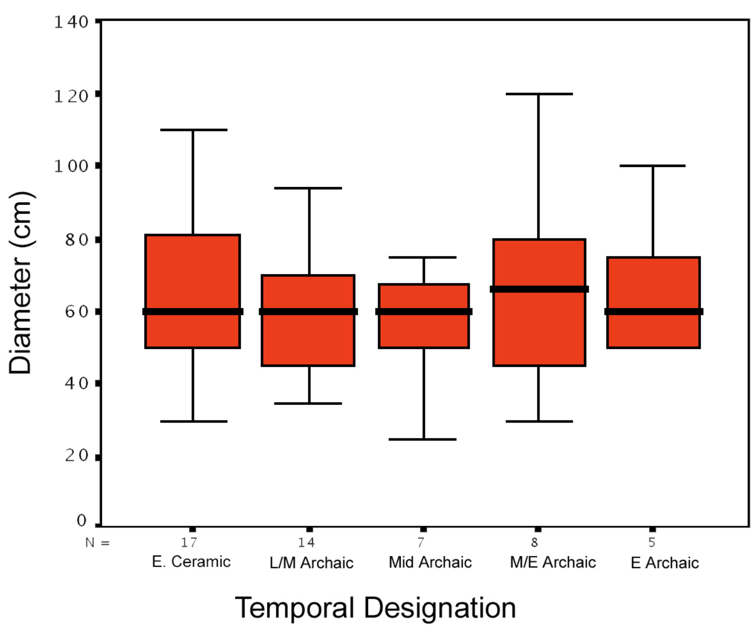

Figure 7.5. Variation in the means and ranges of hearths through time. Middle Archaic hearths show the least variation, while Early Ceramic and Early/Middle Archaic Hearths show the greatest variation.

same dimensions in both directions) (Figure 7.6). The second group distinguished by the K-Means Cluster technique is significantly larger in one or both dimensions, with a break in the size range occurring somewhere around 70-80 cm. This second group, then, represents features that are not the large end of a continuum of hearth sizes, but a group that can be distinguished based on a statistically significant break in the size range, and appears to be analogous to Mark Stiger's (2001:103) classification of small, shallow versus large, deep hearths observed in Archaic sites from the Colorado mountains. Only one of the 13 hearths in the "large" group at Swallow site was associated with the Middle Archaic.

The narrower range and the general lack of large hearths in the Middle Archaic levels suggest a different use of the site at this time. A number of analyses of large hearths suggest that they were heat-retention ovens used to process large numbers of starchy roots that required long cooking (Hixson 2001; Thoms 2009). The use of larger hearths to prepare large quantities at one time is generally thought to be associated with preparations of food for storage or for feeding quantities

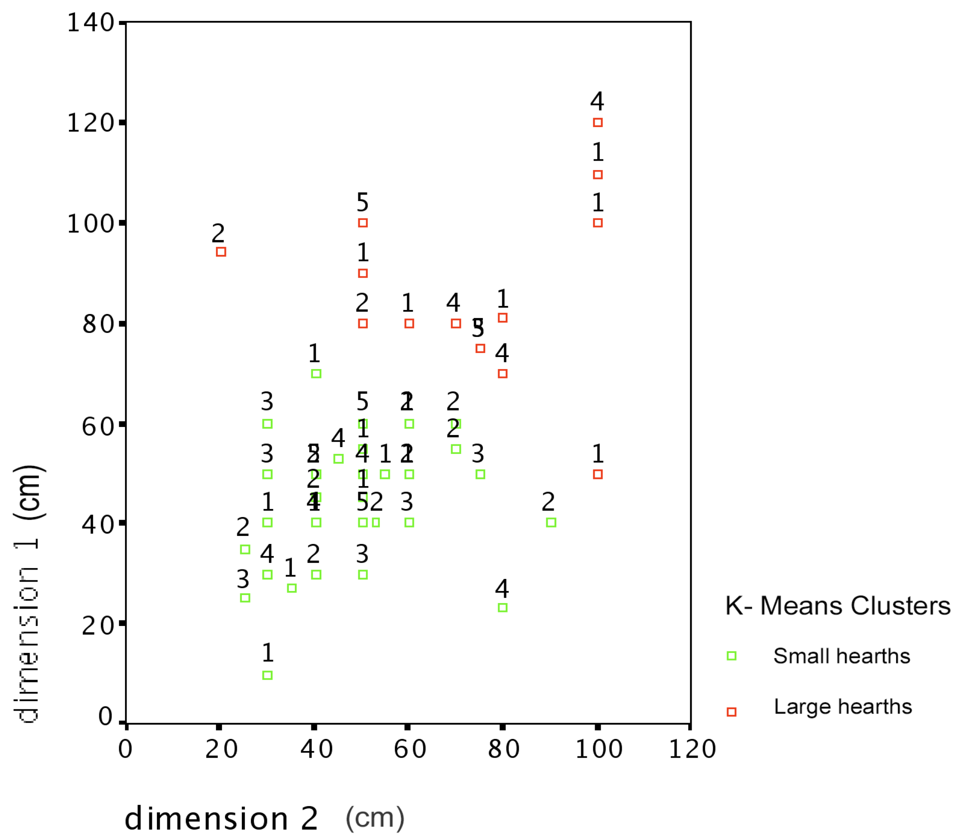

Figure 7.6 K Means clustering of hearths based on maximum dimensions. Numbers indicate temporal affiliation: 1=Early Ceramic; 2=Late/Middle Archaic; 3=Middle Archaic; 4=Early-Middle Archaic transition; 5=Early Archaic.

of people in feasting contexts or at other times when large numbers of people occupied a location (Van Buren et al. 1992). The relative lack of large hearths in the Middle Archaic may, therefore indicate fewer people at the site during this period, or that the reliance on processed, stored foods was less important.

Spatial Analysis of Features

Spatial patterning within the features can be observed both horizontally and vertically. Vertical distinctions were discussed briefly above as a means of identifying temporal distinctions. It also allows for an examination of changes in site use through time, by comparing the horizontal patterning at different levels.

Figure 7.7 shows the total number of features by level at Swallow site. The distribution is somewhat bimodal, with the largest numbers of features in Levels 2-5 and again in Levels 11-13, with a gap around Level 10. This gap corresponds with the transition between the Archaic and the Early Ceramic levels and is consistent with the evidence from radiocarbon dates and diagnostic lithic tools, indicating a reduced use of the location in the Late Archaic.

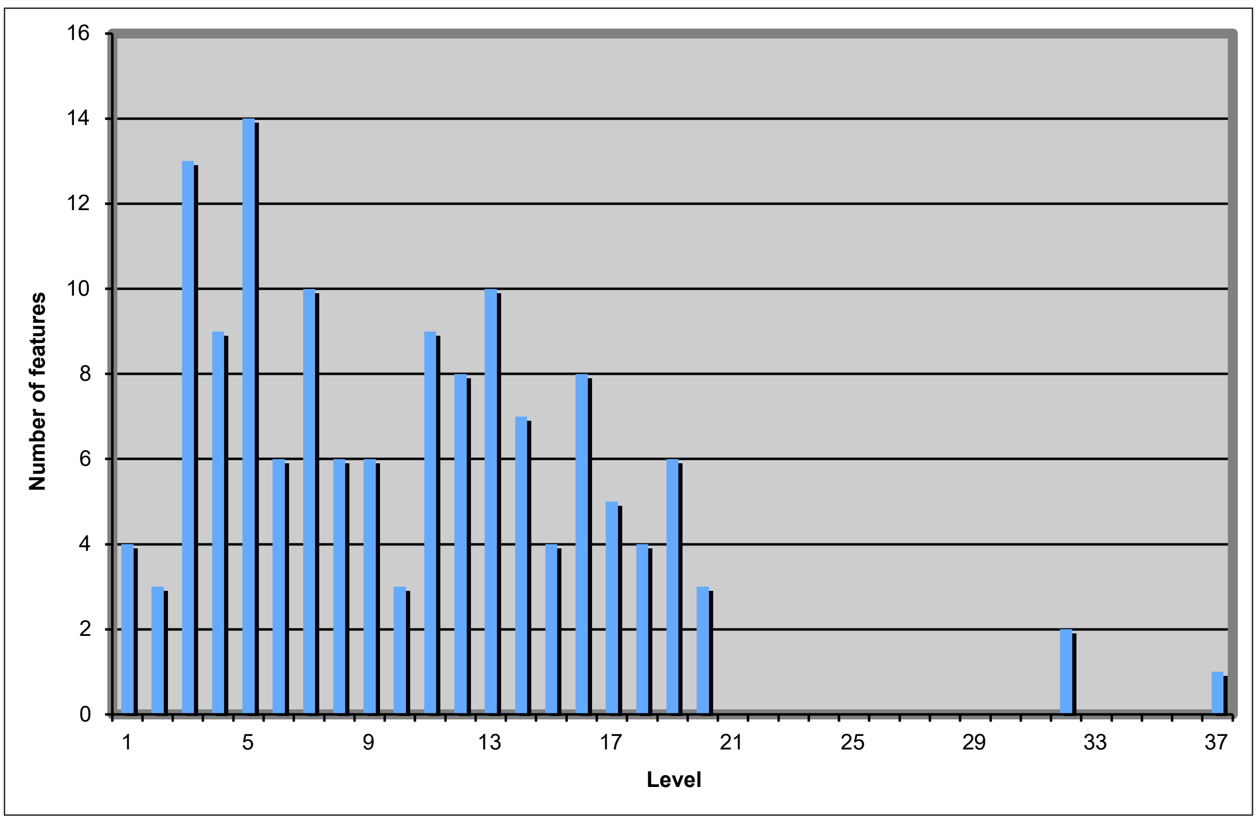

Figure 7.7. Frequency of features by level.

Features in all levels tend to occur along the face of the shelter and along the drip line. The positioning of hearths near the drip line may have been a practical consideration that would have allowed smoke to draft out of the shelter rather than being trapped within it. Beyond this similarity, distinct spatial patterns differ in the Early Ceramic and the Archaic levels.

Early Ceramic stage features tend to be dispersed evenly throughout the site, and no distinct spatial patterning is apparent to define specific activity areas. By Early Ceramic times, there were not significant natural features on the floor of the shelter that would have played a role in determining the location of features. Hearths of all sizes and varieties, as well as other features are found throughout the space.

What is most distinctive about the Early Ceramic levels is the much higher number and greater variety of features that occur. The presence of burned pits without rock fill and of ash pits both suggest a change in cooking practices in this late time period. Whether that change relates to the use of new or different resources, or whether it results from new cooking technologies is not known.

While there is little distinctive spatial patterning in the Early Ceramic levels, a distinct pattern was apparent throughout all Archaic levels. Here, two major loci of activity can be found in the northern and southern portions of the site, separated by the area which, at least on the modern ground surface, is the lowest topographic point of the site.

Features in the northern portion of the site center around Units C1N and C1S. This area was dominated by a complex jumble of large sandstone blocks that had fallen from the overhang sometime in Early Archaic times. The blocks created channels and alcoves, and the features in this northern cluster are tucked into these narrow spaces among the rock fall (see Figure 7.2). The large rock fall blocks had been buried by sediment by Early Ceramic times, and the lack of this site topography may be the reason for the more generalized pattern of use, since there were no distinguishing topography of the ground surface to influence the placement of features.

The second major feature cluster through time occurs in the southern portion of the site, centered on Units D3S, E3S, and portions of adjacent units. This cluster was consistently larger than the northern cluster in all time periods. The large rock fall that breaks up the ground surface in the northern portion of the site was not present in this area, so the feature cluster here was more exposed to the open air.

Differences in the types of features, artifact assemblages, and associated debris all attest to the different uses of the two areas (Table 7.4). Slab-lined hearths are only found in the north cluster, where packed surfaces are also more common. By contrast, unlined hearths are more common in the south cluster and are accompanied by artifact concentrations made up primarily of groundstone. In addition, all of the Archaic large hearth features distinguished by the K-Means Cluster Analysis reported above were located in the southern cluster.

Table 7.4. Differences in north and south cluster features.

Period	Location	Surfaces	Slab-Lined Hearths	Other Hearths	Artifact Concentrations
Late/Middle Archaic	North Cluster	4	1	3	
	South Cluster			6	2
Middle Archaic	North Cluster			1	
	South Cluster			4	
Early/Middle Archaic	North Cluster	1	2	2	
	South Cluster	2		3	1
Early Archaic	North Cluster	1	1		
	South Cluster			5	1
Total	North Cluster	6	4	6	
	South Cluster	2		18	4

This distribution of features suggests different uses for the north and south clusters, a conclusion that is further supported by artifact and ecofact distributions. A slightly higher number of lithic artifacts is associated with the south cluster, but most notably, a much higher frequency of bone occurs in and around the south cluster than the north. Stratigraphic profiles of fire-cracked rock (FCR) densities generated by Bill Hammond show consistently high densities of FCR in the area around and immediately to the west of the south cluster. Taken together, the feature differences and the debris clearly indicate that the processing and cooking of both plant and animal foods was a key activity performed in the southern half of the site. By contrast, the packed surfaces and lined hearths of the northern section suggest that area may have served as a sleeping/sheltering area. The channels and alcoves within the rock fall could have provided protected areas out of sun, wind, and weather. The narrow channels could have been easily roofed over with brush or hides to create a fully enclosed shelter for winter habitation. In replication experiments of hearth design, Stiger (2001:102) found that lined hearths were more fuel efficient and produced constant, low-temperature fires. This observation reinforces the interpretation that the slab-lined hearths in these areas were most likely warming hearths rather than loci of food preparation and could have effectively created lasting warmth with minimal fuel in the narrow spaces during the winter.

The final significant area defined by this analysis is the western portion of the site, especially within the grid coordinates 3-5 and A-C South. This area has relatively few features through time, but a high density of FCR and animal bone. It can therefore be interpreted as the primary midden through the site's occupation. The depth of midden deposits and the density of materials there suggests an intensity of use for the site that is exceptional for sites in eastern Colorado. This is corroborated by the overall number and variety of features throughout the site.

Discussion

Swallow site has an astounding number and variety of features, spanning an enormous time range. Throughout that range, a variety of consistent patterns attests to the long-term stability of subsistence patterns in the Hogback valley, and to the general abundance of the valley and surrounding areas that allowed for the continued use of the site location over a span of 7,000 years.

Both the types and numbers of features at Swallow clearly indicate that it was an occupation site that was inhabited for extended periods of time. Features that have been argued to characterize extended occupation of Archaic sites in the Rocky Mountain region include deep middens, structures (Metcalf and Black 1991; Stiger 2001), burials, and storage features (Larson and Francis 1997). A number of researchers have argued that Archaic sites with these features, in plains-mountain marginal zones, were sites of winter residence and/or home bases for collectors or tethered nomads (Kornfeld 1997; Larson and Francis 1997) that did not travel far from the home base.

Swallow has all the features associated with home base sites, with the possible exception of structures. The only evidence of structures at the site is Feature 44, which is associated with Early Ceramic levels. Although no evidence of structures has been found in earlier levels, the north feature clusters indicate the use of the natural shelter of large blocks of rock as living space, and the presence of fire features in those natural shelters suggests winter use. The only time phase in the Archaic, in which the north cluster is not well established, is the Middle Archaic layers around Levels 12-14. The lack of surfaces or warming hearths in this layer, combined with the generally smaller hearths of the same time period, may suggest that this was an episode of lighter use at the site, or alternatively, that the location was not used for a winter residence, and neither shelters nor large storage/feasting facilities were needed.

Also of interest at Swallow is the continued focus of certain activities in certain areas of the site over a very long period of time, i.e., thousands of years. This patterning also suggests a very intensive use of the location. In their analysis of the Allen site, Bamforth and others (2005) describe a similar pattern in a Paleoindian context, in which areas of the site were used in similar ways over millennia. They argue the most logical explanation is that groups returned to the site frequently enough that the remains of past occupations were visible on the surface, and as a result discard and other activities were done in the areas already defined for those purposes by previous occupants. What is especially intriguing at Swallow site is that many similar outcrops of rock created other shelters up and down the Hogback valley in this vicinity (Johnson 1997), so ample campsite localities were potentially available. Yet few other excavated sites in the area have yielded as intense a level of activity and reuse as Swallow site. This site, then, appears to occupy a special place in the prehistory of the Hogback valley.

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8

Lithic Materials

Peter J. Gleichman and
Jeannette L. Mobley-Tanaka

When the Denver Chapter of the Colorado Archaeological Society (DC-CAS) began investigations at Ken-Caryl Ranch, a lithic material typology was devised by DC-CAS geologists that differs from the standard material types used by archaeologists. Fred Rathbun became a leader in the materials typology effort and conducted lithic materials seminars for DC-CAS in 1977 and 1978. Rathbun (1978) described the local material types in a DC-CAS newsletter article. Material types given are chalcedony, agate, jasper, chert, and flint as being varieties of cryptocrystalline silica (silica dioxide, quartz), and opal as an amorphous (no crystalline structure) form of silica. Rathbun listed other tool stone materials used in the Hogback area including quartzite, both sedimentary and metamorphic; vein quartz; and the igneous rocks obsidian, basalt, tuff or ignimbrite, and felsite (rhyolite and andesite).

Rathbun provided the following definitions: chalcedony has a fibrous structure, translucent to opaque, with characteristic waxy luster, commonly gray. Agate is a variety of impure chalcedony, with the impurities resulting in color banding and layering, and moss or ribbon patterns. Jasper as an opaque colored form of chalcedony mixed with chert and fine-grained material of sedimentary or igneous origin, generally red, green, or yellow. Chert as opaque, generally dull grey to brown, with a coarse blocky cryptocrystalline structure with grainy texture and dull luster. Flint as a dark brown to black chert mixed with opal. Opal was defined as amorphous, hydrous, of many colors, with a distinct satiny luster and crazing when exposed to heat or weather. Quartzite was divided into sedimentary and metamorphic, with sedimentary quartzite formed by silica cementation of sandstones, conglomerates, and breccias, and metamorphic quartzite as a recrystallized form of the sedimentary rocks. Vein quartz is a crystalline mass of quartz occurring as veins crosscutting through igneous, metamorphic, and sedimentary rocks.

2024 *Archaeological Investigations at the Swallow Site, Jefferson County, Colorado*, edited by Peter J. Gleichman, Bill Hammond, and Jeannette L. Mobley-Tanaka, pp. 141-154. Memoir No. 7. Colorado Archaeological Society, Denver.

Rathbun pointed out that silicified or petrified wood may have any of the forms of silica replace the wood, thus there can be jasperized wood, agatized wood, or opalized wood. At some point Rathbun dropped “flint” as a separate type of cryptocrystalline material.

His system, with some modifications, was used to type lithic materials at most of the Ken-Caryl sites, including Swallow, Falcon’s Nest and the sites documented in Johnson and others (1997). The Crescent site (5JF148) was initially tested by DC-CAS (Adkins 1997b; Cummings and Moutoux 1997), but later excavated by CU-Denver (Stone 1994, Stone and Mendoza 1994), who used a standard material typology (chalcedony, chert, petrified wood, quartzite, and quartz).

The earlier excavations at Ken Caryl reported by Johnson and others (1997) did not report chipped stone material types in the site reports. Ground stone material types for metates and manos are reported by site, cultural period, and mano/metate type. Chipped stone material types are given for some of the artifacts from Bradford House III (5JF52) in Appendices E and F (Johnson et al. 1997).

The “Discussion” chapter in Johnson and others (1997:144-146) provides observations about lithic resource selection. The major sources for lithic materials given are local Hogback valley cryptocrystalline sources, petrified wood from the Parker uplift (Dawson formation), and jasper assumed to be from Trout Creek in South Park. Green Mountain petrified wood is present. Middle Park lithic materials such as Table Mountain jasper and Kremmling chert (Troublesome formation) were not recognized at the Ken-Caryl sites but were acknowledged as potentially being present. Obsidian was recovered in small amounts.

The Falcon’s Nest report used the Rathbun system for lithic material types (Adkins 1997a). Detailed descriptions are made for quartz, chalcedony, agate, opal, jasper, chert, and quartzite. The analysis used six primary categories: agate/chalcedony, jasper, quartzite, opal, chert, and other (“Other” includes vein quartz, crystal quartz, tuff, and rhyolite). Great specificity was used in the typology, with lithics categorized into defined subtypes, with 7 subtypes of chalcedony agates, 14 jasper subtypes, 20 quartzite subtypes, 12 subtypes of opal with an additional 11 subtypes of opal wood, and 10 subtypes of chert. Petrified wood was not viewed as a type, instead the petrified wood was divided into subtypes of agate, jasper, and opal. It is stated that jasper dominated the material selection in all periods at Falcon’s Nest (Burris et al. 2008:14), but the intentional inclusion of Dawson petrified wood with jasper skews the data.

Raw Material Types

Jasper

Adkins mentions the disagreement of some geologists and archaeologists with the Rathbun system (1997b III:1). The Rathbun system views jasper, chert, chalcedony, agate and quartzite as varieties or grades of cryptocrystalline quartz. Standard archaeological use is that jasper is not a separate mineral equivalent to chert but is an opaque cryptocrystalline variety of chert that is colored in the yellow/red/brown spectrum by iron inclusions.

Lithic analysis at the Ken-Caryl sites distinguished jasper, and viewed it as being from Trout Creek in South Park, and indicative of repeated movement between South Park and the Hogback valley (Johnson et al. 1997:145). Subsequent research has shown that sourcing jasper is complex. The Trout Creek quarry is well known (Black 2000, Chambellan et al. 1984), but there are sources of jasper in and around South Park other than Trout Creek, in the Arkansas Hills south of Trout Creek and in western and central South Park (Black 2000, Black and Theis 2015, Larmore and Gilmore 2006). Jasper is also present in Middle Park. There are also jasperized wood sources in eastern South Park (Bender et al. 2005). That petrified wood, as well as pieces of Dawson petrified wood that lack visible wood grain, are indistinguishable from jasper, complicating understanding the quantity and source of jasper used.

Opal

Another divergence in the Rathbun system is terming some lithic material as "opal," a non-crystalline quartz. The term "opal" is not generally used by archaeologists, most of whom would lump what is termed "opal" as chert.

Opal is a hydrated amorphous form of silica. Because it is amorphous (no crystalline structure) it is classified as a mineraloid, not a mineral, as opposed to the crystalline forms of silica which are considered minerals (chert, chalcedony). The mineraloid opal has no definite chemical composition because it contains variable amounts of water. Opal can have conchoidal fracture but can also have fibrous or splintery fracture. There are two classes of opal – precious opal and common opal. Precious opal has "play-of-color" and is considered a gem. Common opal does not have play-of-color but may have opalescence, a pearly luster, although much common opal does not have pearly luster. The term "opalite" is used in two ways – to refer to common opal without play-of-color, and to refer to plastic imitation opal with true play-of-color (King 2023).

Common opal is widespread in Colorado, and has been documented in 28 counties, including the Front Range counties of Larimer, Boulder, Clear Creek, Jefferson, and Douglas (Eckel et al. 1997).

The characteristics used by Rathbun and Adkins to separate opal from crystalline forms of quartz are a "satiny" luster and heat crazing on the surface. However, these visual attributes are not necessarily distinctive of opal. Perception of luster is subjective, and luster on a particular artifact can vary from waxy to glassy to satiny. Whether heat crazing is limited to non-crystalline silica dioxide (opal) is undetermined, and little is known about different causes of crazing. To date, no petrographic analysis of artifacts classified as opal has been undertaken. It remains undetermined if non-crystalline silicates were used for tools. The separation of opal from chert and chalcedony could be meaningful in various ways, including learning sources of tool stone. Opal may be from different sources than cryptocrystalline materials. Defining and distinguishing non-crystalline tool stone from cryptocrystalline stone will require research, and whether visual attributes can be used to reliably distinguish opal from chert remains to be determined.

Petrified Wood

At least two varieties of petrified wood are present in the Hogback valley. More common is the multi-colored but often yellow to brown jasperized or agatized wood of the Dawson formation (Parker petrified wood). It occurs widely through the southern part of the Denver basin and the Parker uplift. While the major sources of this Dawson petrified wood are to the south and east of Denver, 30 km or more from the Hogback valley, Tate (1979) reported three procurement sites for it on the Dakota ridge on the eastern flank of the Hogback valley in Roxborough State Park, much closer to Swallow site. Green Mountain, 16 km northeast of Swallow, is partly comprised of the Paleocene age Green Mountain formation conglomerate, which contains a substantial amount of silicified wood (Eckel 1997, Eckel et al. 1997). Green Mountain petrified wood is translucent-to-opaque, often tabular, and of various shades of gray, with blue-green accents or bands of agate (Johnson et al. 1997:145).

It is noteworthy that Eckel and others (1997) list common opal as co-occurring with the Dawson arkose in Douglas County and with the Green Mountain conglomerate in Jefferson County. A petrographic analysis of Dawson petrified wood shows that opal and microcrystalline quartz both occur, sometimes in the same sample (Mustoe and Viney 2017).

Quartzite

Quartzite exists as a sedimentary rock of almost exclusively quartz sand derived by secondary silicification, termed orthoquartzite or quartz arenite; and as metamorphosed quartz sandstones termed metaquartzite. Rathbun stated that both quartzites are common in the Hogback area; however, sources of metaquartzite have not been identified in the Front Range or Hogback zone. Dakota quartzite, an orthoquartzite, occurs in the Dakota formation and is not an uncommon tool stone in the Front Range. Morrison quartzite is a term widely used for silicified sediment, which is not a true orthoquartzite. Silicified sediments have clear to light colored rounded quartz grains floating in a colored matrix, while orthoquartzites have tightly packed quartz grains.

Swallow Site Raw Material Types

The lithic materials used to manufacture chipped stone artifacts at Swallow were typed using the Rathbun system on the catalog cards and on the lithic analysis forms. How consistent the material types are on the catalog cards and lithic forms is unknown, but the Rathbun system was applied fairly consistently to the projectile points. The lithic studies reported here were done at different times by different analysts, who altered or converted the Rathbun material types to more standard types in different ways. The analyses generally viewed the cryptocrystalline materials as translucent material being chalcedony, and inclusive of most agate; and opaque material as chert. A few artifacts had been typed as metaquartzite, without listing the criteria used for distinguishing metaquartzite from orthoquartzite. Those items were lumped as quartzite.

In the Swallow lithic analyses of both projectile points and other tools, jasper was typed as a separate category from chert. Some of the material typed as jasper undoubtedly includes items of Dawson petrified wood that lack wood grain. At present, we cannot determine where jasper is sourced, nor make inferences about travel or conclusions about quantitative use of specific quarries for jasper.

McComb's projectile point study (see Chapter 9 and Appendix B) presents the lithic material types in both the Rathbun system, and the conversions made. Each artifact was examined, and the material was retyped. Most of the agate was converted to chalcedony, but a few items of moss agate were retained as agate. Most of the opal was converted to chert, although some was designated as chalcedony, agate, and jasper. The term "opal" was retained for a few points with satiny luster and heat crazing. Rathbun's identification of Green Mountain and Dawson petrified wood was consistent and was not revised. Morrison quartzite was distinguished from quartzite (orthoquartzite). McComb provides pie charts showing the percentage of different materials from the Rathbun system and the converted system.

Hammond and Couts in their "Other Lithic Tools" chapter (Chapter 10) converted agate to chalcedony, opal to chert, and quartzite is undifferentiated. Petrified wood is undifferentiated for Hammond's summary of bifaces and scrapers, but Dawson versus Green Mountain petrified wood is noted for Couts' study of drills, gravers, and awls.

Mobley-Tanaka's "Debitage" chapter (Chapter 11) relied on the identifications that were made in the lithic lab by CAS volunteers, under the supervision of Fred Rathbun, and using his terminology. The information was converted for analysis by lumping opal and jasper with chert, and agate with chalcedony. Dawson and Green Mountain petrified wood are distinguished where possible. Small amounts of metaquartzite are identified.

Sources of the lithic materials used at Swallow are plentiful within a few kilometers of the site; these local sources can account for over 98% of the lithic assemblage. Chipped stone artifacts made of materials that can be identified as coming from more distant sources are rare. Some artifacts have the visual characteristics and appropriate florescence to appear to be of Kremmling chert (Troublesome formation) and Windy Ridge quartzite. Six flakes of obsidian are present, as are three flakes of possible Alibates chert, and one projectile point of possible Alibates.

The different types of cryptocrystalline material are widely found in cobbles in the alluvium at the foot of the Front Range. In addition, outcrops of chalcedony are present in the Morrison formation on the eastern slope of the Hogback valley. Moore (2002) has recorded a chalcedony (agate) procurement site, 5JF2464, on the Dakota ridge slightly to the north of Swallow site, readily accessible across a saddle of the Lyons ridge. There are numerous outcrops of quartzite in the Dakota as well as the Morrison formations.

Black (2000) and Moore and Bush (2003:10, Table 2) list 21 documented chert, chalcedony, quartzite, and petrified wood quarries along the Dakota Hogback, and more across the Palmer Divide.

Pebbles of vein quartz are common in and eroded from the Fountain formation monoliths. Quartz pebbles and cobbles are also common in the nearby alluvial gravels. Quartz crystal and gneiss are found in the Hogback valley.

Trends in Material Usage

Because different strategies were used in identifying/recording material type in different analyses, comparisons across artifact classes can be made, but require the collapsing of categories in less-than-ideal ways, most notably combining chert and jasper, and combining petrified wood into a single category, despite distinct sources being known. In the information that follows, categories have been combined as necessary to make comparisons. More detailed material information is provided in the individual chapters that discuss each artifact type.

A comparison of material types utilized in the manufacture of different artifact classes indicates that all material types were used for most types of tools. Local materials dominate all assemblages and exotics are rare throughout the assemblage (although see the above discussion for difficulties sourcing jaspers and cherts). Chalcedony and petrified wood are the most common materials in most assemblages (Table 8.1, Figure 8.1). Choppers provide the only exception to this, with quartz standing out as a clear preference for chopper material, while finer grained materials are rarely used for choppers.

Frequencies of different materials in the flake assemblage are similar to those in the artifact assemblages, although petrified wood is slightly underrepresented in flakes in comparison to its prevalence in most artifact classes.

Table 8.1. Percentage of material types by artifact class.

	Chalcedony	Chert/ Jasper	Quartzite	Petrified Wood	Quartz	Quartz Crystal	Other	Number
Projectile points	22.0	23.0	24.0	28.0	1.0	2.0		
Bifaces (non-projectile points)	26.0	17.0	13.9	32.3	6.7		4.3	718
Scrapers, Burnishers, Spokeshaves	31.4	11.6	18.9	24.5	9.4		4.1	318
Drills	33.0	20.5	21.0	22.5	4.0			24
Gravers	30.0	4.0	17.0	39.0		9.0		23
Awls				50.0	33.0		17.0	6
Choppers	2.9		8.6		82.9		5.7	35
Small Flakes (Lot finds)	29.0	20.0	22.0	19.0	6.0	1.0	3.0	27,613
Large Flakes (pt plot 20% sample)	24.0	15.0	22.0	20.0	13.0	1.0	5.0	430

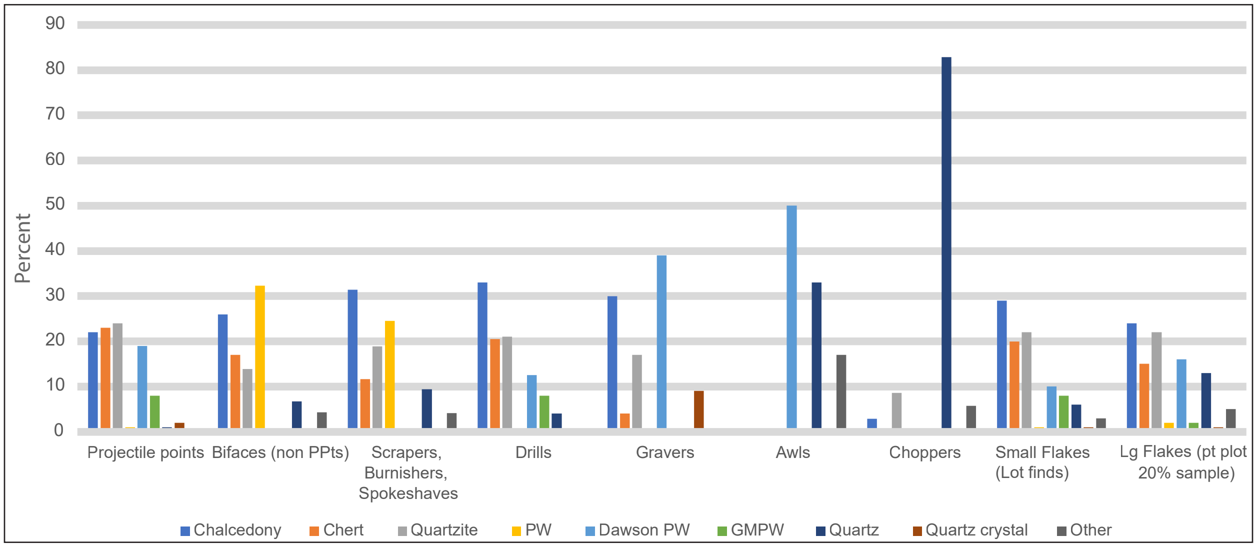

Figure 8.1. Material type by artifact class.

Because the sheer number of flakes overwhelms the number of artifacts if combined, comparisons of material use by time period is presented for artifacts and flakes separately. These comparisons use provenience data for flakes and non-diagnostic artifacts, identifying Levels 1-7 as Early Ceramic, Levels 8-16 as Late and Middle Archaic, and Levels 17 and below as Early Archaic, but recognizing that significant mixing of materials occurred at the site (see Chapters 4 and 5 for discussion of stratigraphy and dating). A second approach to evaluating the use of materials through time is possible using the diagnostic projectile points. Both approaches yield similar results and are presented here. Nondiagnostic artifacts used in this analysis included all flaked stone artifacts discussed in Chapter 10, "Other Lithic Tools" of this report, as well as the nondiagnostic fragments of projectile points listed at the end of the projectile point discussion.

Nondiagnostic artifacts and flakes both show clear trends toward an increase of cryptocrystalline materials (chalcedony, chert and jasper) through time, accompanied by a reduction in the frequency of quartzite and quartz through time (Tables 8.2 and 8.3, Figures 8. 2 and 8.3) Petrified wood, from both Dawson and Green Mountain sources, is common throughout the occupation of the site and does not show a directional trend in usage.

A second approach to examining material usage through time is to use the temporally diagnostic projectile point types, regardless of their vertical provenience. This approach has the advantages that first, it negates the impact of mixing of materials in the stratigraphy, and second, it has the potential to give a more fine-grained breakdown of the chronology than does the stratigraphy. Unfortunately, trends are harder to recognize and are not necessarily statistically significant given the small numbers of points representing certain time periods. Tables 8.4 and 8.5 were created by Bill Hammond to summarize material types through time on diagnostic projectile points presented in Chapter 9. Table 8.4 includes all identified diagnostic points, while Table 8.5

Table 8.2. Percentage of artifact material by time period.

	Chalcedony	Chert	Jasper	Quartzite	Petrified Wood	Vein Quartz	Quartz Crystal	Other	Number
Early Archaic (Below Level 16)	16.7	9.6	5.8	26.3	23.1	12.8	1.9	2.6	156
Late/Mid Archaic (Levels 8-16)	20.3	10.9	7.8	16.0	32.7	8.2	0.6	3.6	523
Early Ceramic (Levels 1-7)	27.7	12.3	11.5	15.9	21.0	7.5	0.9	3.2	694

Table 8.3. Percentage of materials in the flake assemblage through time.

	Chalcedony	Chert/Jasper	Quartzite	Petrified Wood (unknown)	Dawson Petrified Wood	Green Mountain Petrified Wood	Quartz	Quartz Crystal	Other	Number
Early Archaic (Below Level 16)	22.9	13.8	31.6	0.4	9.1	9.4	10.0	0.8	1.9	3,623
Late/Mid Archaic (Levels 8-16)	24.0	18.9	25.2	1.6	9.3	10.6	7.5	0.9	1.9	10,102
Early Ceramic (Levels 1-7)	33.6	22.7	17.7	0.8	10.6	6.5	7.0	1.0	0.1	13,171

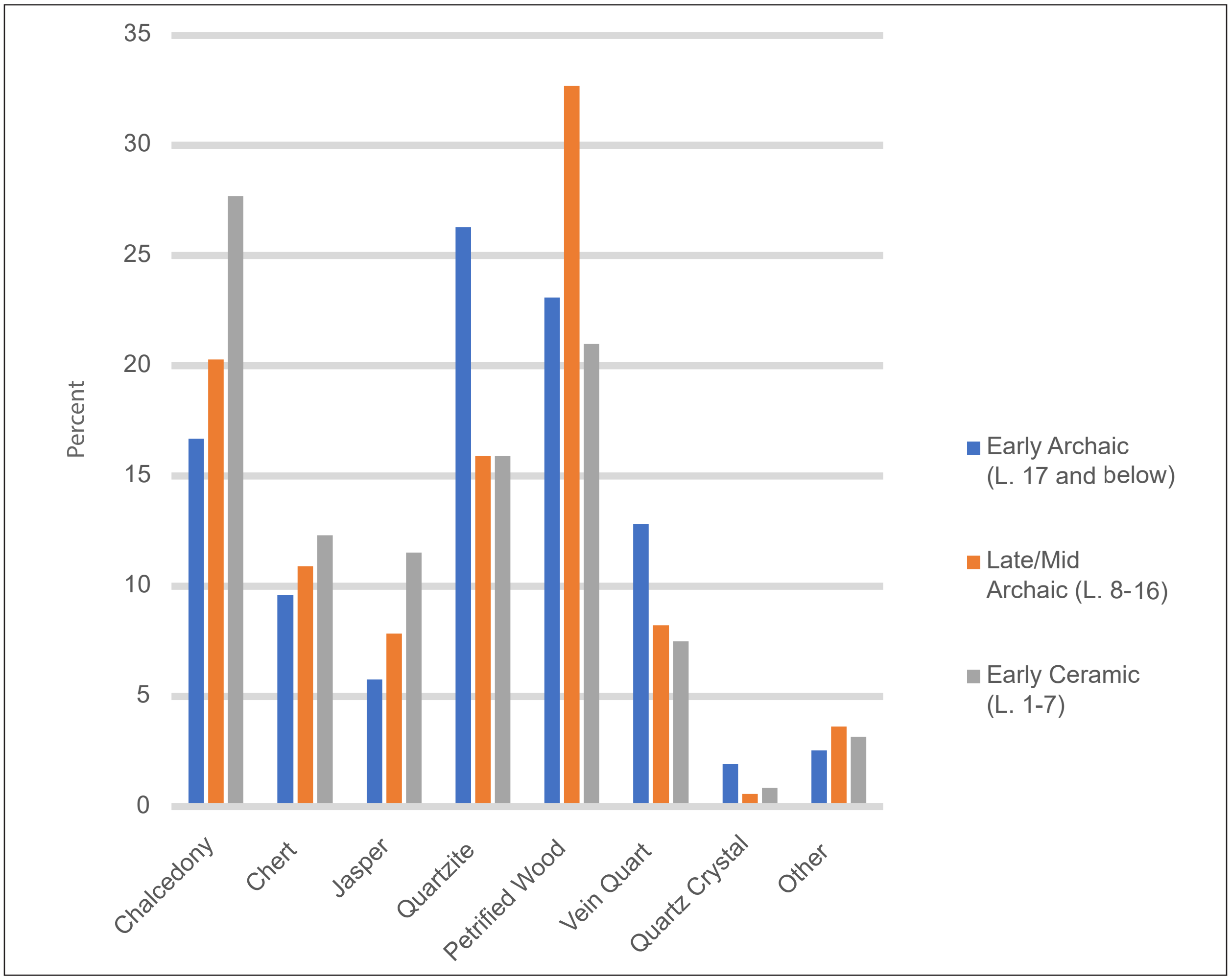

Figure 8.2. Cryptocrystalline usage increases through time, while quartz and quartzite usage decreases in the artifact assemblage.

groups material types and excludes cultural periods with too few projectile points to be statistically meaningful. Figure 8.4 graphs materials of diagnostic points by time period. These tables suggest a similar trend of increasing cryptocrystalline and decreasing quartzite, but with substantially less consistency than seen in the non-diagnostic materials. Quartz is notably absent from the projectile point assemblage, perhaps because it was difficult to flake and only suitable for tools like choppers that required less precision. Quartzite is most common in the Early Archaic and cryptocrystalline material most common in the Early Ceramic, but there is fluctuation of all material types in the Middle and Middle/Late Archaic times that disrupt the trends.

Ground Stone

Materials used for ground stone include sandstone, gneiss, granite, quartzite, and basalt. Fine-

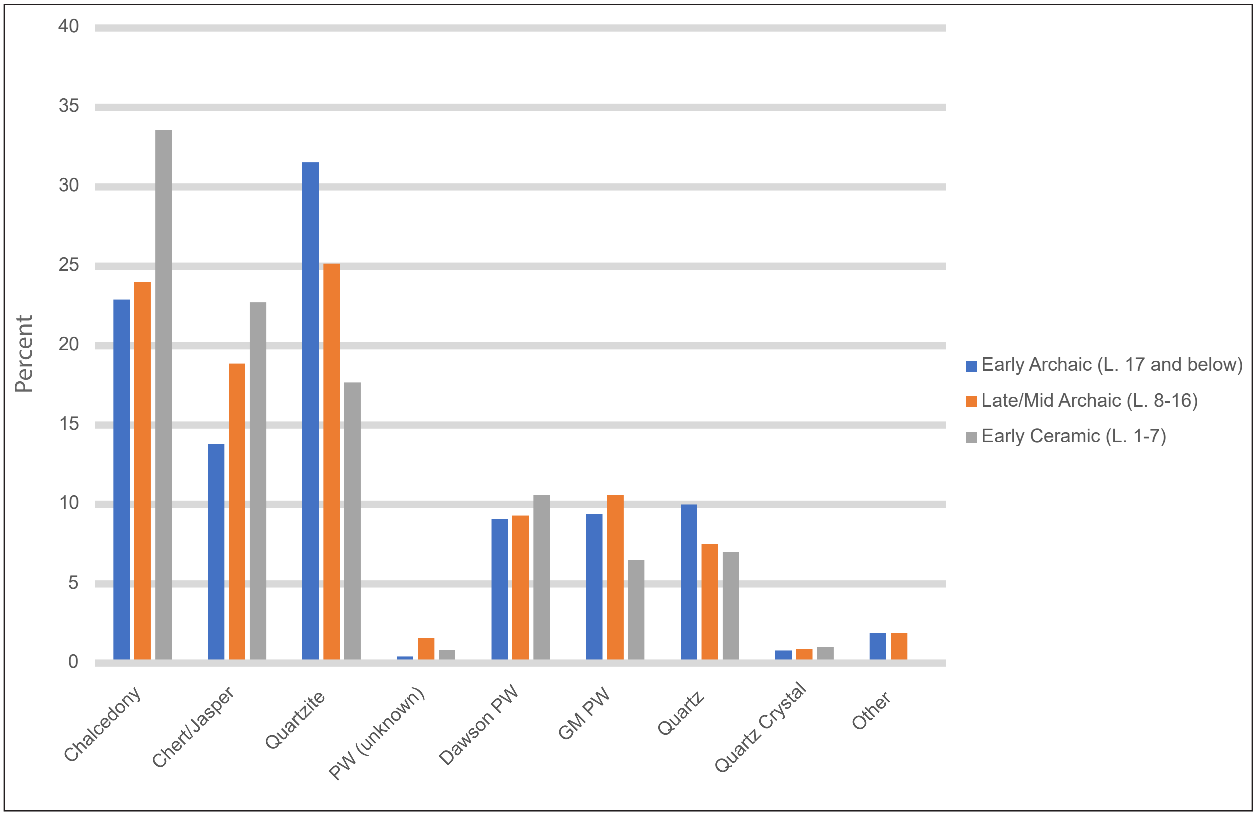

Figure 8.3. Cryptocrystalline materials increase through time while quartzite and quartz decrease in the flake assemblage, similar to the trend seen in tools.

grained sandstone from the Dakota, Lykins, Morrison and Lyons formations of the Hogback valley and ridges was commonly used for grinding stones. Manos are predominantly gneiss (55.0%) followed by fine-grained sandstone (33.7%), and granite, quartzite, and coarse-grained Fountain sandstone. Metates are predominantly fine-grained sandstone (62.6%), gneiss (29.4%), coarse-grained Fountain sandstone (5.6%), and few examples of quartzite, basalt, and granite (See Chapter 10).

At Falcon's Nest, manos are predominantly sandstone, followed by amphibolite, granite, and other materials. Metates are predominantly fine-grained sandstone, with some amphibolite and coarse-grained sandstone (Adkins 1997a:IV:1:1, IV:2:110; Burris et al. 2008:16). Moore and Bush have compiled ground stone material data for 4 excavated sites at Ken Caryl (Bradford II (5JF51), Bradford III (5JF52), Twin Cottonwoods (5JF60), and Southgate (5JF246)) showing sandstone predominated for ground stone tools at all sites, followed by granite and smaller variable amounts of amphibolite, schist, and gneiss (Moore and Bush 2003:11-12, Table 4).

Table 8.4. Material types by time period in the diagnostic projectile point assemblage.

Cultural Period		Ag	Ct	Cy	Js	MQ	Op	PW	PW-D	PW-GM	Qe	Qz-C	Qz-V	Total
Paleo	amt		1											1
	%		100											
EA	amt		3	6	2	4	1		6	1	10			33
	%		9.1	18.2	6.1	12.1	3.0		18.2	3.0	30.3			
EA-MA	amt		1			5			1		2			9
	%		11.1			55.6			11.1		22.2			
MA	amt		8	5	5	4	2		10	10	9			53
	%		15.1	9.4	9.4	7.6	3.7		18.9	18.9	17.0			
MA-LA	amt		3	6	4	7	1	2	11	15	4			53
	%		5.6	11.3	7.6	13.2	1.8	3.8	20.8	28.3	7.6			
LA	amt		2	2	2	1			4	1	3			15
	%		13.3	13.3	13.3	6.7			26.7	6.7	20.0			
LA-EC	amt		2			1								3
	%		66.7			33.3								
EC	amt	3	26	33	12	11	8	1	29	3	39	3	1	169
	%	1.8	15.4	19.5	7.1	6.5	4.7	0.6	17.1	1.8	23.1	1.8	0.6	
MC	amt		4	6		3			4	2	10			29
	%		13.3	20.0		10.0			13.3	6.7	36.7			
Total		3	50	58	25	36	12	3	65	32	78	3	1	365

Table 8.5. Material type data for diagnostic projectile points grouped.

Cultural Period	Quartzite (Qe, MQ)	Petrified Wood (PW-D, PW-GM)	Cryptocrystaline (Ct, Ag, Cy, Js, Op)	Quartz (Qz-C, Qz-V)
Early Archaic	42.5%	21.2%	36.3%	
Middle Archaic	35.9%	37.8%	26.3%	
Middle/Late Archaic	20.8%	49.1%	30.1%	
Early Ceramic	29.6%	18.9%	49.1%	2.4%

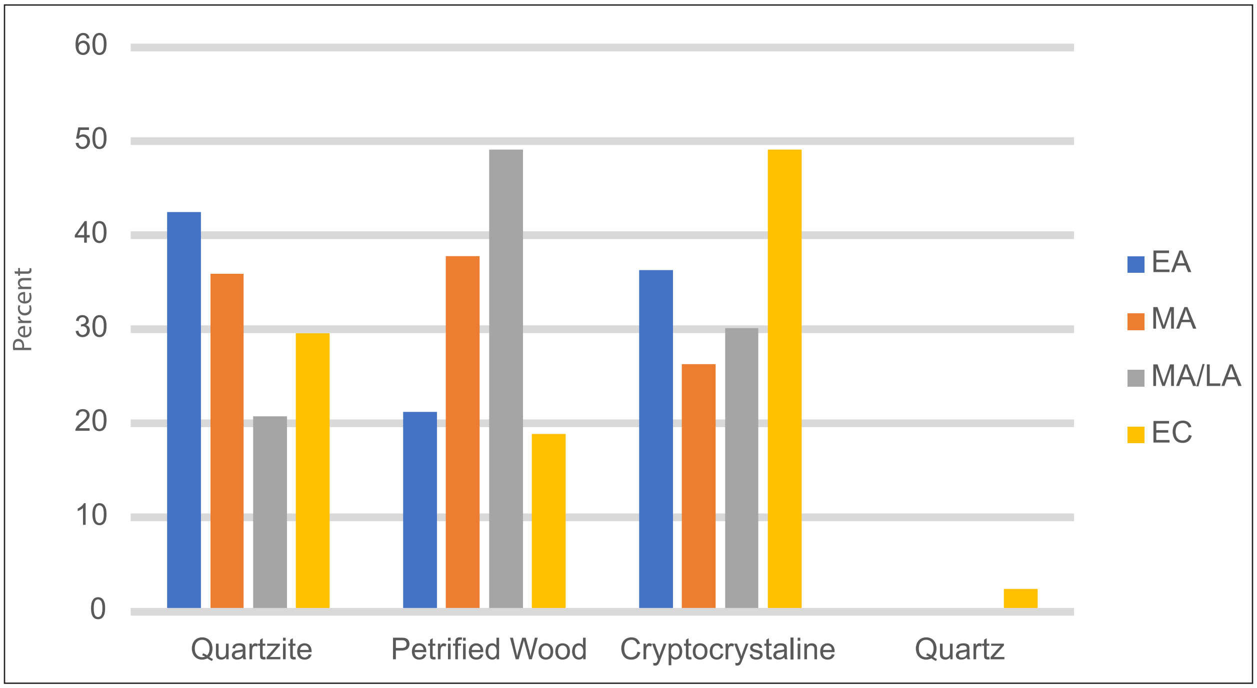

Figure 8.4. Materials in diagnostic points by time period.

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9 Projectile Point Typology

Katherine C. McComb

Over 800 projectile points and fragments of projectile points were recovered from the Swallow site rock shelter. This chapter contains the analysis of those projectile points including a typology for the points based on the variety of point forms. The types and stratigraphic proveniences of the projectile points are charted in correlation with cultural periods. The lithic materials used for the projectile points are delineated and discussed.

About 44 percent (365) of the projectile points and fragments are diagnostic and were classified into named types. The remaining projectile point fragments are divided into five categories: projectile point bases, projectile point tips, notched projectile point fragments, stemmed projectile point fragments, and (unidentifiable) projectile point fragments. These categories are not discussed further in this chapter, but the data for the untypable fragments are in Appendix B.

Background and Methods

The projectile point analysis was conducted by a crew of people from the Indian Peaks Chapter of the Colorado Archaeological Society (IPCAS). The IPCAS crew received a box of 834 Swallow site projectile points and fragments from Bill Hammond, with a handwritten list of the artifacts in order by catalog number giving horizontal and vertical provenience and material type.

The projectile points were already labeled with catalog numbers. However, the points were not thoroughly cleaned (as can be seen in some of the photographs). Some of the points were not numbered, and some of the numbering on the points was illegible. Some of the points on the list were not present in the collection, and some listed points did not have provenience or material type listed. Considerable effort was made to match points with correct catalog numbers and provenience,

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using the handwritten list and a set of catalog cards. A few unnumbered artifacts could not be identified. As a consequence, there may be some slight disparity in the numbers on the tables and the numbers of artifacts in the Swallow projectile point collection.

Each projectile point and fragment was weighed (to the tenth of a gram) and measured (length, width and thickness to the nearest millimeter) by one of the crew. Haft elements were measured, and hafts of all dart points were examined for grinding with an 8-45X stereo microscope. Diagnostic points were checked for fluorescence with both short and long wave ultraviolet light.

The diagnostic points were classified into 13 main types, with a total of 27 projectile point subtypes. Kevin Black guided the division of the projectile points into types. Type descriptions, all photographs, and compilation of the data were completed by the author.

Table 9.1 summarizes the projectile point types and subtypes found at the Swallow site. A brief description, similarity to a named type, time period, and a representative image are presented in the table. Following the table, each subtype is illustrated by representative photographs and pertinent metric data, a more detailed type description and chronological assessment, and the range of material types used for the points in the subtype.

Table 9.1. Projectile point types. Asterisks indicate drawings of artifacts from sites other than Swallow.

Type	Example (Not Scaled)	Description	Similarity/ Named Type	Time Period
1	 *	Unnotched lancelot points. Concave base with grinding on basal edge. The base has a central spur.	Folsom	Paleoindian
2a		Large corner-notched points. Slightly convex to straight base. Deeply notched at the corners. Barbed oblique shoulders. Triangular blade.	LoDaisKa J, MM23	Early Archaic
2b		Large corner-notched points. Straight to very slightly concave base that extends to, or beyond shoulder width. Deeply notched at the corners. Some points almost appear to be side-notched. Oblique shoulders. Triangular blade. 19% of the projectile points are serrated.	LoDaisKa K, MM20	Middle to Late Archaic

Table 9.1 (*continued*). Projectile point types.

Type	Example (Not Scaled)	Description	Similarity/ Named Type	Time Period
2c		Corner-notched points. Wide, convex base extending almost to the shoulders. Large, deep corner-notches. Shoulders are abrupt to tapered/sloping. Short triangular blade, often reworked.	LoDaisKa F, MM22	Late Archaic
3a		Stemmed-indented base points. Very slightly indented to deeply indented base. Straight stem. Small, rounded shoulders to tapered/ sloping shoulders. Triangular blade.	Duncan	Middle Archaic
3b		Stemmed-indented base points. Slight indented base. Slightly expanding stem. Weakly oblique expanding shoulders. Triangular blade.	Hanna	Middle Archaic
3c	 *	Unnotched lanceolate points. Basal indentation. No shoulders.	McKean Lanceolate	Middle Archaic
3d		Stemmed-indented base points. Moderately indented base. Rounded/convex stem edges. Weakly oblique shoulders. Triangular blade.	Pinto Shouldered	Early to Middle Archaic
3e	 *	Medium-large side-notched points. One point has a broadly indented base. The other two have deep narrow indentations that are notch-like. Deep parallel-sided side-notches located near the center of the point, with an abrupt shoulder. Stem edges are straight. All three points are missing a portion of the blade.	Mallory	Middle Archaic
4a		Expanding stem points with straight to very slightly convex base. Shoulders are abrupt to slightly rounded. The broad, high notches form a long stem that gradually expands. Blades are triangular.	LoDaisKa H, MM32	Middle to Late Archaic
4b		Rounded stem points with straight to slightly convex, rounded base. Shoulders are abrupt to rounded. The broad, high notches form a long stem. Some of the stems gradually expand, but most are straight. Blades are triangular.	MM18, MM21	Middle to Late Archaic

Table 9.1 (*continued*). Projectile point types.

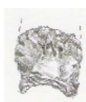
Type	Example (Not Scaled)	Description	Similarity/ Named Type	Time Period
4c		Ovate side-notched points with slightly convex to rounded base. Shoulders are tapered/sloping to slightly rounded. Small, shallow side-notches form a stem and small shoulders. Stems are slightly expanding. Blades are triangular.	LoDaisKa H, MM5	Middle to Late Archaic
4d		Side-notched points with slightly convex to rounded base. Shoulders are abrupt to tapered/sloping. Type 4d distinguishes itself from Type 4c by having side-notches that are deeper. Blades are triangular.	LoDaisKa H, MM3	Early Archaic
5		Concave base points. Definite ears on the base. Very slight shoulder placed low on the base. Ears are ground.	Unknown	Middle to Late Archaic
6	 *	Corner-notched points. Slightly convex base, with grinding on the basal edge. Small, shallow corner notches. Typical Mount Albion corner-notched points have slender, triangular blades.	Mount Albion Corner-Notched	Early Archaic
7	 *	Large side-notched points, with a very large rectangular shaped base. The base is slightly convex. The notches are deep and placed high on the haft element. Shoulders are abrupt and the blade is triangular.	Sudden	Early to MiddleArchaic
8		Small side-notched points. Concave base. Wider notching than Types 11a – 11d. Tapered/sloping shoulders. Triangular blade.	Northern Side-Notched	EarlyArchaic
9		Large side-notched points. Straight to very slightly convex base. Parallel thick blade. Very small amount of grinding on two projectile points.	Besant	Late Archaic
10		Side-notched points. Straight base. Notches located near lower third of the point. Base is rectangular in comparison to Types 8, 11a – 11d. Triangular blade.	Pueblo II, Pueblo III	LateArchaic to Early Ceramic
11a		Small side-notched points. Notches very close to the base. Slightly concave base. Triangular blade.	MM33	Middle Ceramic

Table 9.1 (*continued*). Projectile point types.

Type	Example (Not Scaled)	Description	Similarity/ Named Type	Time Period
11b		Small side-notched points. Notches very close to the base. Slightly convex base. Triangular blade. Miscellaneous points.	MM32	MiddleCeramic
11c		Small, angular corner-notched points. Straight base. Parallel, serrated blade.	LoDaisKa C, MM10	Early Ceramic
11d		Small serrated points with expanding base. Very shallow notching.	LoDaisKa C1, MM12	Middle to Late Archaic
12		Unnotched points. Convex to straight base. This type contains triangular shaped blades, as well as a few lanceolate blades. This type probably includes late production stage bifaces such as projectile point preforms.	MM74, MM75	Middle Ceramic
13a		Small corner-notched points. Convex to straight base. Deep corner notches. Oblique to extended oblique shoulders. Triangular blade. 38% of the projectile points are serrated.	Hogback	Early Ceramic
13b		Small corner-notched points. Convex to straight base. Deep corner notches. Oblique to extended oblique shoulders. Triangular blade. The base differs from Type 13a base by extending almost to the shoulders.	LoDaisKa AA, MM31, Hogback, Ruby Scallorn	Early Ceramic
13c		Small corner-notched points. Slightly convex to straight base. Slender stem. Deep corner notches. Oblique to extended oblique shoulders. Triangular blade. This type is distinguished from Type 13a and 13b by its long, slender blade and slender base.	LoDaisKa CC, MM36, Rose Spring	Early Ceramic

Complete data for each artifact by subtype, including photographs of all typed points, are presented in Appendix B. The data presented include catalog number, provenience by excavation unit and vertical level, weight, metrics including length, width, thickness, maximum and minimum haft width, and presence and location of haft grinding. Material type for each artifact is given using both the Rathbun system and more standard material types, discussed below.

Stratigraphic distribution of points by type is discussed later in the chapter. Lithic material types are discussed following Stratigraphy.

Swallow Site Types

Type 1: Folsom Preform

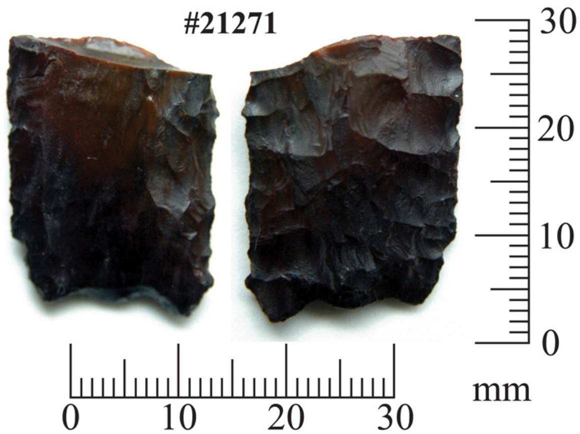


Figure 9.1. Type 1, Folsom preform.

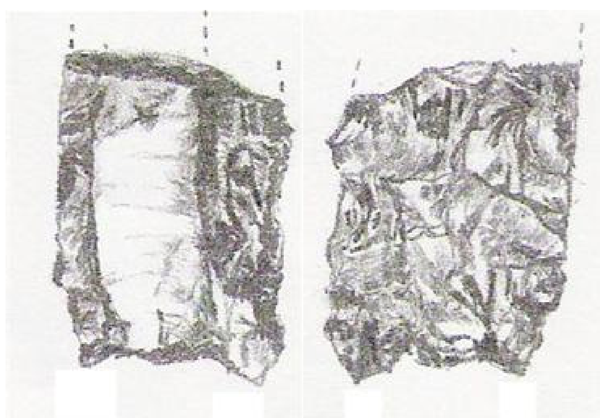


Figure 9.2. Drawing of Folsom preform, #21271.

N=1
Material Type: Chert

Description: This preform has a transverse snap fracture at the middle of the blade. Only one side is fluted. It is ground on the edge of the base. The maximum flute width is 11.3 mm. It is metrically similar to Folsom projectile points and preforms from the Lindenmeier site (Wilmsen and Roberts 1984: 117).

Chronological Assessment: The preform was located under the rockfall and is one of a few projectile points found at the deepest levels of excavation. Scattered charcoal found below the preform was dated at 8320±60 RCYBP (cal 7490-7200 BC, 1-sigma range). The presence of a Folsom preform indicates a possible Paleoindian occupation at the Swallow site or Early Archaic reuse of the artifact.

Type 2a and Type 2b: Large Corner-Notched Projectile Points

Types 2a and 2b are groups of large corner-notched projectile points. The wider base width distinguishes Type 2b from Type 2a. The average haft width of Type 2a projectile points is 69% of the shoulder width. The average haft width of Type 2b projectile points is 88% of the shoulder width.

Type 2a: Large Corner-Notched Projectile Points

Figure 9.3. Type 2a, large corner-notched projectile points.

N=19
Length: 1.91 – 4.02 cm range; 2.86 cm mean
Width: 1.83 – 2.72 cm range; 2.09 cm mean
Thickness: 0.39 - 0.66 cm range; 0.49 cm mean
Material Types: Chert, Chalcedony, Jasper, Morrison Quartzite, Petrified Wood, Quartzite

Description: The four projectile points in the top row of Figure 9.3: Type 2a, Large Corner-Notched Projectile Points, were found beneath the rockfall at some of the lowest layers of the excavation.

The projectile points in this category have slightly convex to straight bases, with an expanding stem. They are deeply notched at the corners with barbed oblique shoulders. Three of the nineteen points are serrated. Four of the projectile points are ground on the base, and four are ground at the notches. Two of them appear to be reworked.

Chronological Assessment: Type 2a is similar to Magic Mountain site MM 23 points associated with the Archaic period (Irwin-Williams and Irwin 1966), and LoDaisKa Type J points associated with the Archaic period (Irwin and Irwin 1959).

Type 2b: Large Corner-Notched Projectile Points with Wide Base

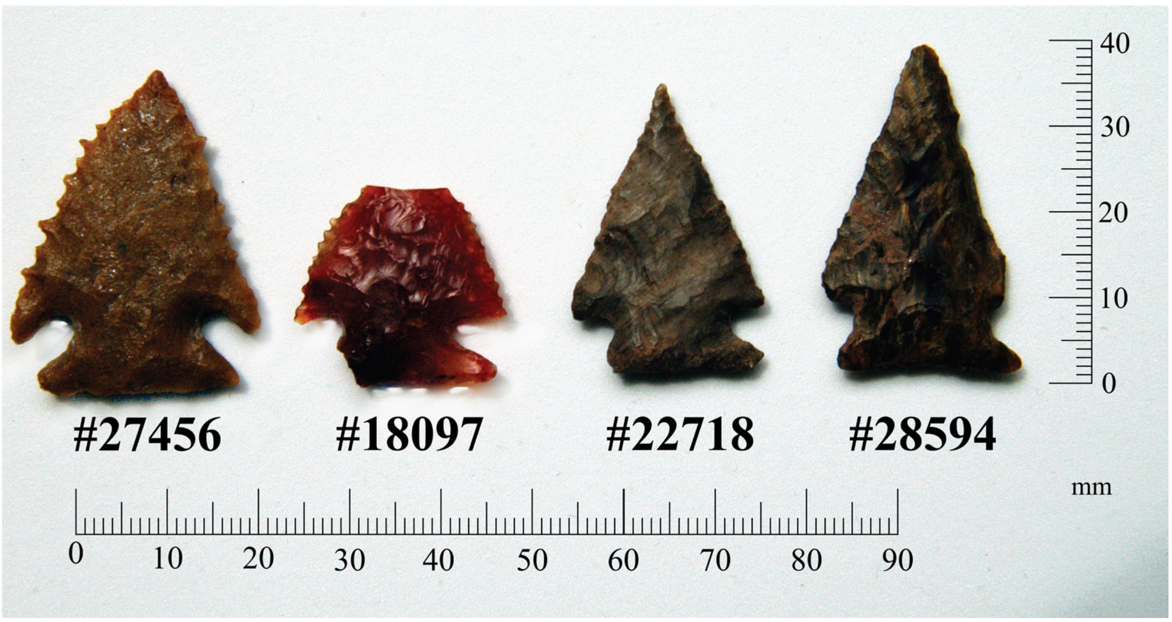


Figure 9.4. Type 2b, large corner-notched projectile points with wide base.

N=16
Length: 1.27 – 3.59 cm range; 2.39 cm mean
Width: 1.24 – 2.75 cm range; 2.10 cm mean
Thickness: 0.37 – 0.57 cm range; 0.48 cm mean
Material Types: Chalcedony, Jasper, Morrison Quartzite, Petrified Wood, Quartzite

Description: These projectile points have straight to very slightly concave bases that extend almost to, or beyond, the shoulder width. They are deeply notched at the corners with some points almost appearing to be side notched. Shoulders are oblique. Four out of the sixteen points are serrated, and two have been reworked. Over half of the projectile points have grinding on the base and/or the notches.

Chronological Assessment: Type 2b is similar to Magic Mountain site MM 20 points associated with the Archaic period (Irwin-Williams and Irwin 1966), and LoDaisKa Type K points associated with the Archaic period (Irwin and Irwin 1959).

Type 2c: Medium Corner-Notched Projectile Points with Wide Bases

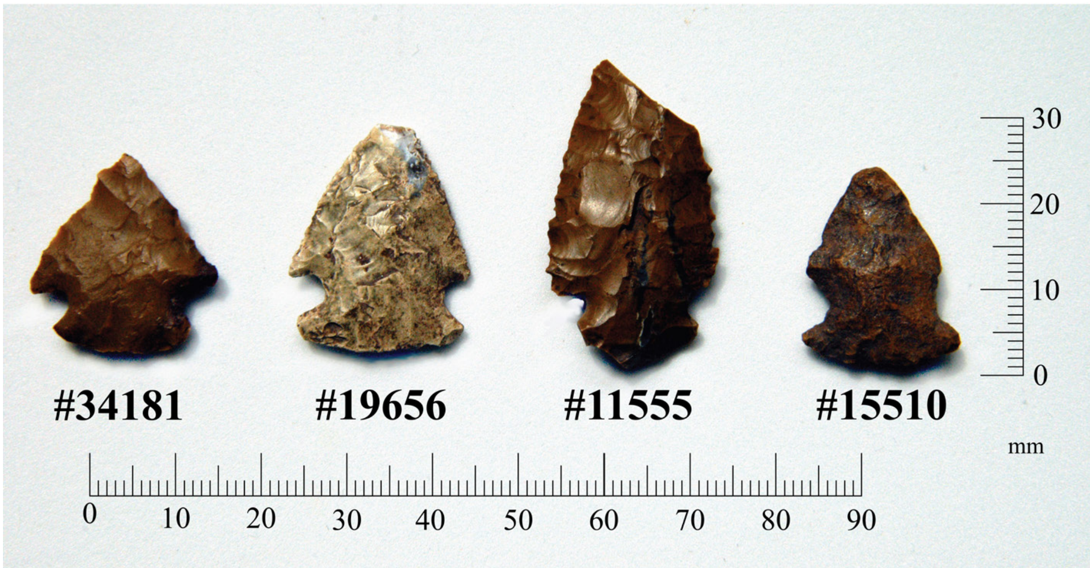


Figure 9.5. Type 2c, medium coner-notched projectile points with wide bases.

N=10
Length: 1.08 – 3.54 cm range; 2.43 cm mean
Width: 1.50 – 2.15 cm range; 1.92 cm mean
Thickness: 0.42 – 0.55 cm range; 0.50 cm mean
Material Types: Chalcedony, Chert, Jasper, Morrison Quartzite, Petrified Wood, Quartzite

Description: These projectile points are smaller than Types 2a and 2b, and are larger than the smaller corner-notched projectile points, Types 13a – 13c. The base of these points is convex and extends almost to the shoulder width, with two of them extending beyond the shoulder width. The corner notches range from deeply notched to a wide shallow notch, giving the base an hourglass shape. Shoulders are abrupt to tapered/sloping. The blade is triangular shaped. Half of the projectile points have some amount of grinding. Two points, #20996 and #27113, are ground on one notch only.

Chronological Assessment: Type 2c is similar to Magic Mountain site MM 23 points associated with the Late Archaic period (Irwin-Williams and Irwin 1966), and LoDaisKa Type F points associated with the Late Archaic period (Irwin and Irwin 1959).

Type 3a: Stemmed-Indented Base Projectile Points (Duncan)

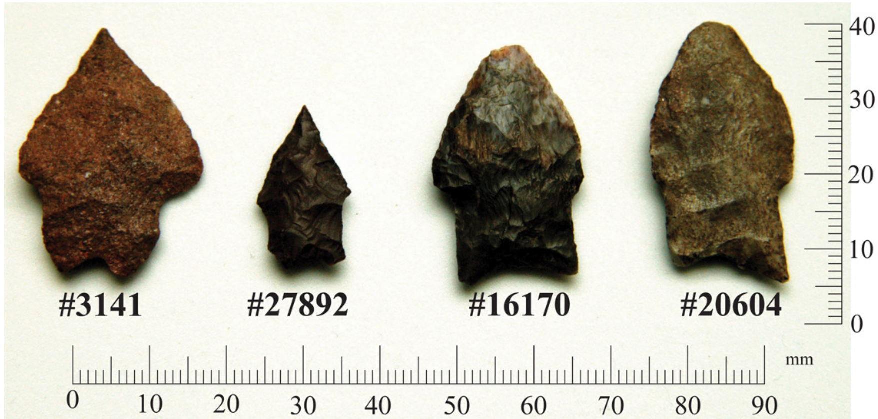


Figure 9.6. Type 3a, stemmed-indented base projectile points (Duncan).

N=44
Length: 0.87 – 4.29 cm range; 2.08 cm mean
Width: 1.14 – 2.65 cm range; 1.62 cm mean
Thickness: 0.29 – 0.75 cm range; 0.45 cm mean
Material Types: Chalcedony, Chert, Jasper, Morrison Quartzite, Opal, Petrified Wood, Quartzite

Description: The indentation on the base of the Duncan points ranges from a shallow concave base to small basal notch. Stems are straight to slightly expanding at the base. Shoulders are tapered/sloping. A few of the projectile points exhibit slightly rounded shoulders. Twenty-three percent of the projectile points have a small amount of grinding on the stem.

Chronological Assessment: The Duncan projectile point type is a named type of the McKean complex (Wheeler 1954) and dates to the Middle Archaic period.

Type 3b: Stemmed-Indented Base Projectile Points (Hanna)

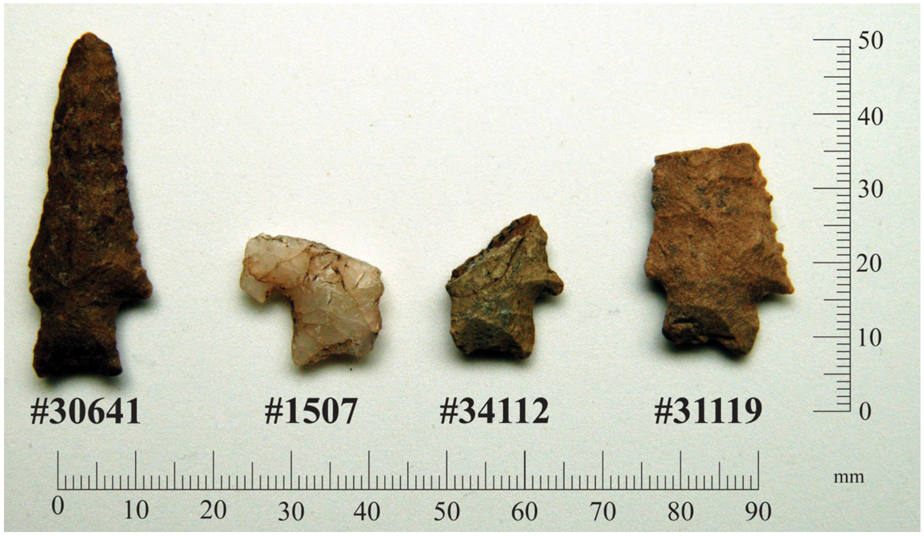


Figure 9.7. Type 3b, stemmed-indented base projectile points (Hanna).

N=4
Length: 1.66 – 4. 49 cm range; 2.67 cm mean
Width: 1.50 – 1.86 cm range; 1.64 cm mean
Thickness: 0.49 – 0.52 cm range; 0.50 cm mean
Material Types: Chert, Morrison Quartzite, Quartzite

Description: The indentation on the base of the Hanna points is a shallow concave base. Stems are formed by a wide, shallow notch. Shoulders are well-defined. Two of the projectile points exhibit very fine blade serrations. All of the projectile points are ground, each on different portions of the stem.

Chronological Assessment: The Hanna projectile point type (Wheeler 1954) is a named type of the McKean complex and dates to the Middle Archaic period.

Type 3c: Indented Base Projectile Points (McKean Lanceolate)

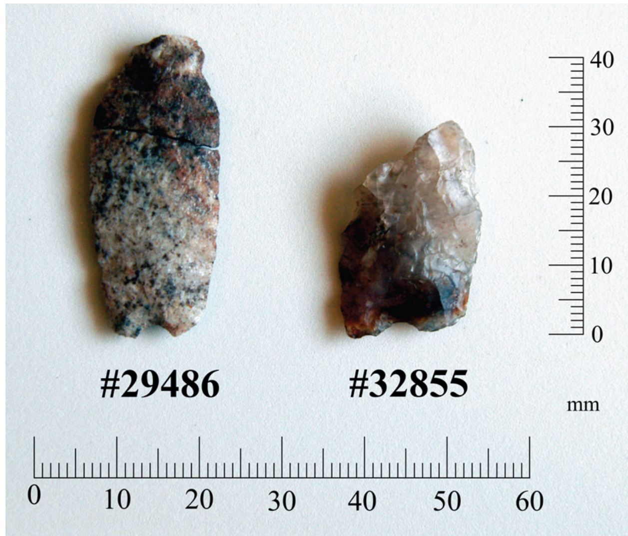


Figure 9.8. Type 3c, indented base projectile points (McKean Lanceolate).

N=2
Length: 2.99 – 3.00 cm range; 3.00 cm mean
Width: 1.79 – 1.85 cm range; 1.82 cm mean
Thickness: 0.48 – 0.62 cm range; 0.56 cm mean
Material Types: Chalcedony, Quartzite

Description: The indentation on the base of the McKean Lanceolate points is a circular notch. Blade edges curve inward toward the tip approximately 2/3 of the length (the point of maximum width) from the base. The lower blade edges are parallel, expanding to the point of maximum width. Artifact #29486 exhibits parallel oblique flaking on one face. The base of artifact #29486 matches the tip portion of #35490.

Chronological Assessment: The McKean Lanceolate projectile point type (Wheeler 1952; Mulloy 1954; Green 1975) is a named type of the McKean complex and dates to the Middle Archaic period.

Type 3d: Stemmed-Indented Base Projectile Points

Figure 9.9. Type 3d, stemmed-indented base projectile points.

N=8
Length: 1.33 – 3.84 cm range; 2.70 cm mean
Width: 1.51 – 1.72 cm range; 1.60 cm mean
Thickness: 0.45 – 0.57 cm range; 0.51 cm mean
Material Types: Chert, Morrison Quartzite, Petrified Wood, Quartzite

Description: The projectile points in this category have moderately indented bases. The indentation is deeper than the Duncan, Hanna and McKean Lanceolate points. This type is distinguished from the Hanna projectile points by the rounded/convex stem edges. Shoulders are weakly oblique. One of the projectile points (#36362) has finely serrated blade edges. All but one of the points are ground, primarily on the stem edges.

Chronological Assessment: This projectile point is similar to the Pinto Shouldered projectile points found at the Yarmony site (Metcalf and Black 1991). Pinto Shouldered projectile points date to the Early Archaic period (Holmer 1993). Stemmed-indented base points date to the Middle Archaic period on the Plains (Lister 1953).

Type 3e: Stemmed-Indented Base Projectile Points (Mallory)

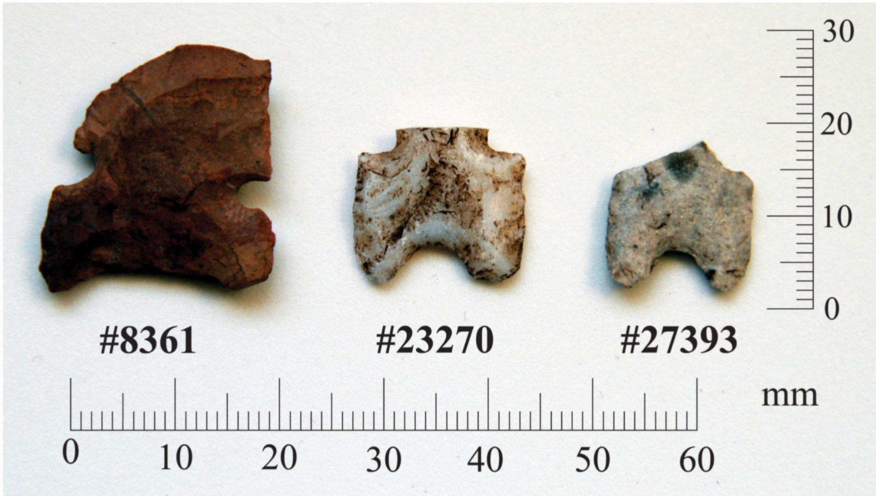


Figure 9.10. Type 3e, stemmed-indented base projectile points (Mallory).

N=3
Length: 1.63 – 3.74 cm range; 2.63 cm mean
Width: 1.51 – 2.13 cm range; 1.82 cm mean
Thickness: 0.42 – 0.68 cm range; 0.54 cm mean
Material Types: Opal, Quartzite

Description: Only one of the projectile points in this category is large enough to classify as a true Mallory point (#8361). The other two points have Mallory characteristics but are smaller than typical Mallory points (#23270, #27393).

#8361 has a shallow, concave base and side notches near the midpoint. The intact portion of the blade suggests a parallel blade shape. The side notches are deep and form well-defined, abrupt shoulders.

#23270 and #27393 have a distinct basal indentation in comparison to #8361. Stem edges are rounded/convex. Both artifacts are snapped at the blade and have notches that are placed high up on the stem.

Chronological Assessment: The Mallory projectile point type (Strong 1935; Forbis 1985) is a named type of the McKean complex and dates to the Middle Archaic period.

Type 4a: Expanding Stem Projectile Points

Figure 9.11. Type 4a, expanding stem projectile points.

N=9
Length: 1.63 – 3.74 cm range; 2.63 cm mean
Width: 1.51 – 2.13 cm range; 1.82 cm mean
Thickness: 0.42 – 0.68 cm range; 0.54 cm mean
Material Types: Morrison Quartzite, Petrified Wood, Quartzite

Description: The base of the Type 4a projectile points is straight to very slightly convex. Length of the base ranges from 1.32 cm to 1.81 cm. Shoulders are abrupt to slightly rounded. The broad, high notches form a long stem that gradually expands. Blades are triangular and appear to be resharpened on several specimens. There is slight grinding on two of the points.

Chronological Assessment: Type 4a projectile points are similar in size and morphology to LoDaisKa type H (Irwin and Irwin 1959). These projectile points probably date from the Middle to Late Archaic periods.

Type 4b: Rounded Stem Projectile Points

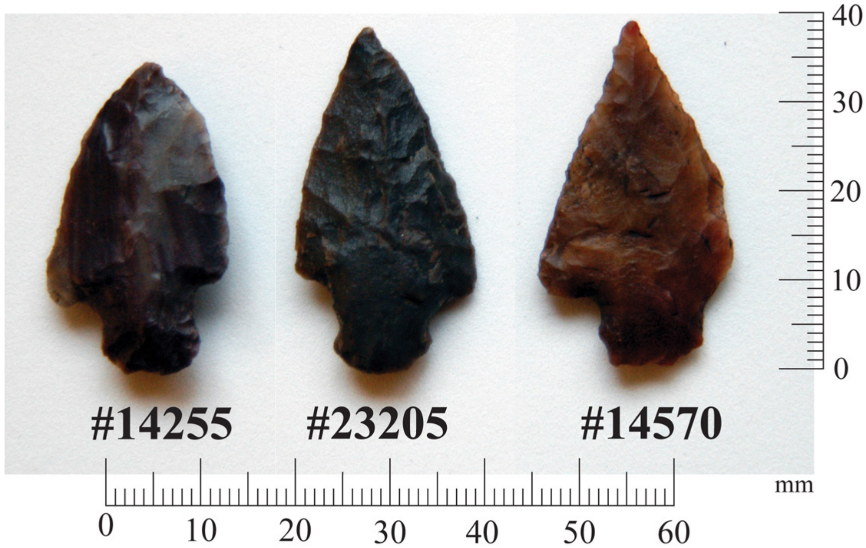


Figure 9.12. Type 4b, rounded stem projectile points.

N=11
Length: 1.10 – 3.63 cm range; 2.85 cm mean
Width: 1.39 – 2.42 cm range; 1.78 cm mean
Thickness: 0.35 – 0.64 cm range; 0.49 cm mean
Material Types: Chalcedony, Chert, Jasper, Morrison Quartzite, Petrified Wood, Quartzite

Description: The base of the Type 4b projectile points is straight to slightly convex and rounded. The base of the Type 4b points ranges from 0.82 cm to 1.2 cm. This characteristic distinguishes these points from Type 4a. Shoulders are abrupt to rounded. The broad, high notches form a long stem. Some of the stems gradually expand, but most are straight. Blades are triangular. Over half of the projectile points in this category have some kind of grinding on the stem.

Chronological Assessment: Type 4b projectile points are similar in size and morphology to Magic Mountain MM18 and MM21 projectile points (Irwin-Williams and Irwin 1966). These projectile points probably date from the Middle to Late Archaic periods.

Type 4c: Ovate Side-Notched Projectile Points

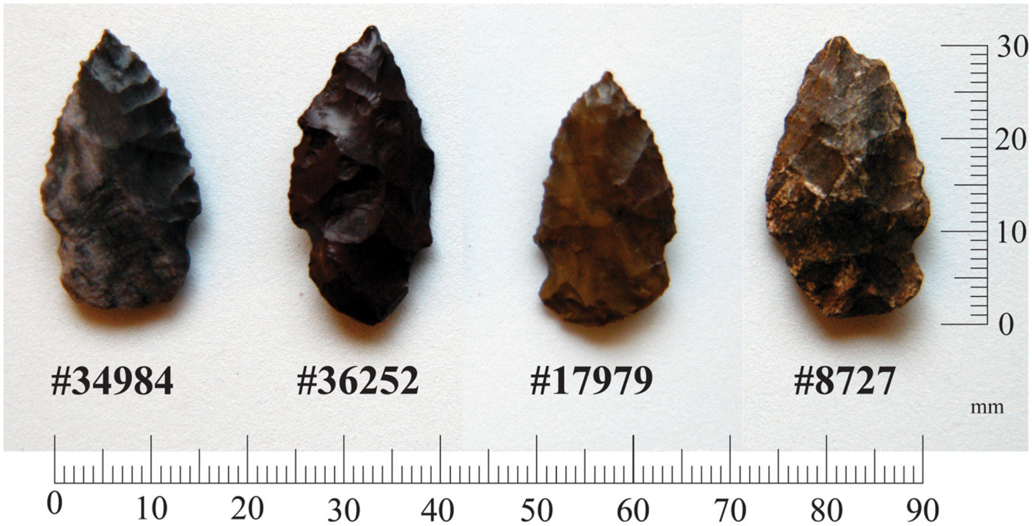


Figure 9.13. Type 4c, ovate side-notched projectile points.

N=14
Length: 1.23 – 3.93 cm range; 2.18 cm mean
Width: 1.40 – 1.74 cm range; 1.55 cm mean
Thickness: 0.39 – 0.78 cm range; 0.58 cm mean
Material Types: Chalcedony, Jasper, Opal, Petrified Wood

Description: The base of the Type 4c projectile points is slightly convex to rounded. Shoulders are tapered/sloping to slightly rounded. Small, shallow side-notches form a stem and small shoulders. Stems are slightly expanding. Blades are triangular. All but two of the projectile points are ground.

Chronological Assessment: Type 4c projectile points are similar in size and morphology to some of the Magic Mountain MM 5 projectile points (Irwin-Williams and Irwin 1966), and LoDaisKa type H (Irwin and Irwin 1959). These projectile points probably date from the Middle to Late Archaic periods.

Type 4d: Side-Notched Projectile Points

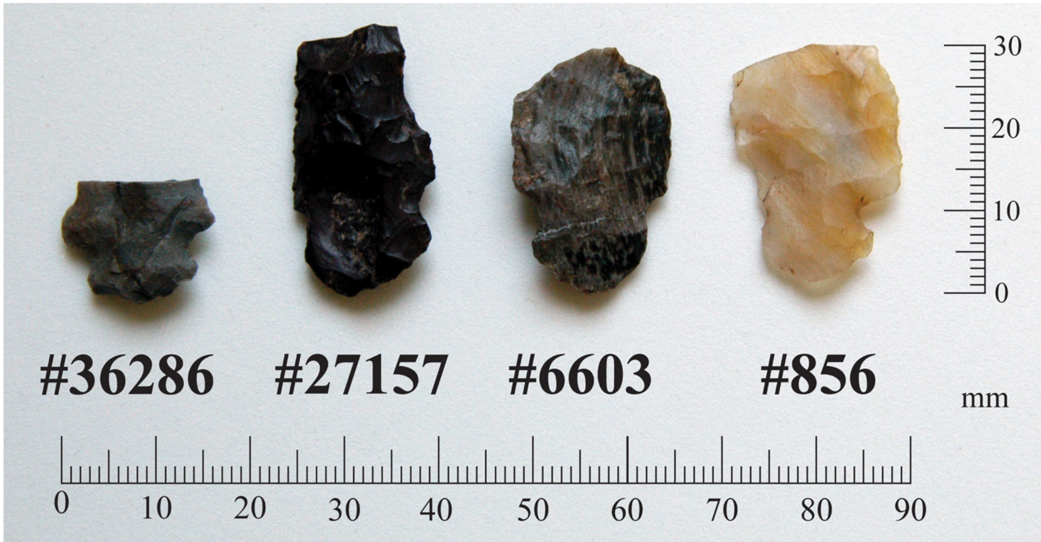


Figure 9.14. Type 4d, side-notched projectile points.

N=11
Length: 1.24 – 3.15 cm range; 2.09 cm mean
Width: 1.45 – 2.04 cm range; 1.76 cm mean
Thickness: 0.25 – 0.64 cm range; 0.48 cm mean
Material Types: Chert, Jasper, Morrison Quartzite, Opal, Petrified Wood

Description: The base of the Type 4d projectile points is slightly convex to rounded. Shoulders are abrupt to tapered/sloping. Type 4d distinguishes itself from Type 4c by having side notches that are deeper. Blades are triangular. Over half of the projectile points have some amount of grinding on the notches or the base.

Chronological Assessment: Type 4d projectile points are similar in size and morphology to Magic Mountain MM 3 projectile points (Irwin-Williams and Irwin 1966), and LoDaisKa type H (Irwin and Irwin 1959). These projectile points probably date from the Early Archaic period.

Type 5: Concave Base Projectile Points

Figure 9.15. Type 5, concave base projectile point.

N=1
Material Type: Chert

Description: This fragment of a projectile point differs from the Duncan projectile points in several different ways. The base is more strongly concave than the Duncan points. The ears on the base are definite and are ground. Few of the Duncan points are ground and the ones that are, are minimally ground. The very slight shoulder on the fragment is lower in placement than the Duncan shoulders. The concavity of the base is thicker and less refined than the Duncan points.

Chronological Assessment: This unique specimen does not appear to resemble any known type in this region. It probably dates from the Middle to Late Archaic.

Type 6: Corner-Notched Projectile Points (Mount Albion)

Figure 9.16. Type 6, corner-notched projectile point (Mount Albion).

N=1
Material Type: Morrison Quartzite

Description: Corner-notched fragment of a projectile point. This fragment has a slightly convex base, with grinding on the basal edge. Corner notches are small and shallow. Typical Mount Albion corner-notched points have slender, triangular blades.

Chronological Assessment: The Mount Albion corner-notched projectile point type (Benedict and Olson 1978) is a named type of the Mount Albion complex and dates to the Early Archaic period.

Type 7: Side-Notched Projectile Points (Sudden Side-Notched)

Figure 9.17. Type 7, side-notched projectile point (Sudden Side-Notched).

N=1
Material Type: Quartzite

Description: This projectile point has high deep side notches, with a straight base that has very slight basal notches from thinning. It is ground on one side of the base. The sides of the base are slightly rounded, and the notches are angled slightly toward the base. Typical Sudden Side-Notched points have triangular blades.

Chronological Assessment: The Sudden Side-Notched type (Holmer 1978, 1993) has been dated from the Early to Middle Archaic periods. Sudden Side-Notched points have been found primarily on the Western slope in Colorado.

Type 8: Side-Notched Projectile Points (Northern Side-Notched)

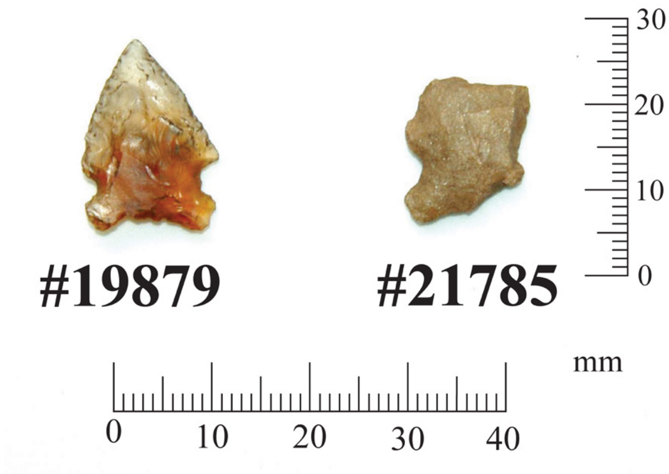


Figure 9.18. Type 8, side-notched projectile points (Northern Side-Notched).

N=2
Length: 1.93 – 2.43 cm range, 2.18 cm mean
Width: 1.54 – 1.73 cm range, 1.64 cm mean
Thickness: 0.47 – 0.49 cm range, 0.48 mean
Material Type: Chalcedony, Quartzite

Description: These projectile points have U-shaped side notches, with a concave base. The side notches, along with the base, form the ears of the base. The edge of the ear is straight. The blade is triangular. One of the points, #21785, has grinding on the existing notch.

Chronological Assessment: The Northern Side-notched point (Gruhn 1961, Holmer 1993) dates to the Early Archaic period.

Type 9: Side-Notched Projectile Points (Besant)

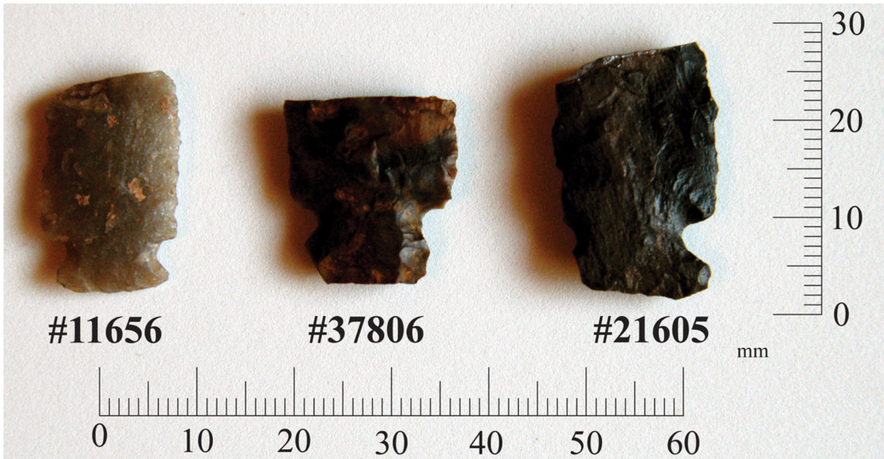


Figure 9.19. Type 9, side-notched projectile points (Besant).

N=5
Length: 1.11 – 3.04 cm range; 2.10 cm mean
Width: 1.61 – 2.05 cm range; 1.83 cm mean
Thickness: 0.34 – 0.55 cm range; 0.43 cm mean
Material Type: Chalcedony, Jasper, Petrified Wood, Quartzite

Description: These projectile points have deep side notches, with a straight to slightly convex base. The base of the Besant projectile point extends to or almost to the edge of the shoulders. The sides of the blade are long and parallel. Three of the projectile points have some minimal grinding on the base or the notches.

Chronological Assessment: The Besant projectile point type dates to the Late Archaic period (Frison 1991).

Type 10: Side-Notched Projectile Points

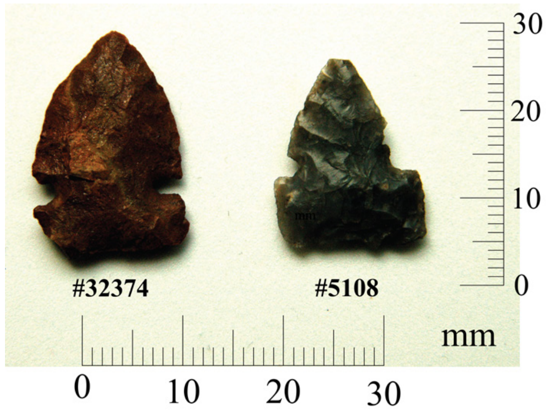


Figure 9.20. Type 10, side-notched projectile points.

N=3
Length: 1.28 – 2.52 cm range; 1.96 cm mean
Width: 1.71 – 1.87 cm range; 1.77 cm mean
Thickness: 0.42 – 0.46 cm range; 0.44 cm mean
Material Type: Chert, Morrison Quartzite

Description: These projectile points have deep side notches and a straight base. They are similar in morphology to the Sudden projectile point type, but they are much smaller. The base has a rectangular shape, with the side notches located at least a third of the distance from the distal end of the projectile point. The blade shape is triangular. Due to its smaller blade, #5108 appears to be reworked. None of the projectile points are ground.

Chronological Assessment: Large Sudden points usually date to the Early Archaic. However, the three smaller projectile points indicate a later date of Late Archaic to the Early Ceramic periods. The points are similar to Pueblo II – Pueblo III projectile points with rectangular bases (Rohn 1977).

Type 11a: Small Side-Notched Projectile Points

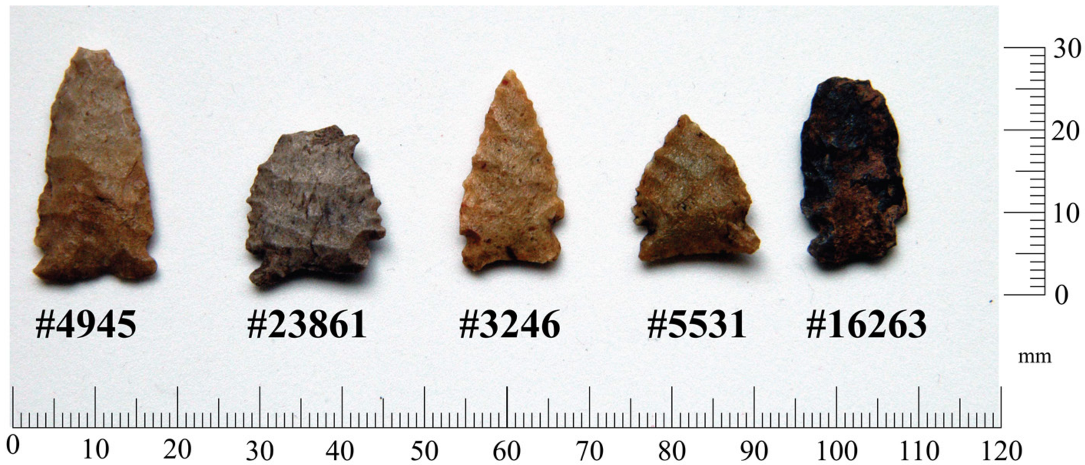


Figure 9.21. Type 11a, small side-notched projectile points.

N=6
Length: 1.37 – 3.02 cm range; 2.17 cm mean
Width: 1.32 – 1.92 cm range; 1.58 cm mean
Thickness: 0.32 – 0. 43 cm range; 0.37 cm mean
Material Type: Morrison Quartzite, Quartzite

Description: These projectile points are small and have side-notches located close to the base. The side-notches are also small. The base has a slight, wide, concavity, making the base appear to be eared. The blade of these projectile points ranges from triangular to parallel. None of the projectile points exhibits grinding.

Chronological Assessment: Although one of these small side-notched arrow points was found at one of the lower proveniences, this type of projectile point dates to the Middle Ceramic period. Type 11a is similar to Magic Mountain site MM 33 projectile points (Irwin-Williams and Irwin 1966). #5531 is smaller and thinner than the rest of the projectile points in this group. It is similar to the Gulf Lake “Classic” Variety projectile point type, dated to the Late Archaic period (Kehoe 1966).

Type 11b: Small Side-Notched Projectile Points

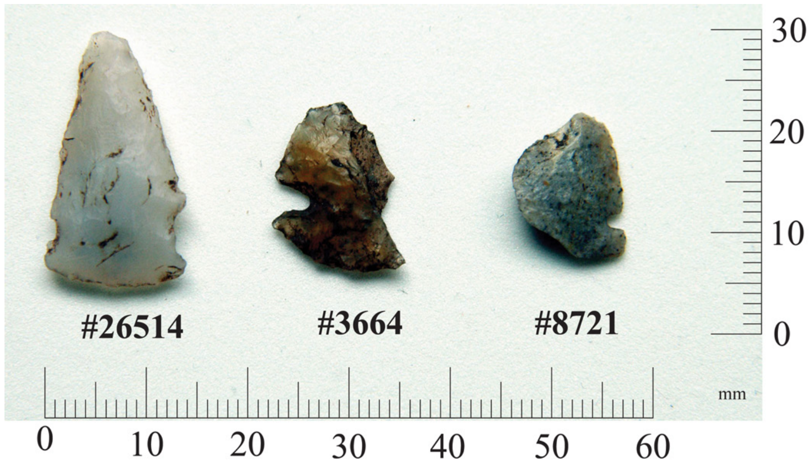


Figure 9.22. Type 11b, small side-notched projectile points.

N=3
Length: 1.19 – 2.33 cm range; 2.17 cm mean
Width: 1.32 – 1.92 cm range; 1.58 cm mean
Thickness: 0.32 – 0.43 cm range; 0.37 cm mean
Material Type: Chalcedony, Quartzite

Description: These projectile points are small and have side-notches located close to the base. The side-notches range from shallow, wide notches to deeply side-notched. The base ranges from slightly convex to more circular, fan-shaped base. None of the projectile points exhibits grinding.

Chronological Assessment: Small side-notched arrow points are characteristic of the Middle Ceramic period. Type 11b is similar to Magic Mountain site MM 32 projectile points (Irwin-Williams and Irwin 1966).

Type 11c: Small Corner-Notched Projectile Points

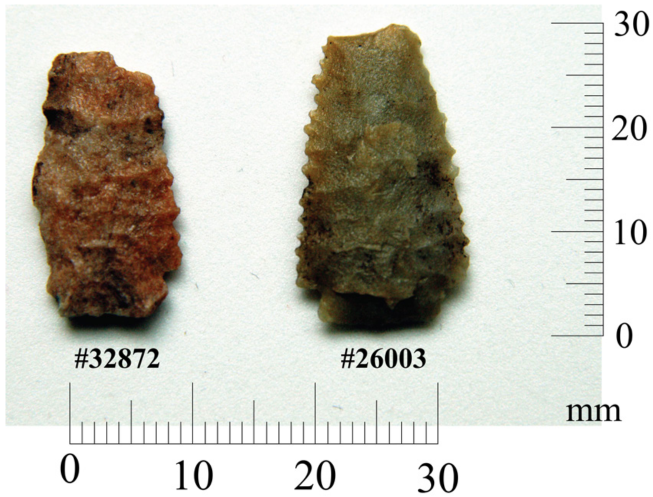


Figure 9.23. Type 11c, small corner-notched projectile points.

N=2
Length: 2.56 – 2.87 cm range; 2.72 cm mean
Width: 1.35 – 1.62 cm range; 1.49 cm mean
Thickness: 0.37 cm (both specimens)
Material Type: Quartzite

Description: These projectile points are small and slender. They have small, angular corner notches located close to the base. The blade is parallel shaped and finely serrated. None of the projectile points exhibits grinding.

Chronological Assessment: Small corner-notched arrow points are characteristic of the Early Ceramic period. Type 11c is similar to Magic Mountain site MM 10 projectile points (Irwin-Williams and Irwin 1966) and LoDaisKa Type C (Irwin and Irwin 1959).

Type 11d: Small Side-Notched Projectile Points

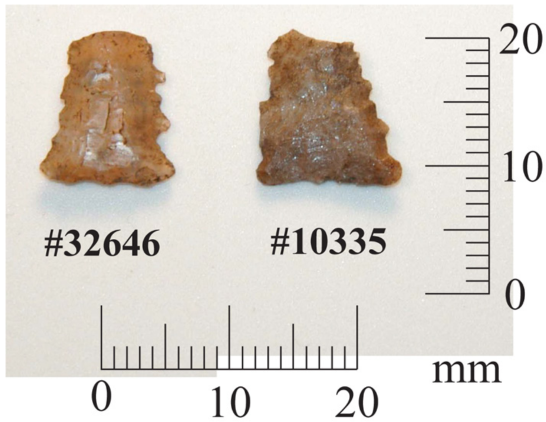


Figure 9.24. Type 11d, small side-notched projectile points.

N=2
Length: 1.57 – 1.60 cm range; 1.59 cm mean
Width: 1.35 – 1.46 cm range; 1.41 cm mean
Thickness: 0.32 – 0.38 cm range; 0.35 cm mean
Material Type: Chalcedony, Quartzite

Description: These projectile points have small side-notches placed close to the base. The base is straight. The blade is parallel shaped and finely serrated, with the notches being only slightly larger than the serrations. None of the projectile points exhibits grinding.

Chronological Assessment: These projectile points are similar to projectile points of the Armijo complex of the Oshara tradition (Irwin-Williams 1973), and date from the Middle to the Late Archaic periods.

Type 12: Unnotched Projectile Points

Figure 9.25. Type 12, unnotched projectile points.

N=20
Length: 1.53 – 3.32 cm range; 2.41 cm mean
Width: 0.97 – 2.05 cm range; 1.65 cm mean
Thickness: 0.28 – 0.80 cm range; 0.39 cm mean
Material Type: Chalcedony, Chert, Morrison Quartzite, Petrified Wood, Quartzite

Description: These projectile points are unnotched. The blade is an ovate or triangular shape, and the base of the projectile points is straight to slightly convex. Two of the specimens have a single notch, and none of the projectile points exhibits grinding. These projectile points are considered to be preforms by some, and unnotched projectile points by others.

Chronological Assessment: Triangular unnotched points are a trait of the Middle Ceramic period (Eighmy 1984). Type 12 is similar to Magic Mountain types MM 74 and MM 75.

Type 13a: Small Corner-Notched Projectile Points (Hogback)

Figure 9.26. Type 13a, small corner-notched projectile points (Hogback).

N=115
Length: 0.69 – 2.76 cm range; 1.84 cm mean
Width: 0.84 – 1.97 cm range; 1.35 cm mean
Thickness: 0.13 – 0.4 cm range; 0.29 cm mean
Material Type: Agate, Chalcedony, Chert, Crystalline Quartz, Jasper, Morrison Quartzite, Opal, Petrified Wood, Quartzite, Vein Quartz

Description: These projectile points have corner notches in a variety of positions on the base. Some points are notched directly from the basal edge, with the notch in almost a vertical position. Some points are notched from the side so that the notches are in a horizontal position. Most of the projectile points exhibit a notch that falls in between the horizontal and vertical position, a diagonal notch from the corner. Bases range from very slightly concave to slightly convex. Shoulders range from rounded to abrupt to tapered/sloping. Blades are triangular. This category of projectile points was not checked for grinding.

Chronological Assessment: The Hogback projectile point (Benedict 1990) is a named type of the Early Ceramic period. The Hogback projectile point is similar to Magic Mountain types MM34, MM35 and MM37 (Irwin-Williams and Irwin 1966), and LoDaisKa types AA and BB points (Irwin and Irwin 1959).

Type 13b: Small Corner-Notched Projectile Points

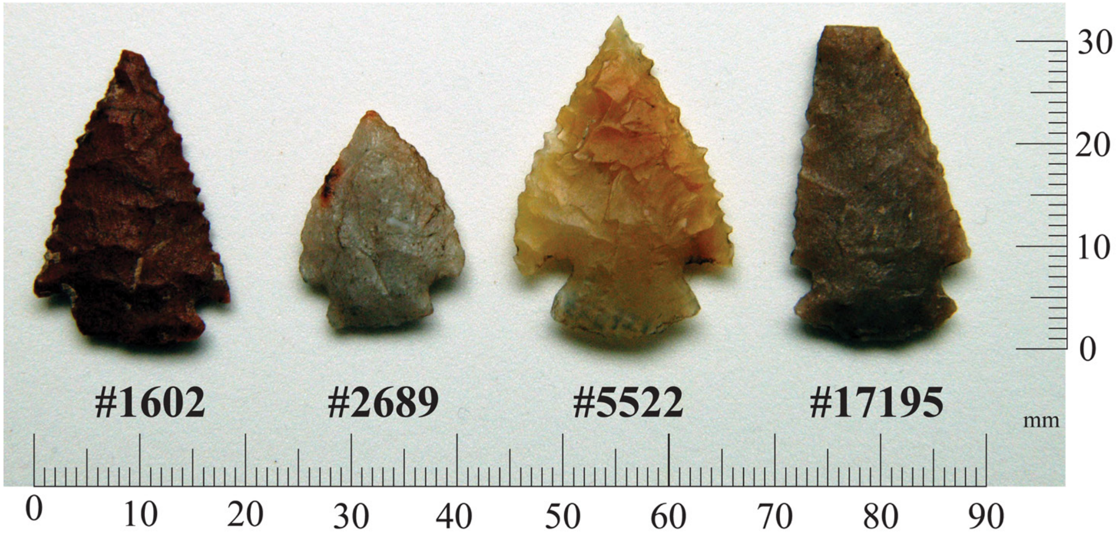


Figure 9.27. Type 13b, small corner-notched projectile points.

N=36
Average Length: 1.11 – 3.54 cm range; 2.25 cm mean
Average Width: 1.00 – 2.05 cm range; 1.54 cm mean
Average Thickness: 0.26 – 0.51 cm range; 0.36 cm mean
Material Type: Chalcedony, Chert, Jasper, Morrison Quartzite, Opal, Petrified Wood, Quartzite, Vein Quartz

Description: A number of the Hogback projectile points have a wide base, which is wider than the typical Hogback projectile point base. Shoulders range from rounded to abrupt to tapered/sloping. Blades are triangular. This category of projectile points was not checked for grinding.

Chronological Assessment: This projectile point type is typical of the Early Ceramic period.

Type 13c: Small Corner-Notched Projectile Points (Rose Spring)

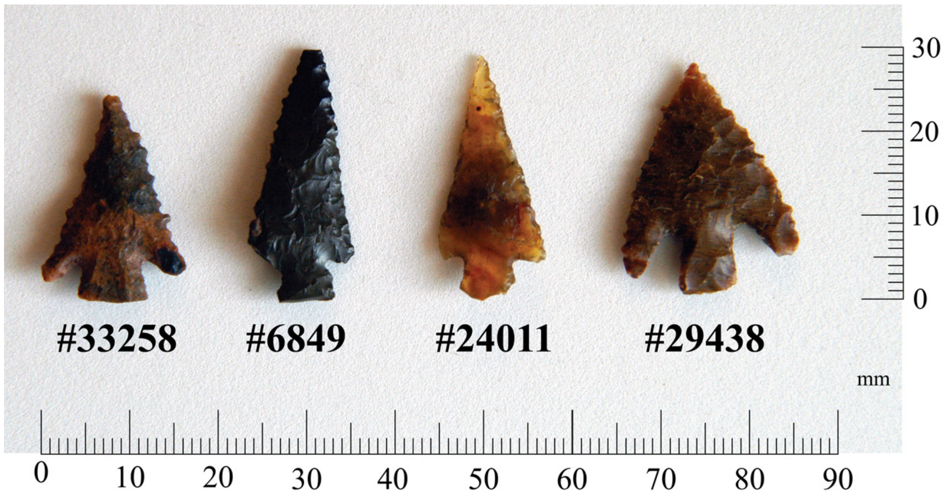


Figure 9.28. Type 13c, small corner-notched projectile points (Rose Spring).

N=16
Average Length: 1.25 – 2.62 cm range; 2.10 cm mean
Average Width: 0.95 – 1.80 cm range; 1.27 cm mean
Average Thickness: 0.21 – 0.36 cm range; 0.29 cm mean
Material Type: Chalcedony, Jasper, Morrison Quartzite, Petrified Wood, Quartzite

Description: These projectile points have small well-defined corner notches. They are characterized by slender stems and slender triangular blades. Sixty-two percent of the projectile point blades are serrated. The base of these points is straight to slightly convex.

Chronological Assessment: The Rose Spring projectile point type dates to the Early Ceramic period (Holmer 1993).

Interesting Fragments

Some projectile point fragments deserve a special mention. These fragments are not diagnostic, but are complete enough to suggest a type designation for each:

- #5400 appears to be a reworked Scottsbluff projectile point. The base is missing, and it is ground on the edges of the stem.
- The base is missing on #23760 and #13791, but these fragments could be Type 2a or Type 2b projectile points.
- #892, #30018, are ovate bases.
- #11554, #13689, #15162, #24045, #28897, #31162 may be Type 2b projectile points.

- #27319 is probably a side-notched arrow point preform.
- #19499 and #24393 are probably Hogback projectile points.

Stratigraphy

Projectile points were found from the surface, down to one of the lowest levels, Level 30. Correlation of strata and cultural material (Chapter 4) and radiocarbon dates (Chapter 5) indicates the following cultural periods can be generally equated to the listed vertical excavation levels. As discussed in Chapter 4, bioturbation has mixed artifacts from different temporal periods in the layers. Middle and Late Archaic materials are so mixed that they cannot be readily separated and form a combined layer. The Upper and Lower Early Archaic layers are separated by the rockfall.

The following abbreviations and level designations are used for the time periods in Table 9.2:

Period	Abbreviation	Layers
Early Ceramic	EC	Levels 1 - 7
Middle Archaic (MA) to Late Archaic	MA to LA	Levels 8 - 16
Upper Early Archaic	Upper EA	Levels 17 – 26
Lower Early Archaic	Lower EA	Levels 27 - 37

Table 9.2 correlates projectile point type with the amount found at each of the proposed temporal layers. The table is arranged in chronological order of the projectile point typology. It is clear, from the table, that the cultural material in the stratigraphic layers is mixed.

Table 9.2. Projectile point types by chronology.

Type		No Vertical Provenience	Levels 1-7 EC	Levels 8-16 MA to LA	Levels 17-26 Upper EA	Levels 27-37 Lower EA	Total	Cultural Period
1	 *					1	1	Paleoindian
2a		2	4	8	1	4	19	Early Archaic
8			1	1			2	
6	 *		1				1	

Table 9.2 (*continued*). Projectile point types by chronology.

Type	No Vertical Provenience	Levels 1-7 EC	Levels 8-16 MA to LA	Levels 17-26 Upper EA	Levels 27-37 Lower EA	Total	Cultural Period
4d 	2	4	3	2		11	
7  *		1				1	Early Archaic to Middle Archaic
3d 		2	1	4	1	8	
3a 	1	13	27	3		44	Middle Archaic
3b 	2	1		1		4	
3c  *		1		1		2	
3e  *			2	1		3	
2b 	2	4	8	2		16	Middle Archaic to Late Archaic
4c 	1	3	7	3		14	
4b 	2	6	3			11	
4a 		5	3	1		9	Middle Archaic to Late Archaic
11d 	1		1			2	
5 			1			1	
2c 	3	2	5			10	Late Archaic
9 	1	1	3			5	

Table 9.2 (*continued*). Projectile point types by chronology.

Type		No Vertical Provenience	Levels 1-7 EC	Levels 8-16 MA to LA	Levels 17-26 Upper EA	Levels 27-37 Lower EA	Total	Cultural Period
10			2	1			3	Late Archaic to Early Ceramic
13a		10	89	14	2		115	Early Ceramic
13b		3	20	8	5		36	
13c		5	10	1			16	
11c			1	1			2	
12		1	12	7			20	Middle Ceramic
11a			3	2	1		6	
11b			2	1			3	
Total		36	188	108	27	6	365	

Material Type

Material type was originally assessed by Fred Rathbun and provided by Bill Hammond on the handwritten list of projectile point attributes. The following definitions are used in the material type charts below:

Abbreviation	Material Type
Ag	Agate
Cy	Chalcedony
Ct	Chert
Js	Jasper
Meta	Meta-quartzite
MQ	Morrison Quartzite
Op	Opal
PW	Petrified Wood

Abbreviation	Material Type
PW-D	Dawson Petrified Wood
PW-GM	Green Mountain Petrified Wood
Qe	Quartzite
Qz	Quartz
Qz-Crystal	Crystalline Quartz
Qz-Vein	Vein Quartz
NMT	No Material Type given

As discussed in the Lithic Material chapter (Chapter 8), the Rathbun system for identifying lithic materials uses types that differ from standard archaeological material types. The differences include identification of opal as a material type and viewing jasper as different than chert rather than a type of chert.

For example, from Figure 9.29, Rathbun Material Type, 16% of the Swallow site projectile points and fragments are opal, while only 2% are chert. Applying standard definitions, most of the opal specimens are agate, chert, chalcedony and jasper.

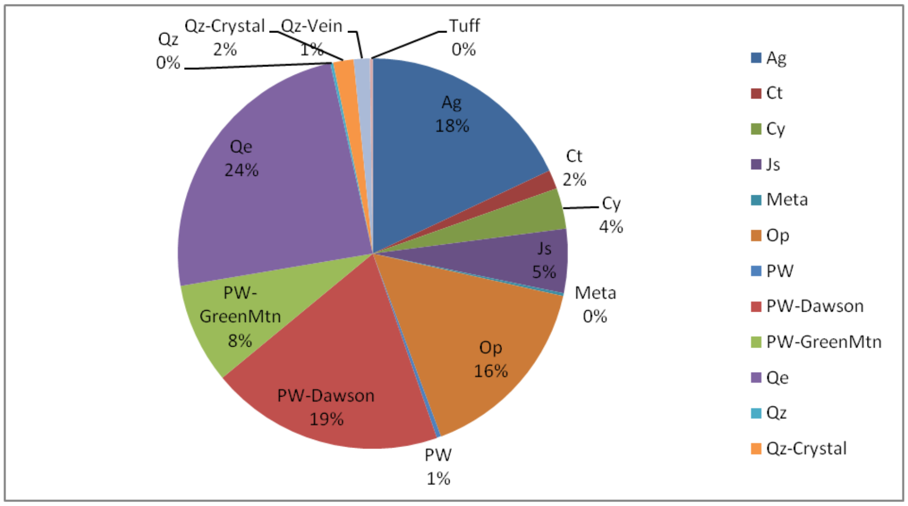


Figure 9.29. Rathbun material type.

The Rathbun assessment of petrified wood is very consistent. Petrified wood is divided into Dawson petrified wood and Green Mountain petrified wood.

In order to provide a material type assessment that is of greater use to the archaeological community, the collection was retyped by Katherine McComb, with oversight by Kevin Black and Pete Gleichman. The Rathbun material type assessment should be used for distinguishing a particular type of petrified wood, and the revised assessment (Figure 9.30) should be used for distinguishing chert and its variants, as well as sub-typing Morrison quartzite from the quartzite portion of the collection. Quartz variants are consistent between the two assessments. A few artifacts which fit the visual characteristics of opal were left as opal and would be useful for further research on opal as a material type.

The data tables in Appendix B contain columns for both the Rathbun system material types and the revised material type assessment. The type descriptions use the revised material type assessment.

Lithic materials used for projectile points are primarily from local sources. However, based on

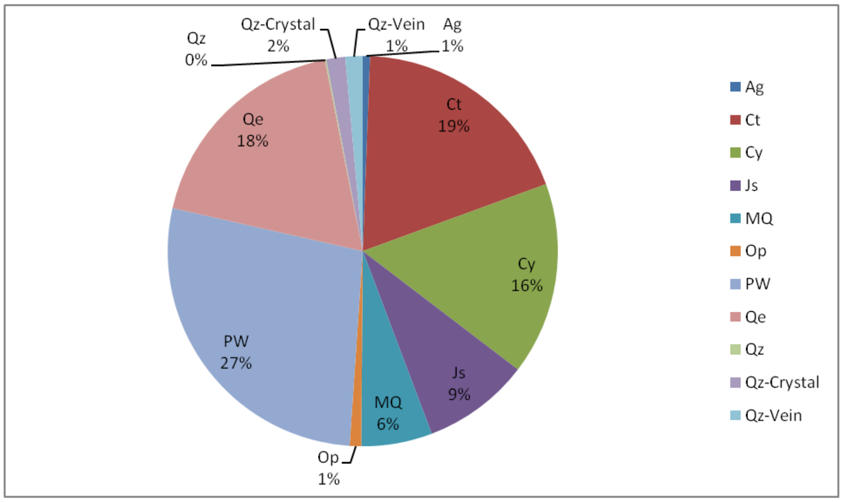


Figure 9.30. Revised material type.

visual characteristics and fluorescence, the assemblage includes four points of probable Windy Ridge quartzite, and 16 points of probable Kremmling Chert, both Middle Park sources. One Hogback point made from possible Alibates chert from the Texas Panhandle is present. Thus 21 of 365 projectile points (5.8%) are probably of exotic material from more distant sources. Five of 164 (3%) Archaic (and Paleo) points appear to be from non-local sources, and 16 of 201 (8%) Ceramic period points are apparently from non-local sources. These materials indicate trade or travel to these areas, as early as the Early Archaic period, and throughout the Archaic, but apparently more common in the Ceramic period than the Archaic stage.

Interestingly, the four points more typical of western Colorado types than the Front Range or eastern Colorado, Type 7 Sudden Side-Notched and Type 10 Smaller Side-Notched similar to Pueblo II-III points, are all of locally available materials.

Lithic material used in each temporal/cultural period are charted and discussed in Lithic Materials, Chapter 8.

Acknowledgments

I would like to thank all the volunteers who worked on the Swallow site projectile point project. The study was facilitated by Kevin Black, then Assistant State Archaeologist.

In addition to the author, the IPCAS crew included Tom Cree, Cheryl Damon, Cecil Fenio, Kris Holien, Christine O'Toole, and JoAnne Turner. Donna Morgan (Denver and Indian Peaks chapters) made detailed drawings of several of the points. The data were stored electronically in a Microsoft Excel spreadsheet (Cheryl Damon, Katherine McComb). Digital scans of the projectile points were made and archived to a CD (Tom Cree).

Special thanks go to the late Tom Cree and to Ginny Cree for opening up their house to us, and to Tom, who scanned an image for each and every projectile point and fragment. These images were endlessly useful in identifying projectile points with missing or indiscernible catalog numbers.

Pete Gleichman performed the microscopic analysis of stem grinding on the Paleoindian and Archaic projectile points. He also analyzed the fluorescence of the diagnostic points.

I wish to thank professional advisors, Kevin Black and Pete Gleichman, for their help with analysis, their review of numerous drafts of this chapter, and their assistance every step of the way.

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10 Other Lithic Tools

Bill Hammond and Wilford Couts

Editors' Note: The appendices referred to in each tool category are spreadsheets giving additional data on the individual tools, including provenience, measurements, material type, and notes on attributes. They are included to make the data accessible for future research. The databases appended are the most thorough ones located from numerous spreadsheets. They do not precisely match the numbers on the summary tables.

Non-Projectile Point Bifaces

Other than projectile points, there are 718 bifaces and biface fragments in the Swallow site assemblage. See Appendix C.1 for detailed biface data, including provenience, measurements, and material type by catalog number. Three-hundred-twenty-eight (45.7%) are from the Early Ceramic zone, 251 (35.0%) are from the Late to Middle Archaic zone, 69 (9.6%) are from the Upper Early Archaic zone, 10 (1.4%) are from the Lower Early Archaic zone (below the rockfall), and 60 (8.4%) are without provenience (Table 10.1).

Horizontally, bifaces in the Early Ceramic zone are distributed relatively evenly across the site except at the northern end (the 2N and 1N Excavation Units), where they are infrequent. In both the Late to Middle Archaic and Upper Early Archaic levels they are concentrated in the southern portion of the site, in Units 3S and 4S. In the Lower Early Archaic zone, the greatest concentration is in Unit C4S.

One-hundred-three are relatively large and intact or nearly so, while 40 intact bifaces are small, thin, and apparently made on biface thinning flakes. These thin bifaces are categorized as "finger knives." Two-hundred-thirty-six bifaces have single snap breaks and 239 are fragments too small

2024 *Archaeological Investigations at the Swallow Site, Jefferson County, Colorado*, edited by Peter J. Gleichman, Bill Hammond, and Jeannette L. Mobley-Tanaka, pp. 195-210. Memoir No. 7. Colorado Archaeological Society, Denver.

Table 10.1. Non-projectile point bifaces by material type and cultural period.

Provenience		Raw Material							Total
		Quartzite	Chalcedony	Jasper	Chert	Petrified Wood	Quartz	Other	
Levels 1-7	N	43	89	41	25	103	13	14	328
Early Ceramic	%	13.1	27.1	12.5	7.6	31.4	4	1.2	45.7
Levels 8-16	N	33	59	19	16	92	20	12	251
Late/Middle Archaic	%	13.1	23.5	7.6	6.4	36.7	8	4.8	35
Levels 17-26	N	15	9	4	8	18	11	4	69
Upper Early Archaic	%	21.7	13	5.8	11.6	26.1	15.9	5.8	9.6
Below Rockfall	N	2	4	0	1	2	1	0	10
Lower Early Archaic	%	20.0	40.0	0.0	10.0	20.0	10.0	0.0	1.4
No Vertical Provenience	N	7	26	4	3	16	3	1	60
	%	11.7	43.3	6.7	5	26.7	5	1.7	8.4
Total		100	187	68	53	231	48	31	718
Percent		13.9	26.0	9.5	7.4	32.2	6.7	4.3	

for much further analysis. (*Editors' Note*: A discrepancy in the total between this paragraph and the one above was discovered by the editors after the principal author passed away. The discrepancy is therefore noted and left uncorrected.)

There is a relatively high percentage of wear on intact bifaces (89%) as opposed to 65.3% on snapped bifaces and 68.3% on small fragments. This suggests a higher percentage of breakage during manufacture than during use or after discard. The non-projectile point bifaces showing wear are classified as knives.

Scrapers

Two-hundred-ninety-one chipped stone tools are classified as scrapers or scraper fragments on the basis of morphology and pattern of wear. Several of the scrapers also have graver tips. An additional 19 tools have concave or notched edges and are classified as spokeshaves. Eight tools with the shape of scrapers have extreme rounding and polish on the working edges and are considered to be burnishers. One of these has an endscraper element. See Appendix C.2 for detailed scraper data, including provenience, measurements, and material type by catalog number. Finally, four finely notched tools are considered shredders, perhaps for processing yucca leaves. The shredders were not included in some of the following analyses, including Table 10.2.

Two-hundred-twenty end scrapers as well as eight end scraper rejuvenation flakes are present. One-hundred-thirty-two end scrapers are intact, while 92 have broken bits. (*Editor's Note*: A discrepancy of four between the previous two sentences was noted by the editors but could not be corrected, as the primary author had passed away.) Twenty-four have bits less than 1 cm wide and are classified as narrow bit end scrapers; three of these have spokeshave components. The bits of the scrapers are fashioned on the distal ends of thick flakes; only two of the 228 end scrapers have

Table 10.2. Scrapers, burnishers and spokeshaves by material type and cultural period.

		Raw Material							
Provenience		Quartzite	Chalcedony	Jasper	Chert	Petrified Wood	Quartz	Other	Total
Levels 1-7	N	25.0	49.0	10.0	7.0	28.0	17.0	1.0	143
Early Ceramic	%	17.5	34.3	7.0	4.9	19.6	11.9	4.9	45.0
Levels 8-16	N	19	27	9	7	30	10	5	109
Late/Middle Archaic	%	13.1	23.5	7.6	6.4	36.7	8.0	4.8	35.0
Levels 17-26	N	7	7	0	0	8	2	0	24
Upper Early Archaic	%	29.2	29.2	0.0	0.0	33.4	8.3	0.0	7.5
Below rockfall	N	6	3	2	0	2	0	0	13
Lower Early Archaic	%	46.2	23.1	15.4	0.0	15.4	0.0	0.0	4.1
No Vertical Provenience	N	3	12	1	1	10	1	1	29
	%	10.3	41.4	3.4	3.4	34.4	3.4	3.4	9.1
Total		60	100	22	15	78	30	13	318
Percent		18.9	31.4	6.9	4.7	24.5	9.4	4.1	

the bit on the platform. One end scraper was made on the broken, distal end of a projectile point. Of the 92 broken bit end scrapers, most have transverse or diagonal breaks. Only 10 have longitudinal breaks and six have irregular breaks. The predominance of transverse and diagonal breaks suggests breakage during use.

Sixty-six side scrapers are included in the assemblage, and 11 scrapers have both end and side working edges. Thirteen carefully made round to ovate scrapers have circumferential retouch.

Horizontally, scrapers are spread over the entire site, although they are more frequently found in the central excavation units. No dense concentration of scrapers, which might indicate specific hide processing areas, are identified. Of the 289 scrapers with adequate provenience, 143 (49.5%) are in the Early Ceramic levels, 109 (37.7%) are in the Middle to Late Archaic levels, 24 (8.3%) are in the Upper Early Archaic levels, and 13 (4.5%) are below the rockfall in the Lower Early Archaic levels. The different types of scrapers are distributed roughly equally between the Early Ceramic and Archaic levels.

Drills

Twenty-four artifacts were identified as drills. "Drill" is a functional term, generally referring to a tool designed to be used with rotational motion to make a hole in some object. No use wear analysis was performed on the tools classified here as drills. Some may have had specialized uses. Drills have a base and a shaft with a pointed or rounded tip, and a cutting edge along the shaft. Information on the drills is presented in Table 10.3, and they are shown in Figure 10.1. See Appendix C.3 for additional data regarding drills.

Table 10.3. Drills.

Catalog Number	Provenience	Material	Length (cm)	Hole Diameter (cm)	Tip
519	D4S-L10	Cy	1.8+	0.3	Missing
1700	D3S-L6	Ja	4.5+	0.6	Missing
2874	E2S-L5	Qe	2.6+	0.8	Present
5359	D2S-L11	Qe	3.3	0.7	Intact
6670	B1S-L16	Ct	3	0.7	Intact
7954	E3S-L7	GMpw	2.4+	0.6	Missing
9542	C2S-L3	Cy	3.9	0.5	Intact
9589	C2S-L3	Cy	2	0.4	Intact
10619	E4S-L3	Qe	2.7	0.5	Intact
11049	E4S-L5	Qe	2.6+	0.5	Missing
12333	E6S-L4	Dpw	3.4	0.5	Intact
12428	E6S-L3	Dpw	2.9+	0.6	Missing
12443	F6S-L3	Qe	2.0+	0.5	Present
14275	C3S-L4	Ja	1.2+	0.3	Present
14439	C3S-L6	Cy	2.2+	0.6	Present
15775	C1S_L11	Cy	3.6	0.9	Intact
20036	BiN-L2	Cy	2.5+	1.1	Present
21077	C1N-L4	GMpw	3.0+	0.8	Intact
21421	C2S-L26	Cy	1.9+	0.5	Missing
23587	D2S-L4	Cy	3.4	0.7	Intact
30710	B3N-L5	Dpw	2.0+	1.1	Present
35819	A3S-nvp	Ja	1.6+	0.3	Present
37482	A3S-L10	Ct	1.3+	0.8	Missing
37732	D4S-L27	Qz	1.7	0.3	Intact

Tip: Missing=tip is missing; Present=tip is present, base is missing; Intact=drill is complete

The artifacts were predominantly (15 specimens) located in the Early Ceramic zone (Levels 1-7). Six were present in the Late to Middle Archaic zone (Levels 8-16), two were in the Early Archaic zone (below Level 16), and one was without vertical provenience. Thus 62.5% were Early Ceramic, 33.3% were Archaic, and 4.1% were without provenience. Ten of the 24 were judged to be intact tools. Of the remaining 14 drills, seven lacked a point or bit, and seven lacked a base.

No trend of size or shape is recognized. Two of the Early Archaic drills are among the smallest, but one found in the Early Ceramic zone is identical in size to the older duo. If used as a drill, four would have made a hole about 0.3 cm in diameter, two would have made a hole about 1.1 cm in diameter, and the 17 remaining were in the 0.4 to 0.9 cm range, as estimated at about midlength of the bit.

All the drills were made of locally available materials, including quartzite, chalcedony, jasper, petrified wood, and quartz. Chalcedony and quartzite were most common and most widely distributed among the zones. Quartz was found only in the Early Archaic zone.

Figure 10.1. Drills. Item number references (below) organized by rows (R) and columns (C). (Item numbers 1700 and 6670 listed in table 10.3 have not been located.)

	C1	C2	C3	C4	C5	C6
R1	519	2874	5359	7954	9542	9589
R2	10619	11049	12333	12428	12443	14275
R3	14439	15775	20036	21077	21421	
R4	23587	30710	35819	37482	37732	

As to possible specialized uses, none had the appearance of the drills used for crack-stoppers in ceramics described by Wylie (1975). One (5359) had the wide base, long shaft, and small radius that suggests a cloth toggle (Adkins and Eidlin 1997). Three drills are possibly foreshaft socket drills described by Padgett (1990); two of these are located in the Archaic zones (5359, 6670), and might have been used for atlatl darts. One drill (12333) has a bit smaller in diameter, is located in the Early Ceramic zone, and might have been used as an arrow dart. The data are far too sparse to be definitive.

Gravers

Twenty-three artifacts have been identified as gravers. Following Gooding, the definition used here is a “unifacially retouched projection on a flake or modified biface. A postulated function of this tool class is for the incising of soft material such as wood, hide, or bone” (1981:77). No use wear study was conducted on these tools. Information on the gravers is presented in Table 10.4, and they are shown in Figure 10.2. See Appendix C.3 for additional data regarding gravers.

Of the 23 gravers, 9 are from Levels 1-7, the Early Ceramic zone, 7 are from Levels 8-16, the Late to Middle Archaic zone, 4 are from Levels 17 and below, the Early Archaic zones, and 3 have no vertical provenience. Thus, 39.1% are Early Ceramic, 47.8% are Archaic, and 13% have no provenience.

Four gravers are of quartzite, 7 of chalcedony, 1 of jasper, 9 of Dawson petrified wood, and 2 of quartz crystal. The distribution of material by cultural zones is roughly similar. Five gravers have 2 tips, and 7 have facets with other uses: 3 have cutting facets, 4 have scraper facets. In addition, a few scrapers and non-projectile point bifaces have secondary graver tips.

Table 10.4. Gravers.

Catalog Number	Provenience	Material	Additional Usage
2101	D3S-L10	Dpw	
2415	E2S-L2	Cy	
2513	E2S-L3	Qz crystal	
3325	E2S-L9	Qe	
3597	D1S-L1	Dpw	
4557	DiN-L2	Cy	
6091	B2S-L9	Cy	
9417	C2S-L2	Dpw	
9659	C2S-L4	Ja	
11589	E4S-L16	Dpw	
15217	C3S-L16	Dpw	Scraper, Knife
16913	C2S-L20	Qe	Scraper
18350	C4S-L16	Dpw	
24581	D4S-L3	Dpw	Scraper
28595	E1S-L7	Dpw	Knife
28898	D3S-L18	Qe	Scraper
31161	A3S-nvp	Cy	
31556	A2S-L11	Cy	Knife
31588	F5S-L18	Qz crystal	Scraper
35803	D5S-nvp	Qe	
35992	F7S-L6	Dpw	
36398	C4S-L22	Cy	
37945	A2S-nvp	Cy	

Figure 10.2. Gravers. Item number references (below) organized by rows (R) and columns (C). (Item number 18350 listed in table 10.4 has not been located.)

	C1	C2	C3	C4	C5	C6
R1	2101	2415	2513	3325	3597	4557
R2	6091	9417	9659	11859	15217	16913
R3	24581	28595	28898	31161	31556	31588
R4	35803	35992	36398	36588	37945	

Awls

In this study, six formal tools were identified as awls. Use wear analysis was not performed. Two subtypes were present. One subtype is termed a perforator; these are flakes that were extensively worked on the dorsal side to produce a well-supported point on the distal end. The second subtype has a rounded, elongated shape with flattened, scooped ends. It is similar to a bone awl shown in Figure 6j of Johnson and Lyons (1997:38). Vertically, four were located in the Early Ceramic zone (Levels 1-7) and one (16551) in the Late to Middle Archaic zone (Levels 8-16). The remaining awl had no vertical provenience (Table 10.5, Figure 10.3). See Appendix C.3 for additional data regarding awls.

All of these tools were made of locally available materials. Three are petrified wood, two are quartz and one is gneiss. One awl has a snapped tip (2554). Two show rounding attributed to wear (17140, 35428), and two appear newly shaped with no recognized attrition (1500, 16551). The one similar to a bone awl (17115) is very smooth and rounded, suggesting extensive use wear.

Table 10.5. Awls.

Catalog Number	Subtype	Provenience	Material	Length (cm)
1500	Perforator	D3S-L3	Dpw	2.94
2554	Perforator	E2S-L3	Dpw	2.24
16551	Perforator	C2S-L13	Qz	3.98
17140	Perforator	C4S-L6	Dpw	2.43
17115	Awl	C4S-L5	Gneiss	3.55
35428	Perforator	B2S-nvp	Qz	2.44

Choppers

Thirty-five stone tools were identified as choppers, a functional designation. No use wear analysis was done on these tools. Seven are considered to be fragments (1068, 2165, 10632, 10651, 20344, 26182, 37722) while the rest are intact. There is considerable variation in the size and weight of the intact tools. One was unusually wide, weighed 596 g, and seemed designed for two-hand usage. The others vary from 67 to 525 g, and all fit comfortably in one hand. A distribution plot reveals a group of 13 between 120 and 220 g; the remainder are scattered in weight. No trend in size or weight is recognized between the Early Ceramic and Archaic cultural periods.

Four choppers were located within features. Catalog number 2165 was in Feature 19 (hearth), 7685 was in Feature 53 (hearth), 24696 was in Feature 174 (rock concentration), and 27847 was in Feature 64 (hearth).

Locally available raw material was used. Twenty-nine of the 35 choppers were quartz. Three were quartzite (10651, 15809, 18514), two were granite (17774, 26182), and one was chalcedony (21171).

Table 10. 6 provides catalog number, provenience, and weight for each chopper. Table 10.7 shows number and percentage of choppers by material type and cultural period. The choppers are shown in Figures 10.4, 10.5, and 10.6. See Appendix C.4 for additional data regarding the choppers.

Figure 10.3. Awls. Item number references (below) organized by rows (R) and columns (C).

	C1	C2	C3
R1	1500	2554	16551
R2	17140	17115	35428

Manos

One-hundred-seventy-eight manos and mano fragments are present in the Swallow site assemblage. Nearly half (49.7%) are intact or nearly intact specimens. Fifty-three display battering on one or both ends, indicating secondary use as hammerstones.

Gneiss is the most common material (55.1% of the specimens). Fine-grained sandstone, most often from the Lyons formation, accounts for 33.7%, while small numbers are of Fountain sandstone, granite, quartzite, and other materials. Many of the manos and mano fragments show fire damage; often these were recovered from hearth features. See Appendix C.5 for additional data regarding the manos.

The degree of shaping and use wear of the manos is variable; while many are shaped and heavily

Table 10.6. Choppers.

Catalog Number	Provenience	Weight (grams)
1068	D4S-L19	156
1097	D4S-L4	596
2165	D3S-L11	95
7685	E3S-L6	108
10252	E3S-L14	164
10541	E4S-L2	317
10632	E4S-L3	75
10651	E4S-L3	336
13343	F3S-L10	444
14329	C3S-L5	179
14469	C3S-L6	152
14574	C3S-L7	219
15404	C3S-L18	306
15809	C1S-L12	96
17611	D1S-L19	209
17774	C4S-L8	187
17990	C4S-L11	455
18514	C4S-L18	480
20344	B1N-L5	160
21171	D1S-L27	328
21889	C2N-L3	174
22140	C2N-L5	132
22589	D5S-nvp	201
24062	B1S-L4	413
24696	C1S-L32	67
25406	F5S-L4	123
26182	B1N-L3	126
26304	B2N-L7	148
27413	B3S-L13	452
27847	D3S-L10	525
31810	B3N-L13	353
33280	F4S-L5	134
33850	C2S-L18	177
37722	F4S-L7	349
22053	unknown	unknown

worn, others are only slightly modified stream cobbles. A minority of the specimens are pecked, usually on the edges. The degree of convexity of the ground surfaces appears to be more a function of the shape of the original cobble than of shaping or amount of wear. Five specimens are extremely smooth on their working surfaces and are subclassified as polishing stones. Fourteen specimens are wedge-shaped and 15 have central ridges on one or both sides, and therefore have three or four facets.

Table 10.7. Choppers by material type and cultural period.

		Quartz	Quartzite	Granite	Chalcedony	Total
Levels 1-7	N	16	1	0	0	17
Early Ceramic	%	94.1	5.9	0.0	0.0	48.6
Levels 8-16	N	7	1	2	0	10
Late/Middle Archaic	%	70.0	10.0	20.0	0.0	28.6
Levels 17-26	N	4	1	0	0	5
Upper Early Archaic	%	80.0	20.0	0.0	0.0	14.3
Below rockfall	N	1	0	0	1	2
Lower Early Archaic	%	50.0	0.0	0.0	50.0	5.7
No Vertical Provenience	N	1.0	0.0	0.0	0.0	1.0
	%	100.0	0.0	0.0	0.0	2.9
Total		29	3	2	1	35
Percent		82.9	8.6	5.7	2.9	

Figure 10.4. Choppers. Item number references (below) organized by rows (R) and columns (C).

	C1	C2	C3	C4
R1	1068	1097	2165	7685
R2	10252	10541	10632	10651
R3	13343	14329	14469	14574

Figure 10.5. Choppers. Item number references (below) organized by rows (R) and columns (C).

	C1	C2	C3	C4
R1	15404	15809	17611	17774
R2	17990	18514	20344	21171
R3	21889	22053	22140	22589

As opposed to chipped stone tools, manos are most commonly found in the Archaic zones; only 43 (24.2%) are from the Early Ceramic zone (Levels 1-7) while 75 (42.1%) are from the Late to Middle Archaic zone (Levels 8-16). Thirty-five specimens (19.7%) are from the Upper Early Archaic zone (Levels 17 to 26) and only 5 (2.8%) are from the Lower Early Archaic zone, below the rockfall. Eighteen manos (10.1%) are without vertical provenience. Sandstone is the predominant material in the Early Ceramic levels (53.5% sandstone versus 34.9% gneiss), while gneiss predominates in the Archaic levels (69.1% gneiss versus 27.3% sandstone) (see Table 10.8).

In both the Early Ceramic and Archaic periods, the densest concentrations of manos are in the southern portion of the site, in Excavation Units C3S, D3S, E3S, D4S, and E4S. Manos are sparsely distributed in the northern portion of the site.

Figure 10.6. Choppers. Item number references (below) organized by rows (R) and columns (C).

	C1	C2	C3	C4
R1	24062	24696	25406	26182
R2	26304	27413	27847	31810
R3	37722	33280	33850	

Metates

There are 337 metates or metate fragments in the Swallow site assemblage. Almost all are fragments; only 10 complete or nearly complete metates are present. Most metates and metate fragments are fine-grained sandstone; 62.6% are from the Lyons, Morrison or Dakota formations, with Lyons sandstone being predominant. Gneiss accounts for 29.4% of the assemblage, while 5.6% are coarse Fountain formation sandstone. One specimen is granite, one is basalt and two are quartzite. See Appendix C.6 for additional data regarding the metates.

Of the 312 pieces for which adequate provenience is recorded, 130 are from the Early Ceramic zone, while 182 are from Archaic levels. Most of the latter (116) are from the Late to Middle Archaic zone; 58 are from the Upper Early Archaic zone, and only 8 are from the Lower Early Ceramic layer beneath the rockfall (Table 10.9). Horizontally, metate fragments in the Early Ceramic are concentrated in the northwestern portion of the site (Excavation Units B2N, B1N, B1S, and C1N) and in the center of the site, in Units D3S and D4S. In contrast, Late to Middle Archaic fragments are most dense in Unit E3S. Most of the metate fragments in the Upper Early Archaic layer are in Unit E4S, while in the Lower Early Archaic most are in Unit C4S.

Table 10.8. Manos by material type and cultural period.

Provenience		Raw Material						Total
		Fine Grain Sandstone	Gneiss	Granite	Quartzite	Fountain	Other	
Levels 1-7	N	23	15	1	3	0	1	43
Early Ceramic	%	53.5	34.9	2.3	7.0	0.0	2.3	24.2
Levels 8-16	N	16	53	4	0	2	0	75
Late/Middle Archaic	%	21.3	70.7	5.3	0.0	2.7	0.0	42.1
Levels 17-26	N	7	23	4	0	0	1	35
Upper Early Archaic	%	20.0	65.7	11.7	0.0	0.0	2.9	19.7
Below rockfall	N	5	0	0	0	0	0	5
Lower Early Archaic	%	100.0	0.0	0.0	0.0	0.0	0.0	2.8
No Vertical Provenience	N	9	7	0	2	0	0	18
	%	50.0	38.9	0.0	11.1	0.0	0.0	10.1
Total		60	98	9	5	2	4	178
Percent		33.7	55.1	5.1	2.8	1.1	2.2	

Table 10.9. Metates by material type and cultural period.

		Raw Material							Total
		Fine Grain Sandstone	Gneiss	Granite	Quartzite	Fountain	Basalt	Other	
Levels 1-7	N	90	37	0	0	1	0	2	130
Early Ceramic	%	69.2	28.5	0.0	0.0	0.8	0.0	1.5	38.6
Levels 8-16	N	71	36	0	0	7	0	2	116
Late/Middle Archaic	%	61.2	31.0	0.0	0.0	6.0	0.0	1.7	34.4
Levels 17-26	N	31	15	1	0	10	1	0	58
Upper Early Archaic	%	53.4	25.9	1.7	0.0	17.2	1.7	0.0	17.2
Below rockfall	N	6	1	0	1	0	0	0	8
Lower Early Archaic	%	75.0	12.5	0.0	12.5	0.0	0.0	0.0	2.4
	N	13	10	0	1	1	0	0	25
No Vertical Provenience	%	52.0	40.0	0.0	0.4	0.4	0.0	0.0	7.4
Total		211	99	1	2	19	1	4	337
Percent		62.6	29.4	0.3	0.5	5.6	0.3	1.2	

Bifacially ground metates make up 22.3% of the assemblage, while most of the rest are too small to determine whether they are bifacially or unifacially ground. Most of the intact metates are bifacially ground. Relatively few are deeply (over 1 cm) dished; most are slightly dished, while many are flat. Sixty-two specimens are pecked. The edges of many specimens have been shaped by unifacial or bifacial trimming. Eight of the thinner metates or large metate fragments have carefully, often bifacially trimmed edges; these are considered “portable” metates. The ground surfaces of a few metates are pitted, suggesting secondary use as “lap anvils.” A minority of the specimens show longitudinal striations in their basins; transverse and circular striations are rare. Many of the metate fragments show fire damage, and some were recovered from hearths, indicating reuse as hearth rocks after breakage.

Four features (Features 128, 132, 134, and 151) consisted of groups of groundstone, sometimes with hammerstones or other artifacts intermixed. All of these features were located in Archaic levels, and three of the four were located in Units E3 and E4, close to the sandstone monolith that formed the back of the overhang. These features suggest that ground stone tools were curated between uses, perhaps tucked away to be out of the way, to prevent them from being used in fire features, or simply to ensure they would be there on a future visit to the site. In addition, three other ground stone features were recorded: Feature 116 was a mano and metate in association, Feature 118 was a metate positioned face down on a surface, also suggesting an effort to preserve it for future use, and Feature 45, a metate shattered by pressure to its center. This last metate was associated with Feature 44, the possible lean-to in the Early Ceramic levels, and was interpreted by excavators as a stone set in place to help support a pole as part of that structure. Some of the slabs used in slab-lined hearths also showed grinding wear. These examples indicate that grinding stones were valuable enough to curate between uses, but also had utility after their use life as grinding tools was over as flat, smooth stones that suited other needs.

Comals and Palettes

Thirty-four fragments of groundstone are uniformly thin (thickness less than 1.5 cm) and flat. They are unifacially ground, and their edges are rounded. They are categorized as comals or griddlestones. Fifteen are of fine-grained sandstone, 15 of gneiss, and 4 of limestone. Seventeen are from the Early Ceramic layer, and 15 are from Archaic layers. Two have no provenience.

Six similar artifacts, five from the Late to Middle Archaic layer and one without provenience, have hematite staining of the ground surface, and are categorized as palettes.

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11

Debitage

Jeannette L. Mobley-Tanaka

About 30,000 flakes, weighing just over 18 kg, and 85 cores were collected from Swallow site. Flakes were found at all levels of the site, but like other materials, were most abundant in the Early Ceramic levels (Levels 1-7). Lithic debitage included all varieties, shapes, and sizes of flakes, including cortex; primary, secondary, and tertiary flakes; thinning flakes; cores; and a small amount of shatter.

Flakes

As discussed in Chapter 8, Lithic Materials, a material typology was developed by Fred Rathbun, a professional geologist, which deviates from the common terms used in archaeology. All lithic flake material was typed in the lithic lab by Colorado Archaeological Society (CAS) volunteers using this methodology and recorded on data analysis sheets. Those data analysis sheets are the basis for this discussion, but with a modification to material terminology to standardize (as discussed in Chapter 8). See Appendix C.7 for additional data on flakes.

For the purpose of this report, flakes listed on analysis sheets as cherts, jaspers, and opals were lumped together as chert. Agates and chalcedonies were combined as chalcedony. Flakes were already distinguished as Dawson petrified wood (identified elsewhere as Parker petrified wood) (Hammond 2020), Green Mountain petrified wood, and indeterminate petrified wood, and these distinctions have been maintained. Only 304 flakes, or 5% of the petrified wood could not be sourced to Dawson or Green Mountain. Orthoquartzite and metaquartzite were distinguished on lab forms, but as this distinction was not made in other lithic studies in this report, and as only 32 flakes of metaquartzite were distinguished from the rest, the quartzites are lumped together here.

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During excavation, flakes were collected in two ways. Small flakes were collected in lots for every 10-cm level excavated. In total, 422 lots were collected. These were processed, weighed, and measured in the CAS artifact processing lab, and the results are included in this chapter.

In addition, large flakes were point plotted during excavation, and bagged separately from the smaller lithic debitage. Approximately 2,150 large flakes were point plotted, although some of those were later reclassified as tool fragments. These point-plotted flakes make up only 7% of the assemblage by count, but 45% of the assemblage by weight. A 20% sample of these large flakes was examined by John Gooding and Bill Hammond and is included in this chapter. The remaining point-plotted flakes were not available at the time of this writing, and are not included here; however, a comparison of the 20% sample of large flakes and the full analysis of the bulk collected flakes suggests that the proportions of materials and overall distribution of large and small flakes are very similar. While, admittedly, it would be better to include all lithic flakes in this analysis, the overall similarity in the assemblage of small flakes and the sample of large flakes suggests that the findings would not be significantly different if the full assemblage had been analyzed. Where there are notable distinctions between the small and large flake material, it will be noted.

Four broad material categories account for 91.4 percent of the flake assemblage (Figure 11.1, Table 11.1). These are chalcedony, chert, orthoquartzite, and petrified wood, with Dawson petrified wood slightly more common than that from Green Mountain.

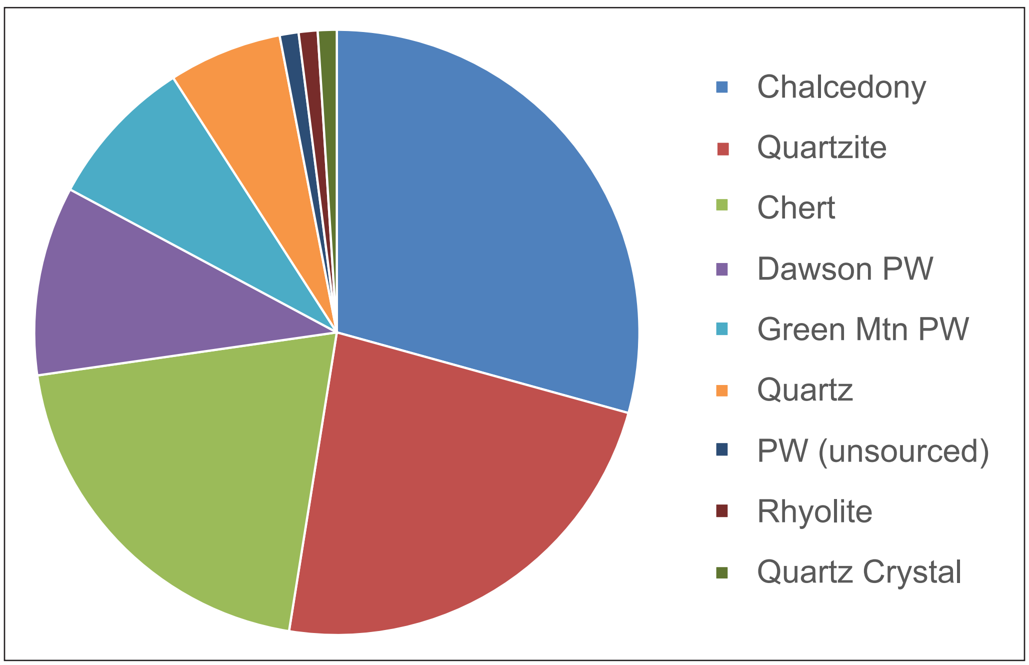

Figure 11.1. Flake material types from Swallow site.

Table 11.1. Flake material types from Swallow site.

Material	Weight (g)	Number	Percentage of Assemblage
Chalcedony	2,375.2	7,905	29.17
Orthoquartzite	2,094.1	6,134	22.63
Chert	1,882.2	5,480	20.22
Dawson Petrified Wood	797.7	2,719	10.03
Green Mountain Petrified Wood	709.9	2,289	8.45
Quartz	1,678.6	1,611	5.94
Petrified Wood	87.8	304	1.12
Rhyolite	189.1	278	1.03
Quartz Crystal	94.4	262	0.97
Amphibolite	62.3	78	0.29
Basalt	9.4	17	0.06
Schist	6.8	9	0.03
Obsidian	2.4	6	0.02
Alibates	0.7	3	0.01
Bottle Glass	0.2	3	0.01
Black Gabbro	0.2	1	<0.01
Total	10,033.7	27,099	100.00

The remaining 8.6 percent of the flake assemblage was made up of a variety of other materials, including (in order of occurrence): quartz (both crystal and vein quartz), rhyolite, amphibolite, metaquartzite, basalt, schist, obsidian, Alibates chert, black gabbro, and three small flakes of bottle glass from the historic levels. Whether these glass flakes indicate historic tool manufacture by indigenous groups or whether the glass was inadvertently flaked by cattle trampling or other historic activity at the shelter is not clear. While a variety of historic artifacts did occur on the surface and in the upper excavation levels, they were primarily of Euro-American origin. The only suggestion of indigenous historic activity at the site was reported by Rathbun in his 1991 interim report; a shard of bottle glass that "appears to have been worked as a unifacial tool" (Rathbun 1991:22). This tool does not appear in later analyses of lithic tools and may have been discounted. There were 24 pieces of bottle glass on or near the surface and, given that the location had sheltered cattle in historic times and the surface was churned by hooves on a regular basis, inadvertent flaking of that glass is quite possible.

A number of the materials found in smaller quantities in the flaked assemblage, notably rhyolite, amphibolite, basalt, schist, and black gabbro are not materials generally associated with the manufacture of flaked lithic tools, being course-grained igneous and metamorphic rocks not well suited for fine conchoidal fracturing. These materials are useful for a variety of groundstone tools, such as manos, metates, and axes, which may be partially shaped by pecking or flaking. Flakes of these materials may also occur due to spalling during heat exposure and could have resulted from the abundant fire-cracked rock found at the site.

To assess differences in the average size of flakes of different materials, a ratio of flake count to weight was calculated. The ratio of flake count to weight for each material type indicates a general similarity for most material types, with ratios ranging around 1:0.25 to 1:0.35 (Table 11.2). Notably high weight ratios occur for some of the courser material types, such as metaquartzite, amphibolite, schist, and rhyolite. These materials were probably not suited to fine tools or finely edged tools, accounting for the presence of fewer small, fine flakes of these materials. Vein quartz also has a high ratio of 1:1.04, a ratio reinforced by the percentage of quartz in the small and large flake assemblages; quartz accounts for only 6% of the small flakes, but 13% of the large flakes, in contrast to chalcedony, chert, and petrified wood, which make up larger percentages of the small flakes and fewer large flakes. The larger size of quartz flakes most likely reflects the difficulty of working that material, and the use of it only for less precisely flaked tools. As discussed in the Other Tools chapter (Chapter 10), the only category of artifacts that was frequently made from vein quartz was choppers, a relatively large and coarsely flaked tool type that would not have required fine pressure flaking in manufacture.

Table 11.2. Material types and mean weight per flake.

Material	Weight (g)	Number	Mean Weight
Chalcedony	2,375.2	7,905	0.30
Orthoquartzite	2,173.0	6,134	0.35
Chert	1,882.2	5,480	0.34
Dawson Petrified Wood	797.7	2,719	0.29
Green Mountain Petrified Wood	709.9	2,289	0.31
Quartz	1,678.6	1,611	1.04
Petrified Wood	87.8	304	0.29
Rhyolite	189.1	278	0.68
Quartz Crystal	94.4	262	0.36
Amphibolite	62.3	78	0.80
Basalt	9.4	17	0.55
Schist	6.8	9	0.76
Obsidian	2.4	6	0.40
Alibates	0.7	3	0.23
Bottle Glass	0.2	3	0.06
Black Gabbro	0.2	1	0.20
Total	10,033.70	27,099	0.37

Comparing the frequencies of various materials in the flake assemblage to those in the projectile point assemblage, there is substantial similarity (Table 11.3). Dawson petrified wood is slightly under-represented in the flake count., which may suggest that Dawson petrified wood was acquired from a greater distance than other materials and was therefore partially reduced before transport more than were other materials. The cores, discussed below, also suggest this may have been the case. To verify this hypothesis, however, more information is needed on the sources of various

Table 11.3. Percent of material types in the flake and projectile point assemblages.

Material	Small Flakes	Large Flakes	Projectile Points	Other Tools
Chalcedony	29.0	24.0	22.0	32.0
Quartzite	22.0	22.0	24.0	18.0
Chert	20.0	15.0	23.0	11.0
Dawson Petrified Wood	10.0	16.0	19.0	12.0
Green Mountain Petrified Wood	8.0	2.0	8.0	14.0
Quartz	6.0	13.0	1.0	8.0
Petrified Wood (unsourced)	1.0	2.0	1.0	2.0
Rhyolite	1.0	2.0	0.0	0.5
Quartz Crystal	1.0	1.0	2.0	1.5

jaspers and cherts at the site, and on potential procurement sites for Dawson petrified wood (for a more complete discussion of sources, see Chapter 8, Lithic Materials).

Non-Local Procurement

During laboratory analysis of flakes, some jaspers were recorded as Trout Creek jasper coming from the southern edge of South Park, while other material was identified as Kremmling chert, coming from Middle Park. Unfortunately, no information was recorded regarding the methodology or justification for these identifications, and so their validity remains uncertain. Kremmling chert has been found at sites on the Colorado Front Range, including at the Rock Creek site, 55 km to the northeast of Swallow (Gleichman et al. 1995), and Trout Creek jasper was identified at other Ken-Caryl Ranch sites excavated by CAS (Johnson et al. 1997:145), though Kremmling chert was not identified at those sites. While it is quite possible that materials from as far away as South Park and Middle Park arrived at Swallow site, other sources of jasper and chert with similar visual characteristics to Trout Creek and Kremmling sources exist on the Front Range. Therefore, without more information on how the identifications were made, they are being treated here only as possibilities, and as a topic for further research that can be pursued in the future (for a more detailed discussion, see Chapter 8, Lithic Materials).

As mentioned above, Dawson petrified wood is a material that may have come from a greater distance from the site than a variety of other materials. Hammond (2020) notes that in his analysis of large flakes, primary flakes with cortex were found for all major material types at the site. Cortex flakes of chert, agate, and chalcedony were typically smoothed and rounded, suggesting that the raw materials came from stream transported cobbles that could have been obtained in a number of locally occurring streams that cross the Hogback valley. Petrified woods, by contrast, had a rough cortex indicative of acquisition from primary deposits. The prevalence of Dawson petrified wood suggests considerable movement and/or exchange between the Parker uplift along the southeastern edge of the Denver Basin and the Hogback valley, with sources potentially some 30-35 km away from the Ken-Caryl sites, though closer sources cannot be ruled out (see Chapter 8).

Exotics in the collection that undoubtedly came from a greater distance away make up a minute portion of the assemblage but include 6 obsidian flakes and 3 flakes identified as the distinctive Alibates chert. The exact source of the obsidian has not been determined. Widely used prehistoric obsidian sources are known in New Mexico, south central Colorado, Wyoming, and Arizona. Obsidian found at the nearby Twin Cottonwoods site (5JF60) was sourced to the Cerro del Medio area in the Jemez Mountains in New Mexico (Beal and Beal 1997:103), but the Swallow material has not been tested. Like that found at other Ken-Caryl sites, the obsidian at Swallow consists of a few small flakes that most likely represent the retouch of artifacts that arrived at the site fully formed rather than the shaping of raw materials into tools at the site.

Alibates chert originates in northern Texas, some 500 miles from the site. It was widely distributed across the Great Plains through much of ancient indigenous time. These few flakes indicate contact or movement over a much greater distance, but their rarity in the assemblage suggests that such movement was more of an anomaly than a regularly occurring aspect of the lifeways of Swallow residents.

Cores

Eighty-five cores, 75 whole and 10 fragmentary, were identified and analyzed by Bill Hammond and John Gooding. The following information is drawn from their analysis. It is not known if these data include all the cores from the site or a sample, as the data set surfaced after Hammond's passing. Thirty-two cores came from the Early Ceramic levels (Levels 1-7), 30 came from the Late/Middle Archaic levels (Levels 8-16), and 9 from the Early Archaic levels (Level 17 and below). See Appendix C.8 for additional data on cores.

All of the major material types recorded in tools and flakes were also found in the core assemblage, with the exception of Green Mountain petrified wood (Table 11.4). Frequencies of materials in the cores are notably different from those in flakes, with chalcedony and quartz dramatically

Table 11.4. Lithic materials utilized for cores.

Material	Number of Cores	Percent of Cores
Chalcedony/Agate	32	37.6
Chert	3	3.5
Jasper	5	5.9
Quartzite	8	9.4
Dawson Petrified Wood	5	5.9
Unsourced Petrified Wood	2	2.4
Vein Quartz	26	30.6
Quartz Crystal	2	2.4
Breccia	1	1.2
Silicified Siltstone	1	1.2
Total	85	100.1

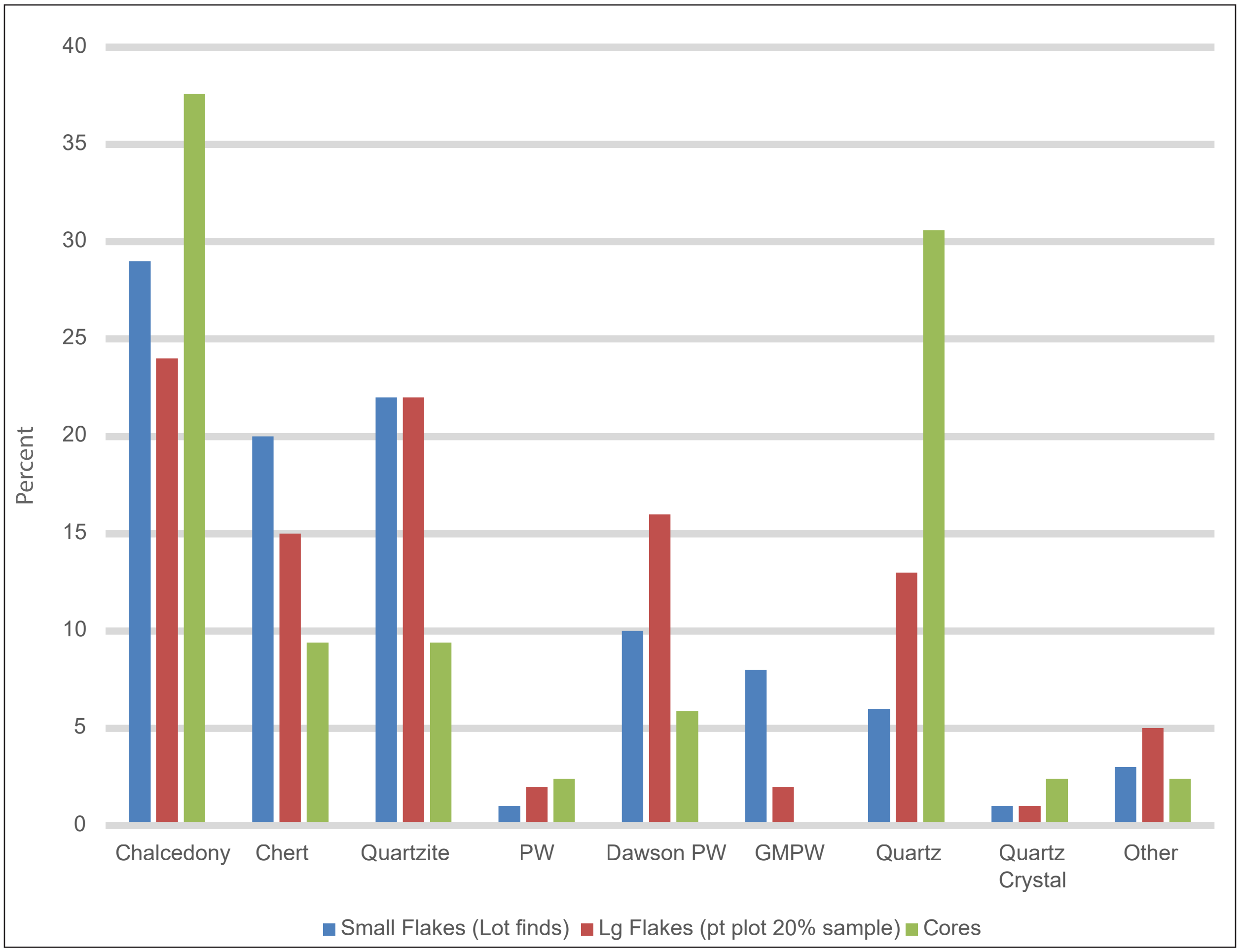

Figure 11.2. Core and flake materials. Chalcedony and quartz are larger components of the core assemblage, while cherts, quartzites, and petrified woods are more strongly represented in the flake assemblage.

overrepresented, while cherts, quartzites, and petrified woods are underrepresented (Figure 11.2). Overall, the flake assemblage is more similar to the material frequencies seen in lithic tools than are the cores.

Hammond and Gooding further categorized core materials to probable geological formations/sources, a level of detail not recorded in the flakes. This was done through visual and low-magnification examination of the cores. They identified chalcedonies from Morrison and Parker formations, cherts from Troublesome (Kremmling) and an unknown source, jasper from Parker and probable Trout Creek sources, and quartzites from Dakota and Morrison formations. Vein quartz and quartz crystal was not identifiable to a given deposit, as it is common in granitic and stream deposits of a variety of origins and locations. Geologic formations for cores other than quartz are provided in Table 11.5.

Table 11.5. Geologic formations for cores other than quartz.

Source Material	Number of Cores
Morrison	21
Parker	20
Dakota	4
Troublesome	2
Lyons	1
Docmann Gulch	1
Trout Creek	1
Unknown	9

Morrison, Dakota, and Lyons materials are all readily available in the immediate area around the site in both primary and stream flow deposits. Docmann Gulch is not a geological formation, but rather the drainage that flows past the site. It is listed as the source for the only core identified as metaquartzite, with a note of a potential source north of the Deer Creek fault, just a few kilometers from the site. Parker formation materials most likely required short-distance travel or trade to acquire. Troublesome (Kremmling) and Trout Creek required longer distance travel or trade. It should be noted that Hammond and Gooding recorded their identification of both the Troublesome and Trout Creek materials as tentative, as mineralogical analysis was not done.

Fifty-one cores could be classified into seven morphological or functional categories. Five morphological categories were recorded: monopolar, bipolar, discoidal, pyramidal, and irregular. Two additional functional categories of burin core and blade core were also recognized. Monopolar, discoidal, and bipolar cores were the most common forms, with some variability among source materials evident. Nearly all of the vein quartz cores were monopolar or bipolar, skewing those as the most common categories, while discoidal cores are more common among other material types (Table 11.6).

It was also noted when cores were exhausted. Thirty-three of the 85 cores, or 38.8% of the assemblage, were deemed exhausted. This percentage varied widely by material type. While only

Table 11.6. Core types.

Source Material	Monopolar	Bipolar	Discoidal	Pyramidal	Irregular	Burin	Blade
Morrison	5	4	6		1		
Parker	1	1	3	1		2	1
Dakota	1						
Kremmling			2				
Lyons	2						
Docmann Gulch			1				
Unknown	1		1				
Vein Quartz	8	7	3				

19% of the vein quartz cores were exhausted, 43% of the Morrison material and 70% of the Parker material cores were exhausted, speaking to the more extensive use of the higher quality and harder to obtain materials (Table 11.7). That said, neither of the suspected Kremmling chert cores was exhausted. The Trout Creek core had been reworked into a small tool; whether or not it was exhausted was not noted, although it was described by Hammond and Gooding as small with "numerous flake scars from several directions."

In an experimental study of transport and material use efficiency, Jennings and colleagues (2010) argue that discoidal cores are among the most efficient forms for materials that must be transported over great distances. The prevalence of this form for non-local materials is evident in the Swallow assemblage, and when combined with the exhausted core data, suggest that maximizing the efficient transport and use of materials from distant sources, including Parker and Troublesome sources, was a priority for Swallow flintknappers.

Twenty-one cores showed evidence of retouch or wear indicative of use as a tool. Tools included scrapers (8), gravers (5), choppers (2), knives (2), and a spokeshave (1). Finally, eight cores showed evidence of thermal alteration. As some cores were found in fire features, it is not clear whether observed thermal alteration was intended to prepare the stone for working or whether it occurred inadvertently after discard.

Table 11.7. Exhausted cores.

Material	Number Exhausted	Percent Exhausted
Morrison	9	43.0
Parker	14	70.0
Dakota	2*	50.0
Quartz crystal	1*	50.0
Vein quartz	5	19.0
Unknown	2	25.0

* Totals are too small for percentages to be meaningful.

Spatial Distribution of Lithic Debitage

Lithic debitage was found throughout the site at all levels, with the densest occurrence of flakes occurring in an approximate central line through the site, with somewhat higher amounts in the southern portion of the site. This area is also where the greatest numbers of features occur. While flake counts are high in the area immediately around hearths, they are even higher in units adjacent to those with hearths, in a pattern suggestive of what Binford (1978) called "drop and toss zones" for groups engaged in activities when gathered around hearths (Figure 11.3).

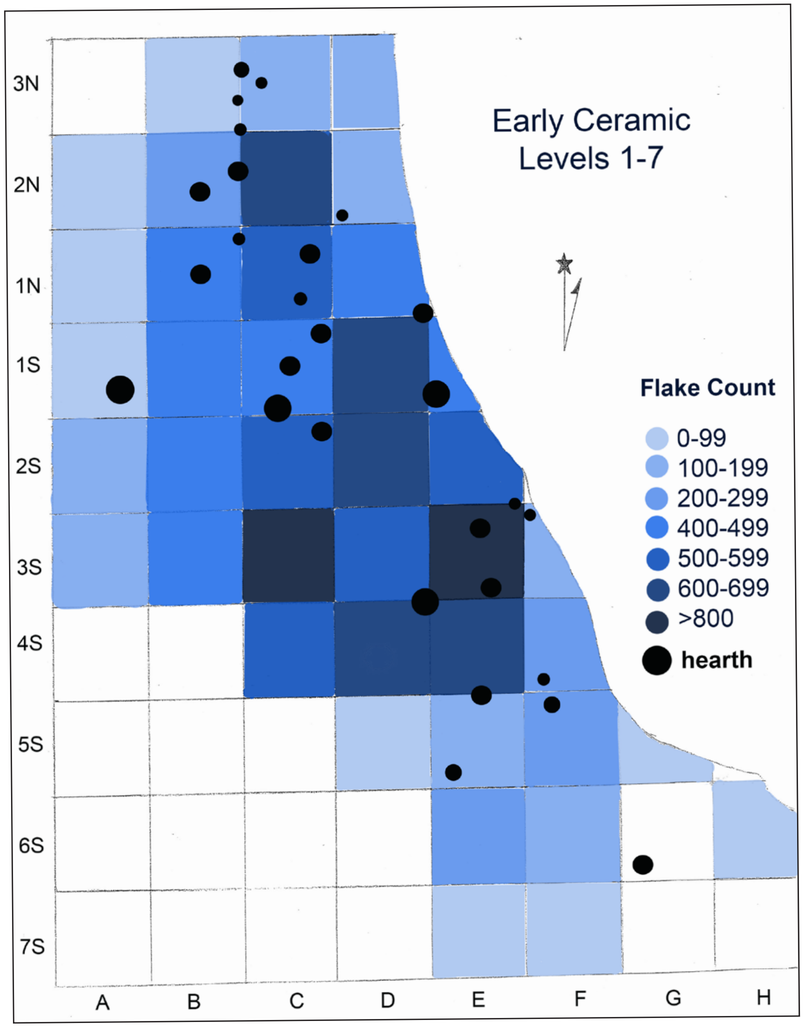

Figure 11.3a. Distributions of lithic flakes at Swallow, with hearth locations shown. In the Early Ceramic levels, densest deposits of flakes suggest drop and toss zones around hearths.

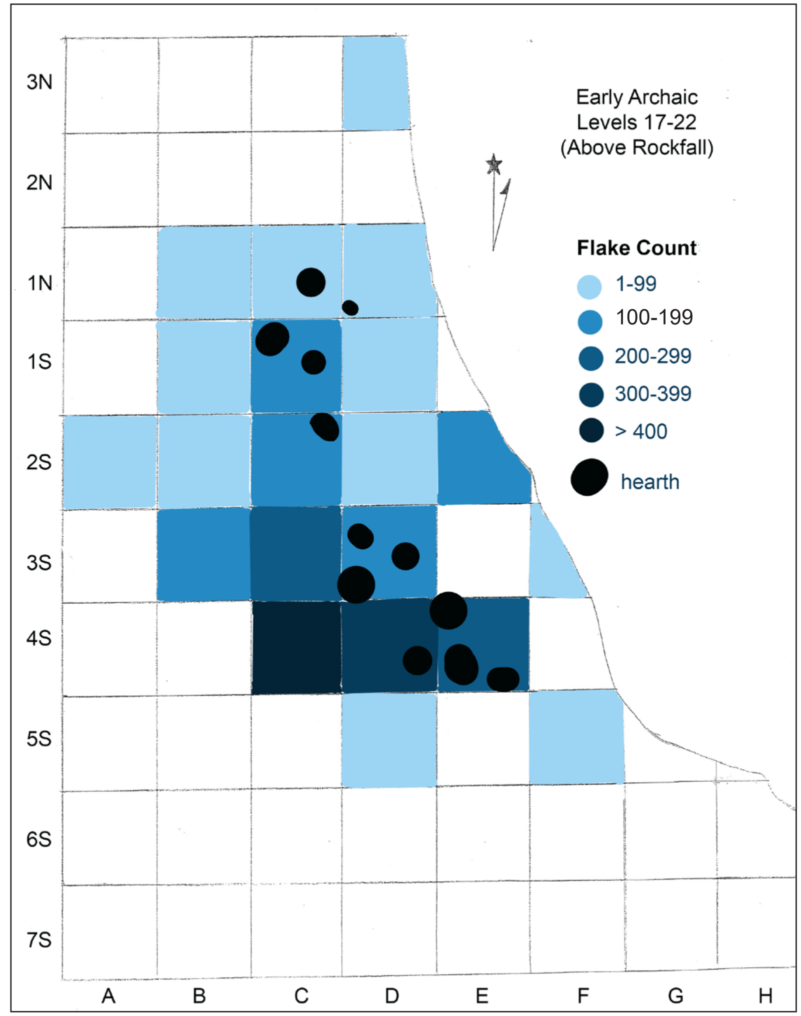

Figure 11.3b. Distributions of lithic flakes at Swallow, with hearth locations shown. In the Early Archaic levels, densest deposits of flakes suggest drop and toss zones around hearths.

It is notable that these lithic distributions are somewhat different than those of fire cracked rock and bone, which occur in denser amounts on the western margin of the site, in an area that most likely represents trash deposits. Those deposits may represent the clearing away of materials after roasting or processing events rather than a generalized trash pile for all trash generated at the site. Certainly, lithic debris does not seem to have been deposited in that area and instead occurs in the highest use areas of the site.

Lithic Debitage Below the Rockfall

A final analysis was done to compare the Early Archaic levels above the rockfall and those below. This was done because defining the Early Archaic in general and evaluating the "sealed" deposits below the rockfall in particular, were stated objectives of the Swallow project (Hammond 2020:7). While materials beneath the rockfall were somewhat scant, precluding a number of analyses, 1,147 flakes, nearly 1/3 of the Early Archaic flakes (31.7%) were recovered from Levels 23 and below, designated as "below rockfall" levels. This allows for an interesting comparison of the occupation of the site before and after the rockfall, both Early Archaic occupations but separated by an estimated span of 600 years (see Chapter 5), as well as by a dramatic change in the topography of the site due to the large boulders deposited by the collapse of a section of the monolith.

Interestingly, both material types and spatial distributions show different patterning before and after the rockfall. Flake materials beneath the rockfall suggest a significantly higher usage of chalcedony/agate and quartzite and a lower usage of chert/jasper and petrified woods than seen in the levels above the rockfall (Table 11.8).

This is intriguing, given Hammond and Gooding's identification of cherts and jaspers in the cores coming primarily from the Parker formation along with petrified wood, while quartzites represent locally available materials and chalcedony is available in both. This distribution, then, could suggest that the earliest occupants of the site were not engaged in the same level of movement or exchange for materials but were dependent on more localized sources, and that the pattern of acquisition that involves the adoption of Parker lithic sources begins with the reoccupation of the site after the rockfall and continues, with increasing use of Parker materials through time. A more fine-scaled sourcing study of materials in the flake assemblage would be useful to support or refine this hypothesis.

Differences in the use of the site before and after the rockfall are further reinforced by the distribution of lithic flakes in the levels below the rockfall, in which the densest deposits of flakes occur in Unit 2SB, both farther north and west than concentrations in later levels. This different use pattern may not be significant, however, given that the monolith itself would have extended farther to the west before a large section cleaved from it, and the overall shape and dripline of the shelter before the rockfall is not known. Differences in activity areas or material scatter may simply be an artifact of differences in the overall usable space in the two eras. The consistent pattern of usage that prevails throughout the Archaic after the rockfall, however, is not present in the levels beneath it.

Table 11.8. Comparison of Early Archaic material (percent) below and above rockfall.

	Chalcedony	Chert	Quartzite	Petrified Wood (unknown)	Dawson Petrified Wood	Green Mountain Petrified Wood	Quartz	Quartz Crystal	Other	Number
Early Archaic below Rockfall	31.60	6.62	41.20	0.17	5.67	4.45	9.59	0.17	0.43	1,147
Early Archaic above Rockfall	18.94	17.12	27.10	0.56	10.70	11.63	10.22	0.13	2.63	2,476

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12 The Ken-Caryl Brown Ware Project: Resource Analysis of Cord-Marked Ceramics From the Swallow Site and Beyond

William A. Lucius

Introduction

The Ken-Caryl Brown Ware Project was initiated in the year 2002 in response to a request by the Denver Chapter of the Colorado Archaeological Society (DC-CAS) to determine if ceramic artifacts recovered from the excavation of the Swallow site (5JF321) represent local manufacture. Analysis of similar ceramics from Rock Creek (5BL2712), located on the Colorado Piedmont, led to the proposition that they were not made locally but probably came from somewhere along the Front Range (Gleichman et al. 1995:124). Ellwood and Parker (1995:12) further suggest that the distinctive micaceous clay used for production may have been obtained from a clay source in Docmann Gulch, a major drainage located adjacent to the Swallow site.

This research focus is not typological but rather constitutes sourcing analysis, which in its most basic form requires knowledge of where on the landscape the pottery was found—its recovery provenience—and where it was made—its production provenience. As archaeologists we can assign GPS coordinates to the location where the sherds were collected, but we generally have no idea where they were made. Traditionally it is assumed that the production and recovery proveniences are congruent—the pottery found at a site was made at the site. At minimum this constitutes an unwarranted assumption (Kidder 1942:i; Plog 1980:15) because where sherds are found is not informative of where they were made. Restated in terms of sourcing analysis, if pottery was made at the site, then matching clay sources must occur in the resource landscape of the site, given that potters live in residential association with the clay sources used for pottery production and move finished pots, not raw materials (Arnold 1975:189).

Compositional ceramic analysis of the Swallow site sherds documents clay type, which cannot be

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determined by simple inspection of sherd surfaces. Refiring analysis and binocular microscopic examination of the clay paste allows for documentation of clay type in terms of refired clay color and their distinctive clay accessories. Their comparison with refired Clay Voucher Samples (CVS) recovered from the immediate resource landscape determines if those sherds represent local production. Clay sources recovered from the resource catchment of the Swallow site do not match the clay types observed in the sherd artifacts in terms of the diagnostic clay accessories and refired clay colors, so the simple answer to the research question is no, pottery production did not occur at the Swallow site. On reflection it became apparent that the original research question should be rephrased to ask where in the landscape did cord-marked pottery production occur? In addition to adding sherd collections from other sites, it became necessary to launch a program of landscape archaeology dedicated to the identification of a geographic locale with matching clay sources, supported by clay voucher sampling and refiring analysis of clay sources along the Dakota Hogback. As noted in the chapter title "and Beyond," the original ceramic analysis report was submitted prior to expansion of the research. What follows is an updated report of long-term concern with identification of the production provenience responsible for cord-marked ceramic production.

This report presents data derived from the Swallow site ceramic analysis and its associated clay voucher sampling and analysis, followed by similar data from site 5DA1957 of the Reuter/Hess Project as well as analysis data derived from a small sample of cord-marked sherds provided by the Colorado State Historical Society from selected Weld County sites. Additionally, Jarre Creek is introduced as a source locale where clays occur that may have been used for cord-marked pottery production.

Swallow Site

Ceramic Analysis Data

Cord-marked ceramics are associated with the Plains/Woodland Tradition. In the hierarchical structure of cultural history systematics, they are representative of the Hog Back Cultural Category, Utility Ware and the Type Ken-Caryl Cord-marked (Table 12.1). All sherds regardless of size were subjected to inventory. However, sherd refiring requires the removal of a portion of each sherd, which effectively removed 11.9 percent of the assemblage from compositional analysis given that they could not be fractured without damaging the provenience labels (as highlighted in Table 12.1). Inspection of Table 12.1 also reveals that percentages based on sherd counts and sherd weights are different. Sherd counts primarily document vessel breakage whereas sherd weights provide a better summary statistic of the sherds in each refired clay color (Chase 1985). The type Ken-Caryl Cord-marked pottery has not been formally described but appears to be a coherent class of cord-marked representing local manufacture during the Early Ceramic period, AD 150-1150 (Gilmore 1999), and follows the convention of naming pottery types after their initial locale of recovery and description (Colton and Hargrave 1937:20).

Table 12.1. 5JF321 ceramic analysis data.

Site Number	5JF321
Cultcat	Hog Back
Ware	Utility
Type	Ken Caryl Cord-Marked

Refiring Color	Count	Weight	Percent of Count	Percent of Weight
2.5YR5/6	102	516.5	38.49%	51.18%
2.5YR5/8	12	123.2	4.53%	12.21%
5YR5/6	9	69.9	3.40%	6.93%
5YR6/6	32	130.8	12.08%	12.96%
5YR6/8	6	23.0	2.26%	2.28%
5YR7/4	1	4.0	0.38%	0.40%
7.5YR7/4	4	21.7	1.51%	2.15%
None	99	120.1	37.36%	11.90%
Total	265	1009.2	100.00%	100.00%

Although the analysis structure allows for documentation of typological assignment, types are mute concerning the location of their production provenience. Technological attribute analysis of ceramic compositional data (Bishop et al. 1982:276; Peacock 1970:376) allows for characterization of the formal attribute of clay type, which records the clay source used for ceramic production, regardless of where the resultant sherds were found. Sherd refiring analysis removes the effects of differential firing temperatures and use and brings all ceramic artifacts to a comparable refired state (Bishop et al. 1982:280). Identification of clay type and clay accessories is enhanced by and often only possible after sherd refiring.

A research kiln with a standardized, firing curve (Shepard 1936:400) with a target temperature of 825 degrees C was used to refire sherd nips detached from each ceramic artifact for analysis. Iron is the primary coloring agent in clays (Shepard 1936:494), and a fully oxidizing refiring atmosphere results in full expression of the iron content in terms of Munsell Soil Color Chart notations of hue, value and chroma (Munsell Color 1976). Each refired clay color represents the selection and use of a unique clay source.

Examination of the freshly fractured edge of each sherd under 30-power binocular microscopic magnification revealed that every sherd contains abundant mica particles and quartz sand fragments of various sizes and roundness. The micaceous clay documents a depositional environment where clay-sized particles were thoroughly mixed with abundant, finely sorted mica. The mica therefore is a natural accessory of the clay. The abundant, sometimes large quartz sand was initially assumed to have been added by the potter as temper, but location of matching clay sources (see Jarre Creek discussion below) revealed that the quartz sand is also a clay accessory. In archaeological parlance, the clays selected for pottery production are self-tempered. Potters probably targeted these clays because the sand serves to reduce shrinkage and warping during drying and firing and the numerous mica particles serve to stop the propagation of cracks created by the firing and repeated thermal shock resulting from use over campfire coals (Eiselt and Ford 2007:223-224).

The ceramic assemblage represents a small, homogeneous assemblage composed entirely of cord-marked cooking (utility ware) jar fragments. Occasional rim sherds and drilled repair-hole rim sherds are simple and tapered. No bowl forms nor non-local pottery types occur in the ceramic assemblage. The brown surface color comes from carbon soot deposited throughout the ceramic paste by use of vessels over campfire coals, which is removed by refiring analysis. Indeed, the only observed resource variability within the assemblage is refired clay color. Although determination of the actual number of vessels in the sherd assemblage is not possible, the MNI (minimum number of individual) vessel statistic equals the number of distinct refired clay colors (Figure 12.1).

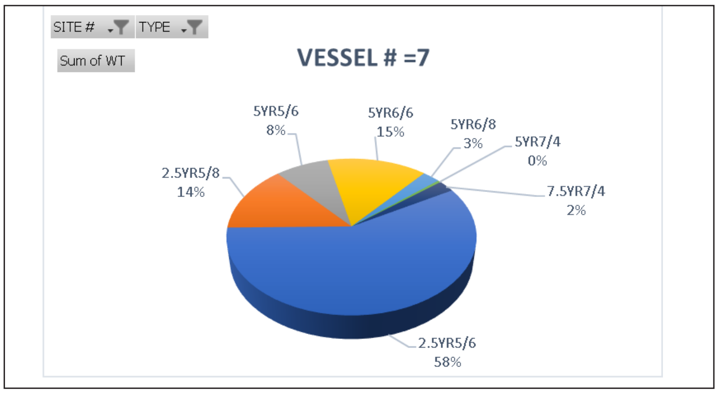
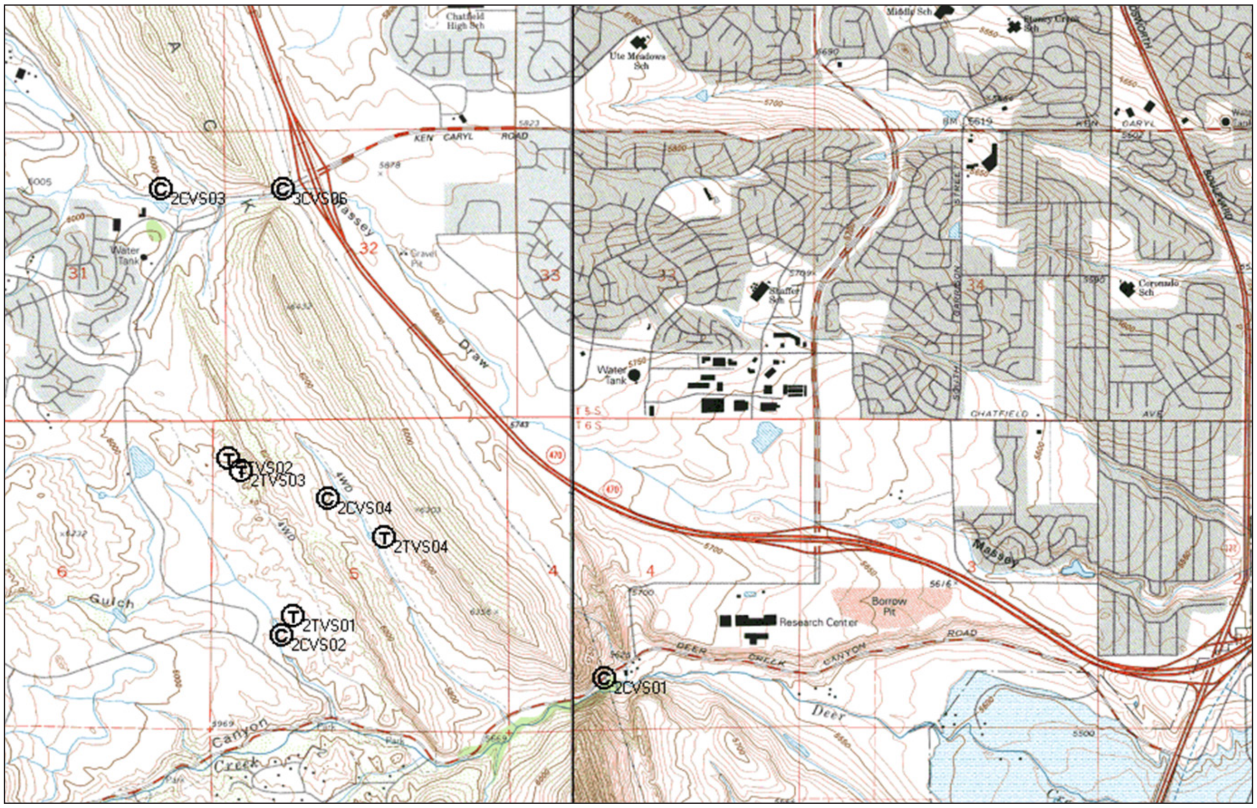


Figure 12.1. 5JF321 ceramics refired clay colors.

Voucher Sample Analysis

Resource analysis (Lucius 1988:28) involves the identification and processing of clay resource voucher samples for comparison with the ceramic artifacts for affiliation of archaeological samples with matching source areas (Rands and Bishop 1980:20). Resource analysis relies on the *resource proposition* (Lucius 1988:7), which states that refired clay color documents the physical association of potters with a geographic locale of matching resource availability. Clay sources are variable (Bishop et al. 1982:301) and are consistently obtained within a catchment area around the ceramic producing community (DeBoer and Lathrap l979:110, Guthe l925). In pedestrian economies bulky clay and temper materials are rarely moved over 5 km. Rather, potters locate adjacent to ceramic resources to facilitate production by minimization of raw material transport costs (Arnold 1975:189). These geographically delimited locales of ceramic manufacture are referred to as *production zones* or simply *zones* (Rands and Bishop 1980:20).

Accompanied by Fred Rathbun, retired geologist and member of DC-CAS, temper and clay voucher samples were collected from various formations in the general catchment of the Swallow site. A hand-held GPS receiver was used to document the exact position of each sample and that location data was subsequently transferred to Terrain Navigator, a computer-mapping program that allows for visual display of the sample data (Map 12.1). Clay and temper resource samples were placed in ore sample bags and assigned a voucher sample number. The samples and all associated data are documented in computer readable format (Table 12.2).



Map 12.1. Ken-Caryl Ranch area voucher sample locations (portions of the Indian Hills and Littleton 7.5-minute USGS quadrangles).

Table 12.2. Ken-Caryl Ranch area voucher sample data.

CVS Number	Comments	Recolor	Project
2CVS1	Excellent Clay, Limonite	5YR7/5	02KCBRP
2CVS2	Poor Micaceous Clay	5YR5/6	02KCBRP
2CVS3	Not Clay, Shale	None	02KCBRP
2CVS4	Poor Clay, Shale & Limestone	2.5YR6/8	02KCBRP
2TVS1	Sand Temper		02KCBRP
2TVS2	Mudstone		02KCBRP
2TVS3	Fine Yellow Sand		02KCBRP
2TVS4	Fine White Sand		02KCBRP
3CVS6	Excellent Clay, Limonite	5YR7/4	02KCBRP

A portion of each sample was retained without alteration to be curated as a voucher sample. The remaining portion was processed for comparison with the archaeological ceramic artifacts. Clay sources were mixed with water to make them plastic, with the addition of quartz sands from various temper voucher samples, ⅓ by weight to reduce shrinkage and heat shock. Labeled test tiles were formed to a wet length of 10 cm and air-dried. The test tiles were then subjected to refiring analysis. Processed resource samples were subsequently returned to the appropriate voucher sample ore bag for eventual return to DC-CAS.

The Swallow site is located within the Fountain formation, one of several geological strata exposed by tilting and erosion associated with the Front Range Hogback. Five clay voucher samples were collected from three distinct geological strata:

- The Dakota sample (2CVS1) proved to be exceptional pottery clay with limonite inclusions. Its light pink refired color (5YR7/5) is typical of Cretaceous age clays. It does not match any of the clay colors recorded in the ceramic analysis.

- The Docmann Gulch voucher sample (2CVS2) referenced by Ellwood and Parker (1995) represents lamina commonly observed within Fountain formation sandstones. It is composed of rounded quartz sand, mica and red muds. The material is aplastic and could not be used for pottery production.

- The first clay voucher sample from the Lykins Formation (2CVS3) proved to be shale rather than clay, which required the collection of another sample (2CVS4) from a different outcrop. It contains abundant limestone fragments not observed in the sherds. Its light red refired color (2.5YR6/8) does not match any of the ceramic artifacts.

- An additional voucher sample was collected the following year. The Dakota sample (3CVS6) was collected from the same outcrop as 2CVS1 but from a locale further north along the Hogback. It also is exceptional pottery clay with the same limonite inclusions. Its refired color (5YR7/4) indicates a slightly lower iron content than 2CVS1.

- Two possible pottery clay samples (provenience reference numbers (13666 and 14297) recovered from the excavation of the Swallow site were also passed through the refiring process. Both represent clay balls encased in a sand matrix of Fountain formation sand. Their light red refired color (2.5YR6/6) does not match any of the ceramic artifacts.

Four quartz sand and sandstone samples were collected from various locales and added to clay voucher samples to allow for comparison with the ceramic artifacts. The fine mica noted in some of the quartz sand voucher samples does not match the size or density of the mica observed in the sherd cross-sections.

- Coarse Fountain formation sand (2TVS1) was collected from the base of the monolith at Swallow. Its size varies from coarse to fine, with quartz, feldspar and fine mica being the predominant minerals.

- Coarse Fountain formation mudstone (2TVS2) was collected from the base of the monolith at Falcon's Nest (5JF211). It required forceful grinding prior to being added to the clay sample

- Fine yellow Lyons Sandstone (2TVS3) was pulverized prior to adding it to the clay samples. It has no counterpart in any of the quartz sand grains observed in the ceramic analysis.

- Fine white Dakota Sandstone (2TVS4) also was pulverized prior to its use. It has no counterpart in the quartz sand grains observed in the sherds.

Summary

None of the clay voucher samples collected from the Fountain, Lykins and Dakota formations exhibit clays with matching refired colors and the diagnostic mica and quartz sand accessories. The pottery sherds recovered from the excavation of the Swallow site were made somewhere else.

Reuter/Hess Project, Site 5DA1957

In 2005 the author was asked by Centennial Archaeology to perform ceramic analysis on selected cord-marked sherds recovered from the excavations of 5DA1957, a ceramic period site located in the Newlin Gulch drainage near Parker, Colorado.

Ceramic Analysis Data

Visual inspection of the ceramic assemblage revealed a small (n=101) homogenous assemblage composed entirely of sooted, cord-marked jar sherds visually identical to those recovered from the Swallow shelter. The sherds submitted for analysis represent only a portion of the entire assemblage that was sorted into sherd lots and assigned tentative vessel numbers by Centennial Archaeology. Sherd refiring was restricted to a total of 18 individual sherds. The clay type variability of the remaining 82.18% of the ceramic assemblage is unknown (as highlighted in Table 12.3). Refiring analysis documents four distinct refired clay colors, resulting in an MNI statistic of four vessels (Figure 12.2).

Table 12.3. 5DA1957 ceramic analysis data.

Site Number	5DA1957
Cultcat	Hogback
Ware	Utility
Type	Ken Caryl Cord-Marked

Refiring Color	Count	Weight	Percent of Count	Percent of Weight
2.5YR5/8	5	57.2	4.95%	26.87%
2.5YR6/8	7	111.6	6.93%	52.42%
5YR7/8	5	23.9	4.95%	11.23%
7.5YR8/4	1	20.2	0.99%	9.49%
None	83	0	82.18%	0.00%
Total	101	212.9	100.00%	100.00%

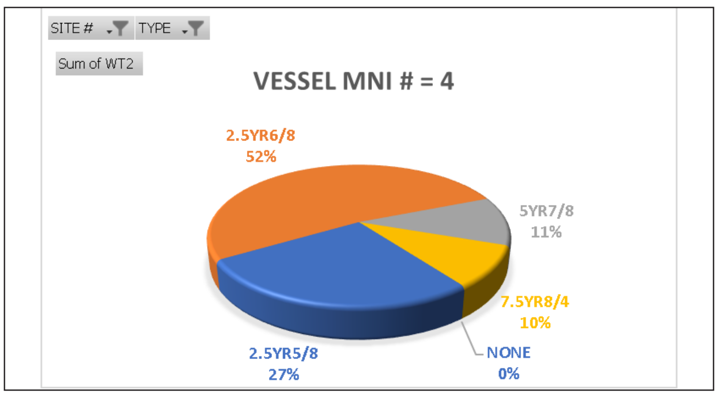


Figure 12.2. 5DA1957 refired clay color pie chart.

Resource Sampling and Analysis

Five clay and six temper voucher samples were collected from various locales in the general site resource catchment (Table 12.4, Map 12.2).

The lack of correspondence between clay resources of the project area with the excavated sherds precludes that ceramic production occurred at the site.

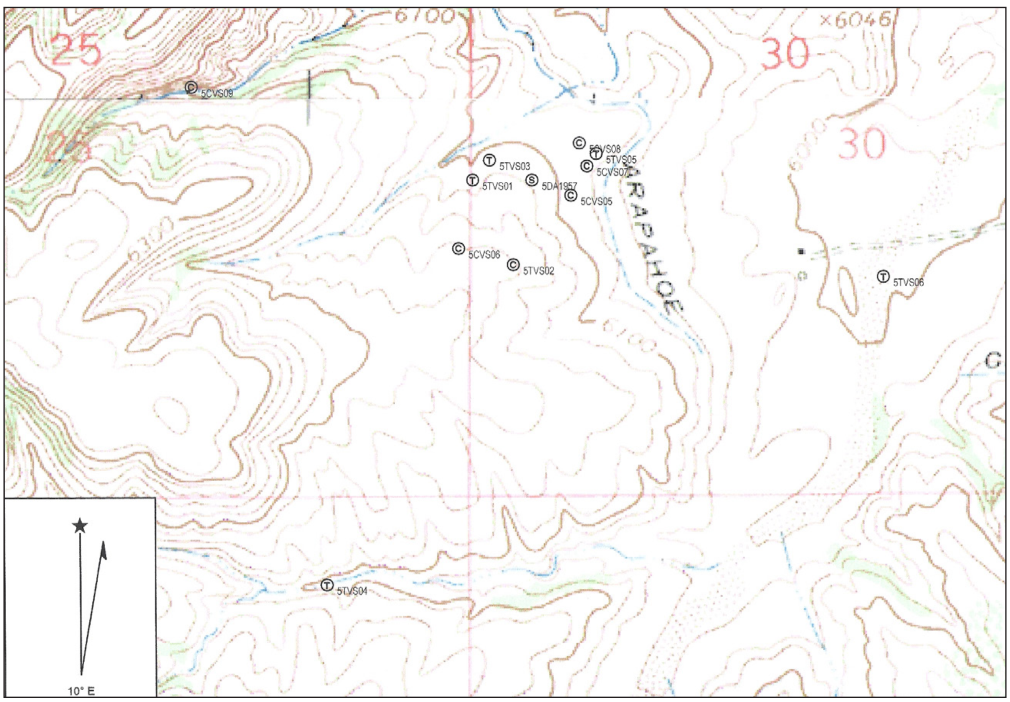
Weld County Sites

Ceramic Analysis Data

Five cord-marked sherds collected from 3 different Weld County sites (Table 12.5) were provided for compositional analysis by Kevin Black of the Office of Archaeology and Historic Preservation. The sherds are identical to those recovered from the Swallow site and 5DA1957 in terms of

Table 12.4. Reuter/Hess area voucher sample data.

Voucher Number	Comments	Recolor	Project
5CVS06	Pond Clay	7.5YR6/4	05RHBW
5CVS05	Soil	5YR5/4	05RHBW
5CVS07	Soil	5YR5/6	05RHBW
5CVS08	Soil	10R4/8	05RHBW
5CVS09	Clay	7.5YR6/6	05RHBW
5TVS01	Quartz Sand	None	05RHBW
5TVS02	Quartz Sand	None	05RHBW
5TVS03	Quartz Sand	None	05RHBW
5TVS04	Quartz Sand	None	05RHBW
5TVS05	Beach Sandstone	None	05RHBW
5TVS06	Quartz Sand	None	05RHBW



Map 12.2. Reuter/Hess area voucher sample locations (portion of the Castle Rock North 7.5-minute USGS quadrangle).

typological assignment and refired clay colors. None of the sites were visited and no voucher samples of their resource catchments were generated.

Clay Voucher Sampling of the Front Range Hogback

The research design developed for the Swallow site ceramic research was necessarily exploratory

Table 12.5. Weld County sites ceramic analysis data.

Form	Jar
Cultcat	Hogback
Ware	Utility
Type	Ken Caryl Cord-Marked

Refiring Color	Count	Weight
5WL215	1	2.5
2.5YR5/6	1	2.5
5WL217	3	11.6
5YR5/6	1	3
5YR6/6	2	8.6
5WL48	1	4.6
2.5YR5/6	1	4.6
Total	5	18.7

given the total lack of knowledge considering compositional variability in cord-marked ceramics or the resource landscapes of the Front Range Hogback. Rather than repeatedly demonstrating where cord-marked pottery was not made, the research design changed to emphasize landscape archaeology for the location of the clay sources used for ceramic production. Although the ceramic analysis data tells us what type of clay to look for, it does not point to where to look for it in the landscape. The working assumption that cord-marked pottery found along the Front Range represents local production rather than imports from similar Plains/Woodland occupations in Nebraska, Kansas and Texas predicts that matching clay sources should occur somewhere along the Hogback. The unusual combination of clay, mica and quartz sand documented in cord-marked sherds serves to enhance their recognition in the landscape (Table 12.6).

Beginning in 2003 the author began examining clay sources in a roughly rectangular area of Hogback from Fort Collins (Horsetooth Reservoir) south to Fort Carson and east from the Pawnee Grasslands to Calhan. The effort utilized windshield observation of road-cuts for clay outcrops to sample. This non-systematic sampling was necessarily spotty and highly biased to areas with established roads. No private property boundaries were crossed. None of the voucher samples collected from numerous clay outcrops exhibited the mica and quartz sand combination observed in the ceramic artifacts.

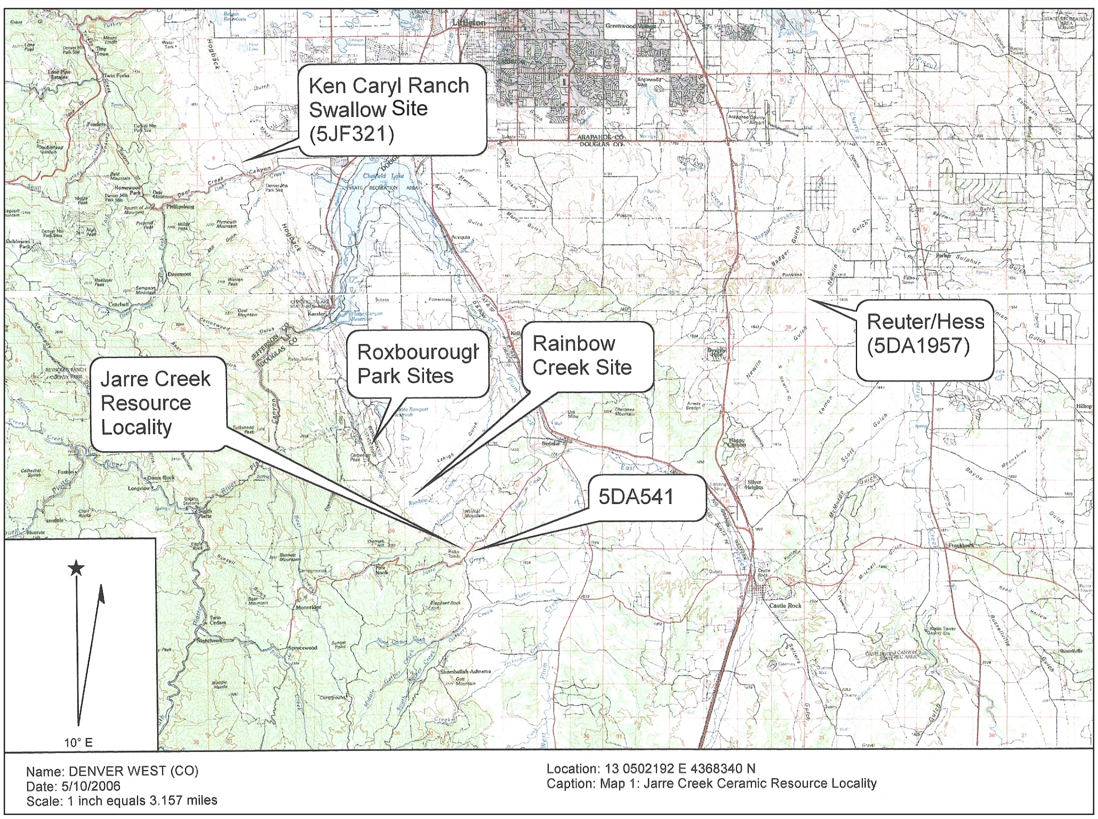
Jarre Creek Clay Resource Locality

The presence of an Early Ceramic period site (5DA541) originally excavated by David Breternitz and reported by Gilmore and Larmore (2003) and Gilmore (2004) in association with Jarre Creek resulted in sampling of associated clay sources (Map 12.3).

Clay voucher sampling began in the year 2003 with subsequent sampling in 2005 (Table 12.7). The

Table 12.6. Front Range Hogback clay voucher sample data.

CVS Number	Recolor	Locale	Accessory	County	State
03CVS18	10YR8/1	Baptist Road	Fine Quartz Sand	El Paso	CO
04CVS07	10YR8/3	Fort Carson	Shale	El Paso	CO
04CVS11	5YR5/6	Fort Carson	Fine Mica	El Paso	CO
04CVS06	5YR6/6	Fort Carson	Fine Mica	El Paso	CO
04CVS05A	5YR8/4	Fort Carson	Gypsum	El Paso	CO
04CVS05B	5YR8/4	Fort Carson	Quartz Sand	El Paso	CO
04CVS10	7.5YR6/6	Fort Carson	Fine Mica	El Paso	CO
04CVS02	7.5YR6/6	Pawnee Grasslands	Quartz Sand	Weld	CO
03CVS14	7.5YR7/4	Golden	Mica, Black Specks	Jefferson	CO
03CVS20	7.5YR8/2	Golden	Iron, Shale, Mica	Jefferson	CO
04CVS08	7.5YR8/2	Fort Carson	Shale	El Paso	CO
03CVS19	7.5YR8/3	Pawnee Grasslands	Fine Quartz Sand	Weld	CO
04CVS01	7.5YR8/3	Horsetooth	Gypsum	Larimer	CO
03CVS15	7.5YR8/3	Golden	Abundant Quartz Sand	Jefferson	CO
04CVS09	7.5YR8/4	Fort Carson	Shale	El Paso	CO
03CVS17	White	Calhan	Massive Quartz Sand	El Paso	CO

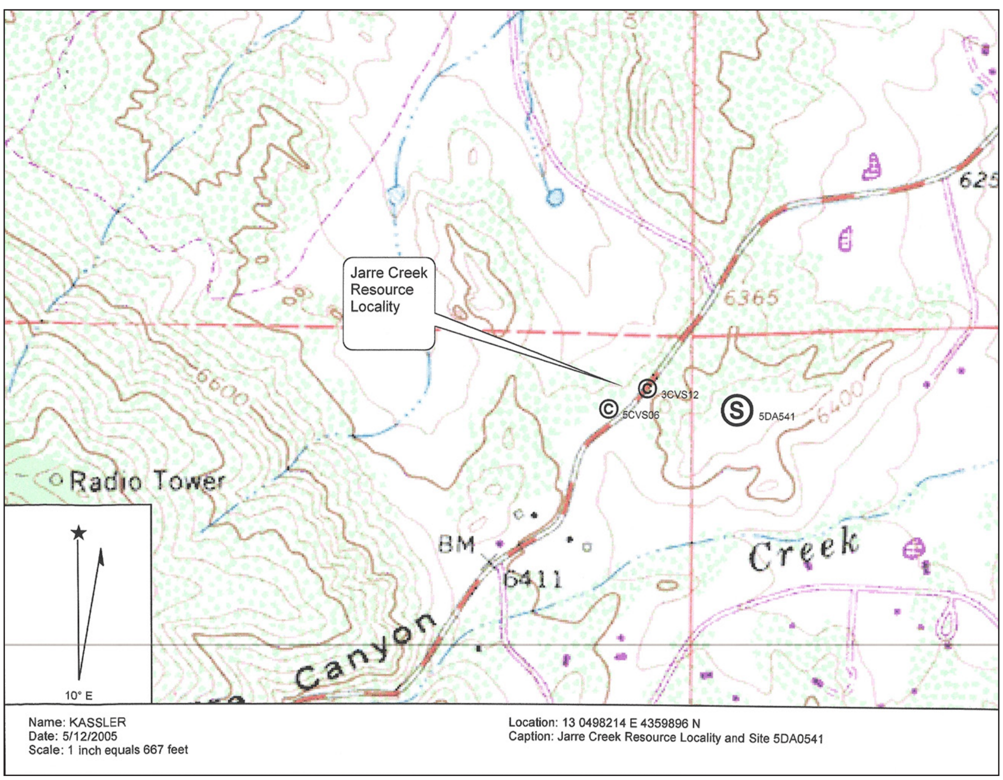


Map 12.3. Jarre Creek resource locality and pertinent sites (portion of the Denver 1:100,000 USGS map).

Table 12.7. Jarre Creek resource locality clay voucher data.

CVS Number	Recolor	Locale	Accessory	County	State
03CVS12	7.5YR7/3	Jarre Creek	Mica, Qsand	Douglas	CO
03CVS13A	7.5YR7/4	Jarre Creek	Mica, Qsand	Douglas	CO
03CVS13B	7.5YR7/3	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS01	5YR5/6	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS02	7.5YR7/4	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS03	5YR6/6	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS04	7.5YR6/6	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS05	7.5YR6/6	Jarre Creek	Mica, Qsand	Douglas	CO
05CVS06	7.5YR6/4	Jarre Creek	Mica, Qsand	Douglas	CO

Jarre Creek Ceramic Resource Locality is centered on an isolated section of the Hogback located just south of Roxborough State Park with two additional clay outcrops further downstream. The clay outcrops sampled exhibit micaceous clays with various refired clay colors, all contaminated with abundant amounts of quartz sand (Map 12.4). Trenching across a series of six distinct clay sources at the hogback reveals narrow (< 0.5 m) clay layers sandwiched between narrow deposits of quartz sand suggestive of a high-energy deposition environment, possibly from the erosion of



Map 12.4. Jarre Creek resource locality and selected clay voucher samples (portion of the Kassler 7.5-minute USGS map).

micaceous schists with pegmatite intrusions. In such a system, the feldspars of the pegmatite alter to clay-sized particles and the schists provide the mica and quartz (Eiselt 2005:5-8). Although not specifically illustrated, the Jarre Creek hogback clays are tilted upward to nearly vertical, documenting the up warping of previously flat lying layers of Pierre Shale during formation of the Front Range Hogback (Sterne 2006: Figure 18).

Inspection of Table 12.8 (as highlighted) reveals that several of the clay outcrops documented in the Jarre Creek Locality correspond with the sherds examined during the analysis. Although color matching of clay sources and ceramic artifacts constitutes a strong argument for a production provenience, verification of their shared identity requires subjecting them to elemental chemical analysis. Standardized procedures developed for sourcing analysis of orange and red ware production in southeastern Utah enlists concurrent portable X-ray Florescence (pXRF) analysis of refired sherds and clay voucher samples to collect elemental data. Principal Components Analysis (PCA) allows for plotting of sherds and clays contemporaneously in PCA biplots to explore the underlying (elemental) patterns in the data. That level of analysis allows for plotting their position in compositional graph space. When sherd and voucher samples aggregate together, they share the same elemental fingerprints (Di Naso et al. 2018). That level of analysis was beyond the scope of the current research.

Table 12.8. Jarre Creek recolors/site sherd recolor correlation data.

Jarre Creek CVS Recolor	5JF321	5DA1957	5WL48	5WL215	5WL217
	2.5YR5/6		2.5YR5/6		2.5YR5/6
	2.5YR5/8	2.5YR5/8			
		2.5YR6/8			
5YR5/6	**5YR5/6**			**5YR5/6**	
5YR6/6	**5YR6/6**			**5YR6/6**	
	5YR6/8				
	5YR7/4				
		5YR7/8			
7.5YR6/4					
7.5YR6/6					
7.5YR7/3					
7.5YR7/4	**7.5YR7/4**				
		7.5YR8/4			

Clays that refire to the same Munsell values as observed in sherds from the various sites of analysis are highlighted above. Clays in the 2.5YR5/6 and 2.5YR5/8 range of Munsell color chips are notably absent in the Jarre Creek clays samples, which suggests the possible presence of another resource locality where cord-marked production occurred. Because the clays used for cord-marked pottery production are uncommon along the hogback, it is possible that additional outcrops may occur in the area immediately north of Jarre Creek. Extension of the current research should focus on clay resource reconnaissance and sampling in those areas, including in Roxborough State Park, where several Early Ceramic period sites have been recorded (Map 12.3). It is also possible that industrial clay mines and housing developments further north along the hogback have obliterated the clay sources used for prehistoric ceramic production.

Summary

Sourcing analysis of ceramic assemblages from two excavated sites and individual sherds collected from unexcavated sites in Weld County reveals that the only variability in the assemblages is refired clay color and that the sherds document a production locale where matching clay sources occur. Extension of the research to a program of landscape archaeology led to the identification of a possible production locale along Jarre Creek. The data further suggest the possibility of another cord-marked production zone adjacent to Jarre Creek.

As such, this report represents a first application of a model of sourcing analysis, one that will require further testing and evaluation by other researchers interested in detailing the structure of cord-marked ceramic production along the Front Range Hogback of Colorado. By extension, the locational data resulting from sourcing analysis are useful for determination of the structure of ceramic exchange and interaction in the Early Ceramic period of the Late Prehistoric stage. Perhaps this report will prompt future research into those subjects.

Acknowledgments

The Ken-Caryl Brown Ware Project was a direct outgrowth of an invitation by John Gooding of DC-CAS to examine the ceramic assemblage from the Swallow site. Fred Rathbun provided much needed guidance for understanding the complicated geologic landscape of Ken-Caryl Ranch, Audrey Marlar assisted in resource sample collection, processing and interpretation and Bill Hammond served as liaison for DC-CAS. Erik Gantt and Bonnie Gibson of Centennial Archaeology and Mike McFaul of Laramie Soil Service assisted in the voucher sampling of the Reuter/Hess voucher resource landscape. The Office of Archaeology and Historic Preservation provided requested data in a timely fashion and Kevin Black provided access to the cord-marked sherds from selected Weld County sites. Irene Lopez-Wessell served as field assistant and acted as a sounding board for the various ideas that necessarily accompany such a scientific research project. Fellow archaeologist Pete Gleichman allowed for expansion of the report beyond the boundaries of Ken-Caryl Ranch. Steven M. Di Naso, Geospatial Scientist and Geoarchaeologist, Department of Earth & Environmental Systems at Indiana State University, provided final edits to ensure my words suitably described the tenets and procedures of sourcing analysis.

Location and Curation of Samples and Analysis Data

All ceramic artifacts subjected to compositional analysis have been returned to their respective owners, along with the vouchers collected from the Ken-Caryl Ranch and Reuter/Hess resource landscapes. The additional clay voucher samples generated by aerial reconnaissance of the Front Range Hogback remain in the possession of the author. Their descriptions and GPS coordinates are being provided as open access data.

The Clay Voucher and Technological/Typological Ceramic Analysis databases associated with this chapter contain sensitive locational data of clay voucher sample and site GPS coordinates and are on file at the Office of Archaeology and Historic Preservation, available to qualified researchers.

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13

Ceramics

Jeannette L. Mobley-Tanaka

A total of 289 fragments of pottery was found at the Swallow site, primarily in the upper layers associated with the Early Ceramic (Plains Woodland) occupation. All of the pottery conforms to the style and materials typical of the Early Ceramic period along the Colorado Front Range, and has the potential to inform on the activities and movements of the occupants of the Swallow site during its final period of occupation. In this chapter, I discuss various analyses of the ceramic assemblage conducted by me, Bill Hammond, Audrey Marlar, William Lucius, Priscilla Ellwood, and Doug Parker. These analyses include stylistic analysis of surface treatment, compositional analysis of both clay and aplastic inclusions, and spatial analysis of sherd distribution across the site.

The pottery from the Swallow site is typical of that found in the Front Range region, and across much of the Great Plains during the Early Ceramic period of the Late Prehistoric stage. Potsherds were found primarily in Levels 1-6, as would be expected, given the horizon marker around 70-80 cm in depth that defined the Early Ceramic/Archaic boundary (Figure 13.1). Radiocarbon dates from Levels 1-6 give a maximum date range of AD 570-1150, placing these levels firmly within the Early Ceramic period time range of AD 150-1150, as defined by Gilmore (1999).

The Early Ceramic designation is further supported by the style of the pottery itself. All sherds found at the site conformed to the standard descriptions for Early Ceramic pottery, as detailed by Ellwood in her analyses of both sherd assemblages (1995) and whole vessels (2002) from Eastern Colorado. Plains Woodland pottery was constructed using the lump-accretion method, in which the potter began with a lump of clay to form the base, then added additional lumps as needed to expand the vessel upward. Lumps were bound together, thinned, and smoothed by the application of a cord-wrapped paddle or dowel that was patted or rolled against the surface of the moist clay.

2024 *Archaeological Investigations at the Swallow Site, Jefferson County, Colorado*, edited by Peter J. Gleichman, Bill Hammond, and Jeannette L. Mobley-Tanaka, pp. 243-255. Memoir No. 7. Colorado Archaeological Society, Denver.

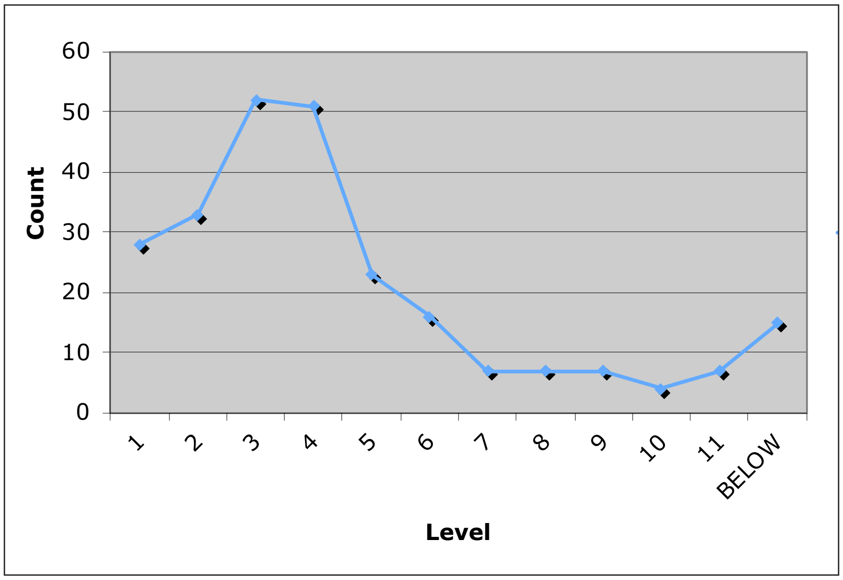

Figure 13.1. Distribution of sherds by level at Swallow site indicates that the majority of sherds were found in Levels 1-6, consistent with the Early Ceramic-Archaic horizon marker identified across the site in Levels 7-8.

Vessels were generally conical with straight sides and very little change of shape at or near the rim. Bases were "roundly pointed" (Ellwood 1995:133) and were generally the thickest part of the vessel. Overall surface treatment consisted of cord marking on the exterior and smooth interiors with little attention given to surface treatment in the interior. Cord marking on the exterior varies in clarity and depth, but is generally perpendicular or diagonal to the rim, and parallel on most of the body of the pot, with overlapping cord markings occurring only near the base where the pot narrows (Ellwood 1995:132-133).

While no large portions of pots were found at the Swallow site, the overall shape and surface finish of sherds indicate that the vessels from Swallow site conform to the expected vessel shape from this time period. Basal sherds in the Swallow site assemblage follow the pattern defined by Ellwood (1995), of thick bases with coarser temper than found in sherds from higher on the vessel. This implies that additional temper may have been added to the clay when construction started, perhaps to improve the firing of the very thick clay at the base of the pot. This observation conflicts with Lucius' view that the clays were self-tempering (see Chapter 12), though it is not inconceivable that temper may have been added to the thick clay lump that formed the base and not elsewhere on a vessel made from clays with considerable aplastic inclusions. Basal sherds in the Swallow assemblage are friable and show some incomplete firing of the thick clay that may have made them more fragile than other parts of the vessel. Rim sherds, of which only four were of sufficient size to evaluate vessel shape, indicate a straight rim with no flair or significant incurving, and no sherds were found indicating a sharply curving shoulder. Taken together, these lines of evidence indicate that vessels at the Swallow site all conformed to the conical shape indicative of Early Ceramic period wares.

Stylistic Analysis

Style has often been used in archaeology to evaluate social boundaries and information exchange (following, most notably, Wobst 1977 and Weissner 1983); however another fruitful approach to style involves the analysis of more subtle details that derive from learning and production patterns that result in unintentional or subconscious material culture variation, sometimes called technological style (Lemonnier 1986; M. Stark 1999; Thebe and Sadr 2017).

In the assemblage from the Swallow site, variations in cord marking were recorded as an aspect of technological style. Variations in cord marking derive from differences in the tools used in the surface finish of the vessels (size and twist of the cordage, tightly or loosely wrapped cordage on the tool), in the application of the tool (how firmly is it pressed into the clay, how wet the surface is when the tool is applied, whether it is applied in a uniform or haphazard pattern), and in the surface treatment after the cord marking is done (whether the cord marking is partially or completely obliterated or left distinct). Given the range of these variables, cord mark distinctions can be used to identify individual pots to some extent, but a number of vessels determined by cord marking is only a minimum number, as a similar tool or technique applied to different vessels can have a similar surface finish. Further, obliteration of cord markings makes vessels constructed with different tools look alike. Therefore, cord marking variations do not correlate directly with individual vessels.

Bill Hammond and Audrey Marlar created an initial sort of cord marking patterns of the Swallow site assemblage based on: fineness of cord-marking (width of the cord and number of cords per cm), depth of cord markings (deep, moderate, or shallow), cord twist (Z or S twist), evenness of marking (parallel, overlapping, haphazard), distinctness or obliteration of the surface, and any other visual characteristics that distinguished the cord marking. Based on these traits, they defined eight different groups of sherds, labeled A through H. Later, Pattern E was eliminated and combined with Pattern D, to create seven distinct patterns. A total of 223 sherds, or 77 percent of the assemblage could be assigned to these seven patterns. Characteristics of each pattern are given in Table 13.1 and described in more detail below.

Cord Mark Patterns

Pattern A. Cord mark Pattern A is the most distinctive of the cord marking patterns at the Swallow site. The cord impressions on Pattern A sherds are very deep (up to 2 mm), extending halfway through the thickness of the sherd in places. Cord markings are widely spaced, averaging only three cord impressions per cm with broad ridges between. The marks are applied somewhat haphazardly and often overlap, which, along with the deep markings, creates a “bark-like” appearance to the surface of the sherds. A small amount of flattening and sometimes polish occurs on the ridges of

Table 13.1. Summary of pattern attributes.

Pattern	N	Cord/cm	Depth	Evenness	Cordage	Other
A	58	3/cm	Deep	Haphazard	Z twist	Bark-like appearance
B	78	4/cm	Shallow	Generally Parallel	Indeterminate	Deliberate obliteration, polish
C	27	2/cm	Moderate	Parallel	S twist	Cordage very distinct
D	33	4/cm	Shallow	Parallel, some overlap	Z twist	Cordage not distinct, lightly impressed, flattening of ridges
F	9	3/cm	Moderate	Parallel, slightly curving	S twist	Cordage very distinct
G	9	4/cm	Shallow	Even, parallel, little overlap	S twist	Indistinct impressions
H	10	5-6/cm	Shallow	Parallel, no overlap	S twist	Slight polish, interior polish

the markings, but the deeper marks are unmodified, and the impressions of the twisted cordage are clearly visible in the troughs. Whether this surface modification was intentional or the result of handling the vessel during manufacture is unclear; however, if intentional, it was not consistently applied across all surfaces of Pattern A vessels, as it varies, even across a single sherd.

Cordage used on the surface of Pattern A vessels was large (5-8 mm in diameter). It was two ply cord, plied with a Z twist. A total of 58 Pattern A sherds was recorded at the site.

Pattern B. The most distinctive aspect of Pattern B is deliberate smoothing and partial obliteration of the cord marks. While cord marks are still clearly visible, they have been smoothed over, both on the ridges and in the troughs, so that the details of the cordage are no longer visible. The depth of the cord marks is shallow, less than 1 mm in height, and the smoothing creates a rounded effect to the marks. Spacing of the marks averages about four per cm. Cord markings are typically parallel, with overlap visible primarily on thicker sherds, probably indicating that overlap only occurred in the narrowing base of the vessel, as suggested by Ellwood (1995). While details of the cordage are mostly obscured by the smoothing of the surface, the cordage appears to be about 3-4 mm in diameter, and some impressions suggest an S twist.

The smoothing of the surface extends evenly into the troughs as well as on the ridges of the cord markings, suggesting that it was the result of deliberate wiping of the surface while the clay was still soft. A light polish resulted from this wiping and is most apparent on the ridges.

Ellwood (2002: 27) argues that smoothing or obliterating of the coils is characteristic of Upper Republican pottery, dating to the Middle Ceramic period, but is also found late in the Early Ceramic period, a suggestion that was borne out by distributions of obliterated sherds in levels at the Bayou Gulch site (Ellwood 1987). This same stratigraphic relationship holds true at Swallow, where Pattern B appears in greater abundance in higher levels than do other patterns (discussed more in the spatial analysis section below). Based on these findings, I suggest that Pattern B represents the latest pottery made or used at the Swallow site, representing a late Early Ceramic or Early Ceramic Transitional variation (following Ellwood 2002). A total of 78 Pattern B sherds was found at the site, the most abundant type by number; however, many of the Pattern B sherds were quite small compared to other types. This may be due to a more friable nature or may simply have resulted from the prevalence of Pattern B sherds in the upper layers of the site where they were more heavily impacted by historic cattle trampling and other transformational processes.

Pattern C. Pattern C sherds are characterized by deep, distinct, widely spaced cord markings. The paddle or dowel used to mark Pattern C sherds was loosely wrapped with cordage, resulting in wide ridges between the deeply impressed (1 mm deep) cord marks, resulting in only two cord marks per cm. The impressions of the cordage in the troughs are clear and distinct. The cord used was a two-ply S twist, 3 to 4 mm in diameter. A large rim sherd of Pattern C indicates that the cord marking was at a slight diagonal angle to the rim, though other body sherds appear to have a more perpendicular orientation. Impressions are parallel with minimal overlap. Although a few sherds show some obliteration of the design, it appears to be unintentional and is inconsistent, even across a single sherd. A total of 27 sherds was recorded with Pattern C.

Pattern D. Pattern D is similar to B in depth and width of the pattern, and like Pattern B, also shows significant flattening of the cord impressions. Unlike Pattern B, the smoothing of cord marks on Pattern D sherds consists of a flattening of the ridges without extending into the troughs. Cord impressions in the troughs are unobliterated but not particularly distinct, suggesting that the tool was only applied lightly to the surface, or more likely, that the clay was drier when the tool was applied. The cord used was 2.5 mm in diameter, plied with a Z twist, confirming that despite the similarities, Pattern D sherds were marked with a different tool than Pattern B, which had an S twist. Pattern D sherds have four coil impressions per cm, and parallel or slightly overlapping cord markings that are perpendicular or slightly diagonal from the rim. Pattern E was originally distinguished based on overlap of impressions, but was later combined with Pattern D, as all other features were the same. A total of 33 Pattern D sherds was recovered.

Pattern F. Pattern F is represented by only nine sherds from the site. It is distinctive in the size of the cordage and the loose wrap of the cordage on the tool, so that large, distinct, widely spaced impressions were left on the vessel. The cord itself was quite large, averaging 1.5-2 mm in diameter, and was firmly applied while the surface of the pot remained soft enough to make a deep, clear impression. The impressions occur at a spacing of only three per cm, with large, distinct ridges between 1 mm deep troughs. The cord itself was 2 ply S twist, and was applied in somewhat curving lines, parallel to the rim of the vessel.

Pattern G. Pattern G was impressed with a medium-sized cordage more tightly wrapped on the tool, resulting in four impressions per cm. The cord markings are shallow and the cord impressions somewhat indistinct although unmodified, suggesting that the surface of the vessel was drier or that the cord-wrapped tool was applied with little pressure. The cord is S twist, and the markings are mostly parallel and perpendicular from the rim. Pattern G occurs on only nine sherds.

Pattern H. This pattern is distinctive for the fineness of the cordage, which was tightly wrapped on the tool, leaving 5-6 cord marks per cm on the surface of the vessel. The cords themselves were only 1 mm in diameter. The impressions are shallow but distinct, revealing an S twist to the cordage. The shallowness of the impressions is due in part to the fact that the cord was wrapped more tightly on the tool, so that the individual cords could not cut as deeply into the clay, but rather presented a more uniform surface when pressed against the clay. Cord impressions are perpendicular to the rim and no overlap of impressions was observed. While Ellwood (1995) tentatively suggests that fine or narrow cord markings are indicative of later time periods, Pattern H sherds do not have a different stratigraphic sequence than various other types with wider cord markings at the Swallow site. In some cases, Pattern H sherds had a slight polish to the interior surface. A total of ten Pattern H sherds was recovered from the Swallow site.

Pattern Distribution by Level

In order to evaluate the temporal occurrence of different surface patterns, all potsherds that could be assigned to a pattern were graphed according to level. To do this, counts were used to evaluate frequency. Frequencies of sherds are commonly done by either count or weight. Count can be skewed if different types of sherds are notably different in size; however weight, as an alternate method of evaluating frequency, is also subject to inaccuracy on Plains Woodland ceramics because of the extreme variation in thickness between bases, bodies and rims of vessels. For this analysis, counts were used, recognizing that Pattern B sherds were noticeably smaller in many cases and thus are elevated in numbers over other sherds. Since the goal of the analysis was not to compare overall frequency or ubiquity but rather to compare the distribution curves for each pattern in the stratigraphy, counts should not present a significant problem.

Of the 250 sherds that could be provenienced to level, 203 (81%) of these came from Levels 1 through 6, indicating a substantial amount of integrity to the Early Ceramic levels and justifying a more detailed stratigraphic analysis. Levels 3 and 4 have the highest number of sherds, accounting for 41 percent of the total assemblage. Not surprisingly, most of the patterns described above also show the highest number in these two levels, but not all the patterns do. This suggests some variation in time in the use of different patterns. Figure 13.2 shows the frequencies of each pattern by level. Patterns A, D, G, and H all have similar distributions, occurring in the highest frequencies in Levels 3 and 4, peaking in Level 4 and then falling dramatically in frequency in Level 5 (although H does not dramatically decrease in frequency until Level 6).

By contrast, two patterns, B and F, have a stronger representation in higher levels. Pattern F peaks slightly later, in Level 3; however, Pattern F is represented by only nine sherds and may represent a single vessel. Pattern B is more distinct in its distribution, and most likely represents a later type. It occurs in greatest frequency in Levels 2 and 3, with high numbers of sherds also occurring in Levels 1 and 4. The obliteration of the cord marking further supports the idea that Pattern B represents the final occupation of the site and is most likely terminal Early Ceramic period, in keeping with the latest radiocarbon dates from the site.

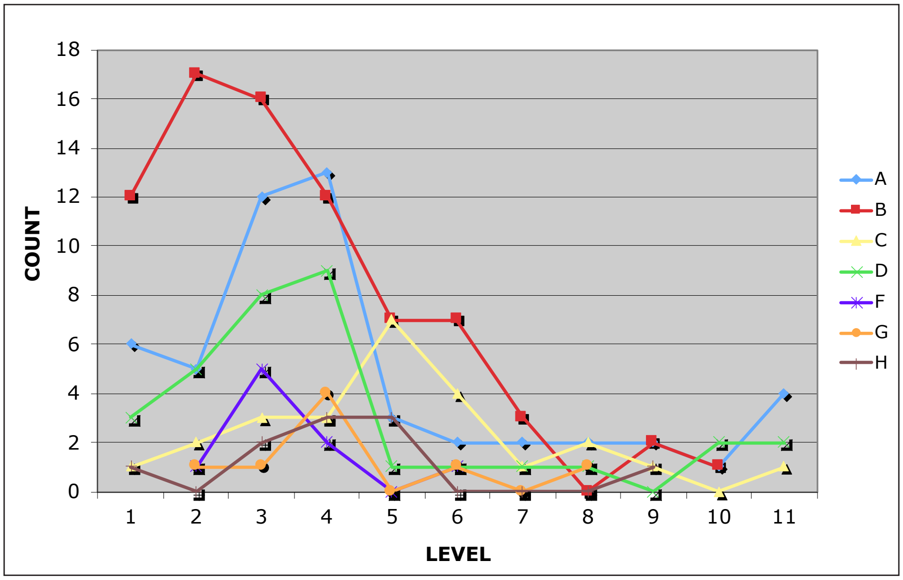

Figure 13.2. Distribution of cord designs by level at Swallow suggest cord mark patterns varied through time.

Pattern C is found in highest frequency in Levels 5 and 6, the levels in which other types are dramatically reduced in numbers. This suggests that Pattern C represents earlier vessels, perhaps associated with the beginning of pottery manufacture and use at the site.

The overall time spread represented by this seriation is not entirely clear. Radiocarbon dates for the levels in which ceramics occur suggest a time span of several hundred years. The pattern variations may represent single vessels or may represent manufacturing episodes in which a group of pots were made with a single cord-marking tool (or a period of time in which such a tool was in use before being replaced by another tool).

Given the findings of William Lucius (see Chapter 12/Appendix D) that indicate some of the clays at Swallow site and elsewhere came from sources near Jarre Creek, 21 km to the south of Swallow, the cord mark patterns may also indicate the occasional vessel or group of vessels imported to Swallow site at various times. It seems likely that the vessels found at Swallow site, with their variable clays and surface finishes, represent a number of different potters, who were acquiring their materials independently of each other. Pottery was not abundant at Swallow or other neighboring sites, though certainly not rare.

The overall low frequency of vessels suggests that they were made relatively infrequently. The production of pottery was most likely done on an as-needed basis, not as an ongoing domestic responsibility as it is in many agricultural societies, such as in the American Southwest. Production occurred in the Jarre Creek area and other, as yet unidentified, locations along the Hogback valley or base of the Front Range, as no sherds from the site indicate production either in mountain or plains geologic zones. Pots were transported to the site, either through exchange or through group mobility. Short distance moves within the Hogback valley were undoubtedly being made, and vessels were being carried from one location to another in those moves.

Minimum Number of Vessels

Because pottery is not abundant at the Swallow site, the compositional analysis combined with the stylistic analysis can give a minimum number of vessels for the site. The actual number of vessels present was most likely higher but cannot be ascertained from the assemblage. For example, ethnoarchaeological studies indicate that potters tend to make multiple vessels at a time (B. Stark 1984, 1985), and archaeological analyses of kilns (Mobley-Tanaka 2011; B. Stark 1984, 1985) indicate that vessels made and fired together often share stylistic and compositional traits. This occurs because potters making several vessels at a time will use the same clay, temper, and tools in the construction of all, resulting in vessels that will be indistinguishable in a fragmentary ceramic assemblage. In addition, a potter who makes vessels over a period of years or months may return to the same clay sources and use the same tools, so her work may be indistinguishable over a longer period of time as well. Therefore, minimum number of vessels may not reflect specific vessels but specific production groups or specific producers and cannot be assumed to directly relate to number of pots used at the site. It is primarily a number useful in comparing to other sites to assess similarities in the scarcity or ubiquity of pottery.

Lucius suggests a minimum number of vessels as seven based on refired colors that represent different clays. This number can be expanded to twelve by cross-referencing those colors with the seven cord mark patterns discussed above. While there was an overall strong correlation in surface treatment and Lucius's clay colors, three of his identified clays were associated with more than one surface finish (Table 13.2).

Table 13.2. Refiring colors (as per Lucius) cross-referenced with cord mark patterns/vessel.

Refire Vessel #	Refire Color	Cord Mark Pattern	Combined Vessel #
1	2.5 YR 5/6	B	1B
1	2.5 YR 5/6	C	1C
1	2.5 YR 5/6	D	1D
1	2.5 YR 5/6	F	1F
2	2.5 YR 5/8	C	2C
2	2.5 YR 5/8	G	2G
3	5 YR 5/6	H	3
4	5 YR 6/6	A	4A
4	5 YR 6/6	C	4C
5	5 YR 6/8	A	5
6	5 YR 7/4	A	6
7	7.5 YR 7/4	A	7

In all cases where multiple cord mark patterns occurred in association with a single refiring color, the patterns span different times, if the seriation presented above holds, suggesting that clay sources were often revisited. Of particular interest is the Vessel 1 group, which exhibits Patterns B, C, D, and F, which span all Early Ceramic levels at the site, suggesting that the as yet unidentified clay source (refiring to 2.5 YR 5/6) was used frequently throughout the Early Ceramic occupation. This was the most common clay in Lucius's sample, accounting for 58% of tested sherds.

Spatial Analysis

Spatial analysis was done to further explore number of vessels, to see if specific vessels identified by Lucius showed spatial clustering consistent with a "pot drop" (a location where a single vessel had broken or been discarded) and to evaluate the overall use and discard of pottery at the site. Locations of each of the twelve vessels defined in the above analysis were plotted on the site map, and dense clusters of sherds were observed. While sherds were scattered throughout the site, clusters did appear representing specific vessels in specific locations (Figure 13.3). Interestingly,

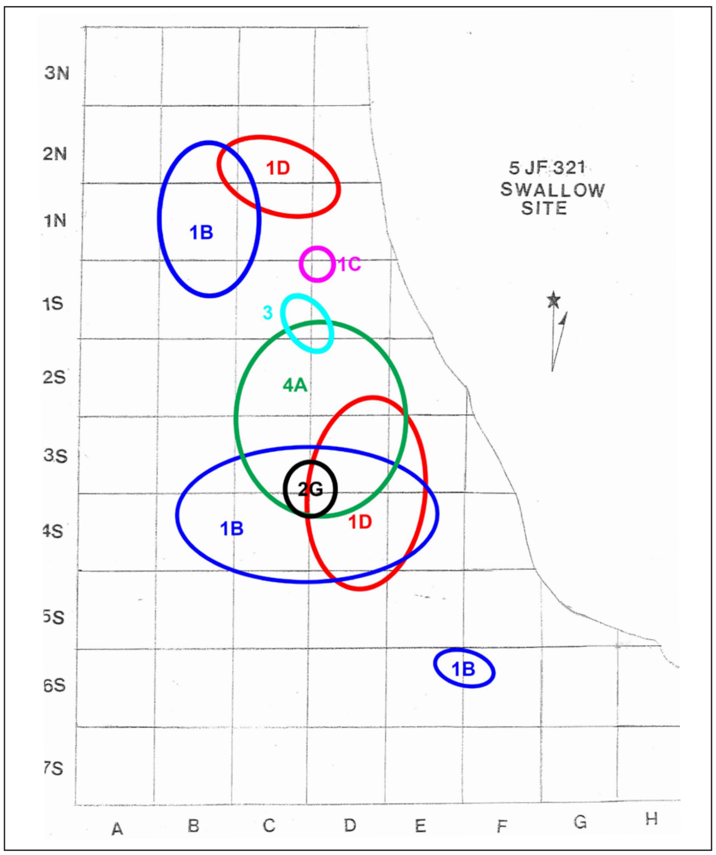

Figure 13.3. The general locations where sherds were found for each "vessel" (as defined by a combination of clay refire color and cord marking characteristics).

while some vessels, like Vessels 1C, 2G, and 3 were clustered tightly in a specific location, implying the location of a single pot, several others (1B and 1D) appeared in more than one area. Vessel 1B occurs clustered in three areas, one in the north of the site, one central and one in the south. Likewise, 1D has two dense clusters, one at the north end and one in the central region. This suggests that 1B and 1D may again represent several vessels with similar characteristics, which were ultimately discarded in different portions of the site. Two sherd matches were made across these clusters, however, so the meaning of the clusters remains ambiguous. All three of the clustered areas are associated with hearth areas.

In addition to evaluating the locations of the identified vessels, the density by unit of all potsherds found at the site was mapped (Figure 13.4). Overall, the distribution suggests that the majority of potsherds occur near fire features or in discard locations within close proximity to fire features at the site. The densest distribution of sherds occurs in a roughly diagonal line, paralleling the rock face of the shelter about two to three meters out from the rock face, just outside the drip line,

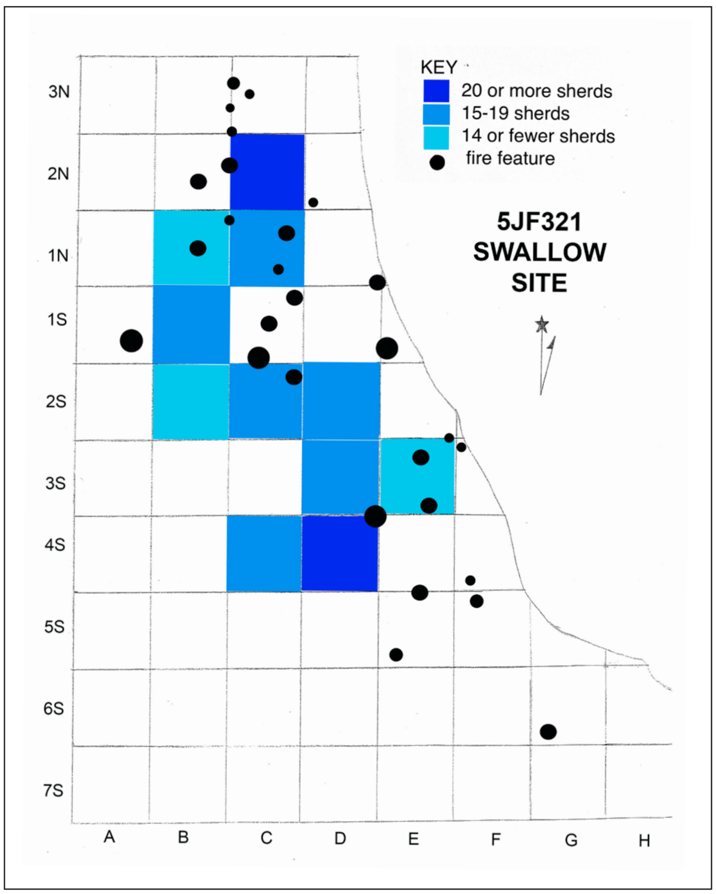

Figure 13.4. Distribution of pottery and fire features in the Early Ceramic levels at Swallow site.

slightly to the west or overlapping with the majority of fire features at the site, which also parallel the rock face. This probably indicates the role that ceramics played in cooking.

While the limited amount of pottery at the site indicates that it was not central to food preparation, its appearance in the Early Ceramic times indicates a new style of cooking coming into use. This is corroborated at the Swallow site by the occurrence of ash pits and pit hearths without stones exclusively in the Early Ceramic layers, features that may also have been used in new cooking practices (see Chapter 7). While the adoption of pottery is often associated with the arrival of cultigens, evidence of cultigens is scarce in Front Range sites (Gilmore 1999: 236-240) and was not found at the Swallow site. It may be that culinary practices associated elsewhere with corn were adopted in the region to make more extensive use of wild plant foods, but what these foods were is not clear. The adoption of pottery and the associated new cooking practices it implies, therefore, needs to be explored further, to better understand the role new methods of food preparation played in the overall resource use and diet of Early Ceramic people in the Hogback valley and along the Front Range of the Rocky Mountains.

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14

Faunal Analysis

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Analytical Procedures

Analysis of faunal material recovered from Swallow was conducted for several purposes. One purpose was to identify and discuss the animals used for subsistence and distinguish those from intrusive animal remains. A second purpose was to identify and describe worked bone, bone that had been intentionally modified into tools or ornaments. A third area of analysis was to document the taphonomy of the bone. Taphonomy is defined here as the study of all physical, chemical, and biological processes that cause changes in organic remains.

Bones from Swallow site that were received for bone identification were grouped in bags according to excavation unit and level. These bones had been assigned a laboratory number, and given a preliminary identification, and white artifact cards were prepared for them. A preliminary examination was made of the bones in each bag to ensure that the bones in these bags were all from the same excavation unit and level. The comparative bone collection maintained by the Colorado Archaeological Society (CAS), as well as references such as *Mammal Remains from Archaeological Sites* (Olson 1973) and *Mammalian Osteology* (Gilbert 1980) were used to identify the bone element, right or left side, and genus/species of the animal. Additional field guides and biological studies were used to better understand behaviors and distributions of taxa represented in the assemblage, including Bissell (1982), Burt and Grossenheider (1976), and Fitzgerald et al. (1994) for mammals; Peterson (1947) and Sparks and Soper (1987) for birds; and Hammerson (1982) and Stebbins (1966) for amphibians and reptiles.

Data tables and forms were devised to document and organize information. When genus/species identification could not be confidently made but the size and thickness of the bone fragment was

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consistent with an animal found at the site, the common name of the animal was assigned to the fragment (i.e., deer-sized).

If the genus/species of the bone specimen could be identified, the following data were recorded: provenience, genus/species, bone element, side (proximal or distal, lateral or medial, cranial or caudal, dorsal or ventral), and presence or absence of epiphysial fusion. Bone completeness, sex, and, where applicable, tooth type and tooth wear, and age of the animal were also noted. Modification for tool use or ornament production was recorded. The description of the worked bone included the laboratory identification number, genus/species of the animal, bone element, breakage of the bone, use, wear, dimensions, weight, and a general description of the tool or ornament. Evidence of taphonomic processes such as burning, butcher marks, mineral coating, and animal modification (rodent or carnivore) were noted. These processes are described in detail below.

Faunal Remains

The faunal remains from Swallow site were divided into two groups, food/use and intrusive. The animals that were considered to be food or used for clothing, decorations, ornaments or other uses were grouped together as a food/use group. The other group of animals found at the site that were not used by the human inhabitants were collectively called intrusive. Some of these animals used the site location for homes, burrowing and disturbing some of the levels in the site. Other intrusive animals were carried in by predators. Most of the bones at this site were broken, making positive identification impossible. Broken bones, showing no identifying characteristics, were grouped together based on the size, thickness, and curvature of the bone. Common names, such as rabbit-sized, deer-sized, etc. were used to classify these bones. Closest fit (cf.) was used when the bones were about the same shape and size of a certain species. The scrap bone identified as undifferentiated long bone from each level was grouped with deer-sized bone. This scrap bone was bagged, weighed, and given a laboratory number. These bags of bones were washed in the laboratory to remove any soil from the site that was clinging to the bones. After this cleaning, the scrap bone fragments were examined to determine if any tools or identifiable bone could be found. The tools were removed and given artifact numbers. The scrap bone fragments were divided into burned and unburned fragments. Any scrap bone that could be identified as salamander, frog, rodent, deer tooth enamel, or bird- or rabbit-sized were recorded on the data table in their proper category. The remaining scrap bone fragments were divided into +15 mm and -15 mm size range and grouped with the deer-sized bone. The number of each of these pieces was recorded, with notations of burned or unburned.

All of the scrap bone fragments were re-examined for additional pieces of bone decorated with the punctate design that is unique to this site.

Cultural Periods

Swallow site was divided into four cultural periods. These periods were Early Ceramic (EC), Middle and Late Archaic (MLA), Upper Early Archaic (UEA), and Lower Early Archaic (LEA). According to data received in August 2007, the following cultural periods were determined:

- The EC period consists of Levels 1 through 6 in all the excavation units.
- Level 7 is considered to be a transition level. The bone fragment count in this level was not included in the bone data compiled for Swallow site.
- The MLA period includes Levels 8 through 18 in every excavation unit, and all the deeper levels in the A and B Excavation Units that were above the rockfall. The C and D Excavation Units above the rockfall were also part of the MLA period with the exception of C3S, C4S, D3S, D4S, E3S, and E4S.
- The UEA period consists of Excavation Units C3S, C4S, D3S, D4S, E3S, and E4S Levels 19, 20, and 21.
- The LEA period consists of all the excavation units below the rockfall, B1N, Levels 25 through 29 and B1S, Levels 27, 27A, 29-33, B2S Levels 31, 32, 32A, 33-35, B3S Levels 30-38, C1N Levels 26-30, C1S Levels 28-36, C2S Levels 27-37, C3S Levels 30, 30A, 31-41, C4S Levels 37-41, D1N Levels 27-28, D1S Levels 27-30, D2S none, D3S Levels 34-40, and D4S Levels 37-42.

Appendix E provides information on specimen counts by taxon, level, cultural period, and condition.

Editor's Note: As discussed in the Preface, various correlations of cultural periods with strata and excavation levels were devised over the decades of analysis. This correlation from 2007 varies slightly from the final correlation presented in Chapters 4 and 5, where the EC period is considered to include Level 7. The MLA period extends from Levels 8-9 to Levels 16-18, the UEA extends from Levels 16-18 to Level 22 and in a few places lower, and the LEA below the rockfall from Level 25 to Level 37 or 38.

Summary of Food/Use Animals in the Site

There were 56,939 bone fragments collected at Swallow site. Of these, 49,845 were called food/use bones representing 88% of the total bones collected at the site. The remaining 7,094 (12%) were from intrusive animals.

In the site, 16,066 (32%) food/use animal bone fragments were burned, 718 (1.4%) made into tools or ornaments, 728 (1.5%) had butcher marks, 267 (0.5%) were carnivore chewed, and 127 (0.2%) were rodent gnawed.

There were 22,150 food/use animal bone fragments in the EC levels representing 44% of the total number of food/use bones in the site. The minimum number of individual (MNI) food/use animals of 66 animals in this cultural period represented 40% of all food/use animals in the entire site. In the EC levels, 6,887 (31%) of the food/use animal bone fragments examined were burned, 283 (1%) were modified for tools/ornaments, 285 (1%) had cut marks, 91 (0.5%) were carnivore chewed, and 34 (less than 0.5%) were rodent gnawed. The majority of the bone fragments, 19,748 (89%), representing the EC period were deer. Rabbits comprised the next largest group of animal bone fragments with 1,402 (6%) of the total number of the food/use animal bone fragments in EC levels. The remaining food/use groups make up the remaining 5% of EC bone fragments.

In the MLA levels, there were 25,488 food/use animal bone fragments, representing 51% of the bone fragments from the food/use group in the site. The MNI for this period was 73 animals or 44% of the food/use animals in the site. In this cultural period, 8,357 (33%) food/use animal bone fragments were burned, 378 (1.5%) were modified as tools/ornaments, 395 (1.5%) had butcher marks, 164 (0.6%) were carnivore chewed, and 75 (0.3%) were rodent gnawed. In the MLA levels, 23,115 (91%) of the food/use animal bone fragments were identified as deer. The 1,286 rabbit bone fragments represent 5% of the food/use bone fragments in this cultural period.

The UEA levels had 1,567 bone fragments or 3% of the total food/use bone fragments in the site. The MNI for this cultural period was 12 animals or 7% of the food/use animals in this site. Five hundred fifty-three bones (35%) had been burned, 29 (2%) were modified as tools/ornaments, 27 (2%) had butcher marks, 6 (0.4%) were chewed by carnivores, and 9 (0.6%) were gnawed by rodents. In the UEA levels, 1,373 (88%) of the food/use bone fragments came from deer and 91 (6%) came from rabbit, with the remaining 6% distributed among the remaining genus/species in the food/use group.

In the LEA levels, 640 bone fragments represented 1% of the food/use animal bone fragments in the site. There was an MNI of 15 (9%) of the food/use animals in the site. There were 269 (42%) burned bones, 28 (4%) were modified into tools/ornaments, 21 (3%) had butcher marks, 6 (1%) were carnivore chewed, and 9 (1.4%) were rodent gnawed. In the LEA levels, 550 (86%) of the bone fragments were identified as deer and 37 (6%) were rabbit bone fragments. The remaining 8% of the bones were from the other taxa of the food/use group.

Food/Use Animals

Large-Sized Indeterminate Mammals

The group of bones determined to be large indeterminate mammal bones included artiodactyl bone fragments such as deer, elk, and antelope. This group may also include cow, bison, and domestic or mountain sheep. These bones were large and often too fragmented to determine a thickness, size or shape that could place them into a specific animal group. These animals would have been used as a food source, the bones for making tools, and the hide for clothing and blankets.

At Swallow, 973 (2%) of the bone fragments were identified as from large-sized indeterminate mammals.

In the EC levels, 433 bone fragments were identified as large indeterminate mammal bones. Eleven of these bone fragments were made into tools or ornaments. They include 5 awls, 4 generic tools, 1 bead, and 1 decorated bone fragment. Two of these worked bone items are described and illustrated in the Tools and Ornaments section (#1 a button or bead, and #6 a double end awl). Ninety-four of the large indeterminate mammal bone fragments were burned, 10 had butcher marks, 4 were carnivore chewed, and 2 were rodent gnawed.

In the levels associated with the MLA cultural period, 478 of the food/use bone fragments were identified as large indeterminate mammals. Twenty-four had been modified into tools or ornaments. They include 8 awls, 7 generic tools, 5 decorated bone fragments, 1 pendant, 2 shaped bones, and 1 scraper. One hundred twenty-nine of the MLA large indeterminate mammal bone fragments were burned, 9 had butcher marks, 2 were carnivore chewed, and none of them were rodent gnawed.

In the UEA levels, 31 of the food/use animal bone fragments were identified as from large indeterminate mammals. Nine of these were burned, 1 had butcher marks, 2 were carnivore chewed, and 5 were rodent gnawed. Four had been modified, including an incised bone, a pendant, and 2 generic tools. One is described and illustrated in the Tools and Ornaments section (#22 an incised bone).

In the LEA levels, 31 of the food/use bone fragments were identified as from large indeterminate mammals. Nineteen were burned, 1 had butcher marks, and none were made into tools, carnivore chewed, or rodent gnawed.

Medium-Sized Indeterminate Mammals

These bones were smaller and thinner than bones grouped with the large indeterminate mammal bone fragments. Their size, thickness, and shape were too incomplete to include them in any of the medium-sized mammal groups found at the site. Medium-sized mammals from which these bones could have come include foxes, coyotes, dogs, raccoons, porcupines, skunks, badgers, and bobcats.

One hundred eighty-one (0.4%) of the bones at Swallow site were identified as from medium-sized indeterminate mammals.

Eighty-five bone fragments identified as from medium-sized indeterminate mammals were found in the EC levels. None of these bone fragments were made into tools, 19 were burned, 3 had butcher marks, and none were carnivore chewed or rodent gnawed.

In the MLA levels, 87 bone fragments were identified as from medium-sized indeterminate mammals. Thirteen bone fragments were burned in this cultural period, 5 had butcher marks, 1 was carnivore chewed, and none were rodent gnawed. Three of the bone fragments of medium-sized mammals were made into tools/ornaments, and include 1 awl, 1 generic tool, and 1 bead.

In the UEA levels, 7 of the bone fragments were identified as medium-sized indeterminate mammal bones. One was carnivore chewed, 1 burned, none had butcher marks, and 1 was rodent gnawed. None were made into tools.

In the LEA cultural levels, 2 bone fragments were identified as from medium indeterminate mammals. One was burned, none had butcher marks, neither one was made into a tool, or was carnivore chewed or rodent gnawed.

Bison bison (Buffalo/Bison)

The group *Bison bison* includes bison-sized bone and bones identified as *Bison/Bos*. The term *Bison/Bos* refers to the bones that could be either *Bison bison* or *Bos taurus* (cow). No cow or other domestic bovine bones were identified at the site, but the area was known to have been a cattle ranch for nearly one hundred years, and cattle dung and hoof action was observed on the surface, indicating that some intrusive cattle bone could be present in the assemblage of bison-sized bone. Bison was the largest mammal found at the site. The criteria used to identify bison-sized long bone was a greater length and thickness in comparison to deer and elk bone. The predators of the bison include wolf, coyote, man, and mountain lion. Early human inhabitants used the bison as a source of shelter, blankets, clothing, food, and tools.

After the arrival of the Europeans, the large native herds of bison were destroyed. At the present time, bison no longer exist in the area of adjacent plains. Bison traveled in vast herds during the EC period and earlier. In eastern Colorado bison migrated from east to west in late fall and winter seeking refuge from cold weather and snow. They reversed this migration in spring and summer seeking warmer climates.

Bison bone was scarce at Swallow site, despite evidence that bison hunting was practiced by Swallow residents and in the general area of the Hogback valley. Several of the projectile points in the site were found to have bison blood residue. Eight chipped stone tools (25% of the tools with blood residue) tested positive for bison blood (see Chapter 17).

In the late summer to early fall of 1999, site number 5JF2213 (Bison bone project) was dug by CAS volunteers (Moore 2000). This site is in the North Ranch of the Ken-Caryl valley in the flood plain of Dutch Creek. Bison bones were identified at this site, which is located in close proximity to both the Massey Draw and Dutch Creek sites. The bones from this site were brought to the Swallow bone lab for identification. The fragments were found to be a femur, ribs, a thoracic vertebra, and some horn core fragments. The thoracic vertebra was determined to be from a bison 7 years or older using Gilbert (1980).

Massey Draw (5JF339) is only a few miles from Swallow site and also has ample evidence of bison hunting in the area. It was a short-term camp and processing site utilized in the Early and Late Archaic, in which bison were among the most common animals represented in the faunal assemblage. The report on Massey Draw (Anderson et al. 1994) shows an MNI of 9 bison in comparison to an MNI of 2 at Swallow.

Sixty-seven (0.1%) of the bone fragments at Swallow site were identified as bison.

In the EC levels, 31 bones were identified as *Bison bison*, bison sized, or *Bison/Bos*, giving an MNI of 2 bison. One of the 31 bone fragments was burned, and none had butcher marks. There were 3 bone fragments that were modified as tools. None of the bison bone fragments in this cultural period had been carnivore chewed or rodent gnawed. Nearly one half of all the bison bone fragments found at this site were associated with the EC cultural period. The bison bone fragments identified as tools were classified as 2 scrapers and 1 smoother. One of these tools, #9, a smoother, is described and illustrated in the section on Tools and Ornaments.

In the MLA cultural strata, 33 bone fragments were identified as bison. This gives an MNI of 1 bison. One bone fragment was burned, 7 were modified as tools, and 1 was rodent gnawed. None of the bison bone fragments had butcher marks or were carnivore chewed. The 7 bison bone fragments identified as tools were classified as 1 abrader, 1 scraper, 2 gouges, and 3 generic tools. There were no awls, beads, or decorated bone.

One unusual item, a nearly whole scapula identified as *Bison bison*, was located in E5S Level 9. Since it was large and nearly complete and was brought to the site for some purpose, it was probably intended to be a tool; however, there is no sign of use on the scapula. This was the only large, nearly complete bison bone at the site. In F3S Level 10, a nearly complete *Odocoileus hemionus* scapula was found which was broken in the same way as the *Bison bison* scapula. It also shows no evidence of modification. These two scapulas may have been saved for use or used for the same purpose, possibly as a digging tool that broke near the area of use, but use could not be confirmed by wear.

In the UEA levels, there was 1 bison bone found; this long bone fragment represents 0.06% of the food/use bone fragments in this cultural period. This bone was not burned, butchered, modified, carnivore chewed, or rodent gnawed. There was an MNI of 1 bison in this cultural period.

In the LEA levels, there were 2 bison bone fragments, a skull fragment and a vertebra fragment found for an MNI of 1 bison. These bone fragments were not burned, had no butcher marks, were not made into tools, or carnivore chewed or rodent gnawed.

Cervus elaphus (Elk or Wapiti)

Elk are between the bison and deer in size. At the present time, elk in Colorado are found in the mountains in the spring and summer but migrate to the plains and foothills in fall and winter. Elk have been seen and heard bugling at Swallow site in the fall. Predators included man, wolves, black bears, mountain lions, and coyotes. The elk hide could have been used for making blankets or clothing and bones and antlers used for tools.

There were 145 (0.3%) elk bone fragments found at Swallow site.

In the EC cultural levels, there were 62 elk bone fragments identified. This represents an MNI of 1 elk. Elk may have been a larger food source than the number of bones indicates. As with bison, the meat may have been carried into Swallow site while many of the bones were left at the kill site. One elk antler fragment was identified at Swallow site in E3S Level 4. Two elk bone fragments were burned, 6 had butcher marks, 4 were modified as tools, 1 was carnivore chewed, and 1 rodent gnawed. The 4 elk bone tools were identified as 1 scraper, 1 antler tool, and 2 generic tools.

In the MLA cultural levels, there were 77 elk bone fragments found. This represents an MNI of 1 elk. Five of the elk bone fragments were burned. Eight of the elk bone fragments had butcher marks and 9 were modified into tools. These tools were classified as 2 awls, 2 scrapers, 2 generic tools, 1 abrader, 1 gouge, and 1 elk tooth pendant. Two elk bone fragments were carnivore chewed, and none were rodent chewed.

In the UEA levels, there were 2 elk bone fragments resulting in an MNI of 1 elk. Neither of these fragments were burned, modified into a tool, carnivore chewed, or rodent gnawed. One of these fragments had butcher marks.

In the LEA levels, there were 4 elk bone fragments. This represents an MNI of 1 elk. None of these fragments were burned, had butcher marks, had been made into tools, or were carnivore chewed, or rodent gnawed.

Odocoileus hemionus (Mule Deer)

Deer were the most common mammal found at the site. The deer in the area today is *Odocoileus hemionus* (mule deer), and it is presumed to be the species found during the time of human occupation of the site. Deer tend to follow the same game trails to water, making them easy prey for predators such as man, black bears, mountain lions, wolves, and coyotes. The deer in this site were the major food source for the human inhabitants as evidenced by the quantity of bone fragments found. The bones of the deer were used to make a variety of tools. Antlers were often used in the process of making lithic tools. Deer hides were tanned and used for clothing, moccasins, blankets, and shelter. The following discussion provides details of the presence of deer bone in the four cultural periods represented at Swallow site.

EC Cultural Period

In the levels associated with the EC cultural period, 19,748 (89%) bone fragments were identified as deer or deer sized. An MNI of 11 deer was determined. The number of burned deer bone was 6,477. Only 217 of the bones had butcher marks on them. The number of carnivore chewed deer bone was 72, and 29 were rodent gnawed. Of the 19,748 deer bone fragments, 201 were made into tools or ornaments, 86 were identified as awls, 71 were identified as generic or expedient tools, and there were 4 beads, 19 scrapers, 4 abraders, 3 gouges, 1 smoother, 8 shaped or grooved tools, 4 miscellaneous tools, and 1 decorated bone fragment. The ages of the deer were determined using complete molars and premolars that could be identified as either from the right or left side and by comparing the tooth type, eruption, and tooth wear as described in Gilbert (1980:100-103). Nearly all the teeth were separated from the skulls and mandibles making a specific age determination impossible. A range of possible ages was recorded for each whole tooth. Using only the right lower second molar an MNI of 7 deer was recorded. After combining the data from other sources, a broad MNI value of 11 deer was determined (Table 14.1).

Table 14.1. Deer minimum number of individuals (MNI) and age range in the Early Ceramic.

Number of Deer	Age Range
2	7-8+ years
2	5.6-6 years
1	3-7 years
3	2-2.5 years
2	1-1.5 years
1	2.5-3 months

Only one deer younger than 1 year was found. Most of the deer were 2.5 years and older with the oldest individual being over 8 years. The 1 younger deer, assuming it was born in June or July, could have been killed in September or October. The rest of the deer found at the site could have been taken at any time of the year.

From the 11 deer found, a total of 38 premolars, 48 molars, 32 incisors, and 534 undifferentiated tooth fragments were located during the excavation. Five tooth fragments were burned, 2 were made into tools (1 described as #12 in the Description of Select Bone Tools and Ornaments section), and 1 had butcher marks. Fifty-nine mandible fragments containing teeth were part of the recorded assemblage. One of these fragments was used as a tool and 1 was burned. More of these mandible fragments could have been tools. There were 773 small fragments of skull found in this cultural period. One hundred twenty-three of these fragments were burned and none were used as tools. None of the skull, antler, tooth or mandible fragments were carnivore chewed or rodent gnawed.

Thirty-two antler fragments were found. Four of these were considered to be tools. Two were considered to be miscellaneous tools, 1 an awl, and 1 an antler tip. Nine of the antler fragments were burned. Antler was used historically to flake stone tools and was probably used this way by the people during the EC time. The antler fragments could have been brought to the site with deer that were butchered or shed by deer and picked up in the fields around the site. Only the male deer have antlers which are shed in February or March and are fully developed in the breeding season of November or December.

There were 2,424 deer rib fragments. Six hundred thirty-four rib fragments were burned, 18 had butcher marks, and 14 were modified as tools. They include 9 generic tools, 1 is described as #11 in the Tools and Ornaments section. Three are awls, 1 is decorated bone, and 1 is a bead. Seven (less than 0.5%) were carnivore chewed and 1 (less than 0.5%) was rodent gnawed.

There were 304 vertebra fragments found: 276 generic vertebra, 2 axis/atlas, 5 cervical, 5 thoracic, 12 lumbar, 2 caudal vertebra and 2 sacrum fragments. Out of all the vertebra fragments only 2 had butcher marks, 2 were tools, and 2 were carnivore chewed. None of the vertebra fragments were rodent gnawed. One hundred eleven of the vertebra fragments were burned. The tools include 1 miscellaneous tool and 1 awl.

Innominate, pelvis and sacrum fragments represent 38 of the EC deer bones. Only 4 were burned and 2 were rodent gnawed. None of these fragments were made into tools, had butcher marks or were carnivore chewed.

There were 66 scapula fragments including 60 scapula fragments that were undifferentiated, 2 right scapula fragments and 4 left scapula fragments. Seven (11%) of the scapula fragments were burned, 5 had been made into tools, 2 had butcher marks, and 1 was carnivore chewed. The tools included 2 scrapers and 3 generic tools.

The forelimb bones, humerus, radius, ulna and radius/ulna contained 97 fragments. Fourteen of these bones were burned, 10 had been made into tools, and 7 contained butcher marks. Five (5%) of the bone fragments were carnivore chewed, and 1 was rodent gnawed. The 10 forelimb tools included 3 humeri (1 awl, 1 generic tool, and 1 scraper) and 7 radii (1 scraper, 4 generic tools, 2 awls).

None of the ulna fragments were made into tools.

The forelimb bone fragments were distributed as follows: 56 radius, 24 humerus, 16 ulna, and

1 radius/ulna. Three of the humerus fragments were right and 3 were left. Four of the radius fragments were right and 4 were left. Three ulna fragments were right and 4 were left. Seventy-six of the forelimb fragments were undifferentiated.

The group containing right and left metacarpals, undifferentiated metacarpal, carpal, and vestigial metacarpals had 164 bone fragments. There were 41 fragments of the metacarpal group burned, 2 had been modified. The 2 tools, 1 gouge and 1 generic tool, were both made from metacarpal fragments. None of the carpals or vestigial metacarpals had been modified. None of the metacarpal group had butcher marks, or were carnivore chewed or rodent gnawed. There were 4 right and 4 left metacarpals, 23 generic metacarpals, 30 vestigial metacarpals, and 103 carpals. All of the metacarpals were broken while the carpals were mostly whole.

The hind limb group, composed of femur, tibia and lateral malleolus bones, contained 88 bone fragments. There were 38 undifferentiated femurs and one identified as left. There were 31 undifferentiated, 12 right and 1 left tibia fragments. There were 5 unbroken lateral malleoli. Six of the hind limb fragments had been burned, 4 had been made into tools, 12 had butcher marks, 4 had been carnivore chewed, and 1 was rodent gnawed. The 4 tools were 2 generic tools made from femur fragments and 2 tibia fragments made into 1 scraper and 1 awl. None of the lateral malleoli were burned, made into tools, had butcher marks, or were chewed by carnivores or gnawed by rodents.

The group of bone fragments containing metatarsals, a patella, and tarsals as well as undifferentiated metapodial fragments contained 348 of the EC deer bone. There were 210 undifferentiated metapodial fragments. Seventy were metatarsals. There were 60 metatarsal fragments that were undifferentiated, 3 were right and 7 were left. Of the entire group 98 were burned, 12 of them had been made into tools, 9 were rodent gnawed, and 9 of the group had been carnivore chewed. The 12 tools included 7 awls, 3 generic tools, 1 gouge, and 1 smoother. All of these tools were made from metatarsal fragments. There were 67 complete tarsals, 16 of which had been burned. None of the tarsals had butcher marks, were modified into tools, or were carnivore or rodent chewed. The one patella identified was not burned, did not have butcher marks, was not made into a tool, or chewed by carnivores, or gnawed by rodents.

The undifferentiated long bones were broken fragments that could not be identified as forelimb, hind limb, or metapodial. The count of the undifferentiated long bone fragments included only those fragments that were over 15 mm in length. There were 14,244 undifferentiated long bone fragments found in this period. There were 5,283 of these bones burned, 137 modified as tools, 158 were butchered, 40 were carnivore chewed, and 10 were rodent gnawed. The breakdown of the 137 deer long bone fragment tools/ornaments is as follows: 71 awls, 2 of which are described in the Description of Select Bone Tools and Ornaments section (#7 and #8), 2 beads described in the Description of Select Bone Tools and Ornaments section (#2 and #3), 43 generic tools, one of which is described in the Description of Select Bone Tools and Ornaments section (#10), 11 scrapers, 4 abraders, 1 gouge, and 5 shaped or grooved bones.

The phalanges group, including sesamoid bones, contained 458 deer bones in the EC cultural period. There were 147 of these bones burned, 2 were modified into tools, and 3 had butcher marks. There were 4 carnivore chewed fragments and 5 fragments were rodent gnawed. The 2 tools were both 1st phalanx fragments. One was a generic tool and 1 a drilled bone. Many of the bones in the phalanx group were unbroken.

MLA Cultural Period

There were 23,115 deer bone fragments in the MLA levels. There was an MNI of 19 deer associated with this cultural period. There were 7,927 bone fragments burned, 344 bone fragments had butcher marks, 150 bone fragments were carnivore chewed, and 70 were rodent gnawed. Of these fragments 284 were modified into tools or ornaments. There were 130 identified as awls, 94 were generic or expedient tools, 2 were beads, 32 scrapers, 4 abraders, 1 smoother, 1 graver, 6 gouges, 6 shaped or grooved, 1 miscellaneous, and 7 decorated pieces. Six of these tools are described in the Description of Select Bone Tools and Ornaments section.

Eight hundred thirty-seven generic broken deer tooth fragments were found. Twenty-two of these fragments were burned and one was made into a tool. No butcher marks were found and none of the tooth fragments were carnivore chewed or rodent gnawed. The tool was identified as a generic tool.

The 113 left and right molars and premolars were used to determine the ages of the deer as shown in Table 14.2.

Table 14.2. Deer minimum number of individuals (MNI) and age range in the Middle-Late Archaic.

Number of Deer	Age Range
1	8+ years
1	7 years
2	3-7 years
5	2.5+ years
5	1.5+ years
4	1 year
1	2.5 months

This indicates an MNI of 19 deer, and an average age of the deer between 1.5 and 3 years. There was one deer approximately 2.5 months old found in both the EC and MLA period. Since it was probably born in early spring, it was likely killed in the fall. This indicates that the occupants of the site were hunting deer in the fall and winter during both the EC and MLA cultural periods.

All of the teeth, both broken and whole, were scattered throughout the entire site. There were 66 mandible fragments of which 2 were burned and 1 had butcher marks. There were 9 maxilla fragments of which 2 were burned and 1 had butcher marks. The mandible and maxilla fragments containing teeth were also scattered randomly across the site.

There were 679 skull fragments. Ninety-two of these were burned. One of the skull fragments had been modified as a generic tool. Three of the fragments had butcher marks and none were carnivore chewed or rodent gnawed.

There were 13 antler fragments. Five of these fragments were burned, and none had butcher marks, were modified into tools, or were carnivore chewed or rodent gnawed. There was no evidence of use seen on these antler fragments, but they may have been used as tools.

There were 2,839 rib fragments. Six hundred seventy-two of the rib fragments were burned, 22 of them had butcher marks, 10 had been modified, 12 of the rib fragments were carnivore chewed, and 7 were rodent gnawed. The 10 tools included 2 awls, 3 generic tools, 1 scraper, 1 abrader, 1 grooved bone, 1 notched bone, and 1 decorated piece.

There were 202 bone fragments in the vertebra group. The breakdown of these vertebrae is as follows: 174 generic vertebrae, 3 atlas/axis, 14 thoracic, 7 lumbar, 3 caudal vertebrae, and 1 sacrum. Twenty-eight vertebra fragments were burned, none of the vertebrae had butcher marks, or were modified, 1 bone fragment was carnivore chewed, and 1 rodent gnawed.

Twenty-nine bone fragments were identified as innominate, pelvis or sacrum. Two of these were burned, 2 had butcher marks, 1 was modified as a tool, and none were carnivore chewed or rodent gnawed. The bone tool was considered to be an awl.

There were 106 deer scapula fragments. Ninety-four were identified as undifferentiated scapula fragments, 8 right and 4 left scapula fragments, 7 burned, 1 modified, 6 had butcher marks, and 5 were carnivore chewed. None of the scapula fragments had been rodent gnawed. The scapula fragment tool was a generic tool.

The deer forelimb bones comprised 116 of the MLA deer bones. There were 11 burned bone fragments, 15 were modified into tools, and 13 had butcher marks. The 15 tools included 9 radius fragments made into 2 generic tools, 3 awls (1 described as #15 in the Description of Select Bone Tools and Ornaments section), 3 scrapers, and 1 gouge; 4 humerus fragments used as 1 awl, 1 scraper, 1 abrader, and 1 gouge; and 2 ulna fragments used as 1 awl and 1 generic tool. The forelimb bones were distributed as follows: 64 radius fragments, 28 humerus, 23 ulna, and 1 radius/ulna fragment. There were 3 right and 11 left humerus fragments. There were 3 right and 7 left radius fragments. There were 8 right and 1 left ulna fragment. Eighty-three of the forelimb bones were undifferentiated.

The deer metacarpal group of right, left, and undifferentiated metacarpal, carpal and vestigial metacarpals contained 110 of the MLA deer bone fragments. Twenty-six of the fragments in the metacarpal group were burned, 3 had been modified, 1 had butcher marks, 2 had been carnivore chewed, and 1 had been rodent gnawed. The 3 metacarpal fragment tools were all identified as generic tools, and 1 is described as #17 in the Description of Select Bone Tools and Ornaments section. There were 4 right, 12 left, 18 generic metacarpals, 20 vestigial metacarpals, and 56 carpals.

The hind limb group of bone fragments consists of right and left femurs, tibias and lateral malleoli. There were 84 deer bone fragments in this group including 41 undifferentiated femur, 21 undifferentiated tibia, 2 right femur, 2 left femur, 5 right tibia, and 9 left tibia fragments. There were 4 lateral malleoli. Four of these fragments were burned, 7 were modified as tools, 10 had butcher marks, 8 were carnivore chewed, and 2 were rodent gnawed. The breakdown of the 7 tools is as follows: 3 femur fragments made into 1 awl and 2 generic tools, and 4 tibia fragments made into 2 awls, 1 scraper, and 1 generic tool. None of the 4 lateral malleoli had been burned, modified into tools, had butcher marks, or were carnivore chewed or rodent gnawed.

The group of bones containing metatarsal, patella, and tarsal fragments as well as undifferentiated metapodial fragments contained 357 deer bone fragments. There were 200 undifferentiated metapodial fragments, and 85 metatarsals. There were 68 tarsal fragments and 4 patella fragments. Eighty-seven of this group were burned, 20 modified into tools, 23 had butcher marks, 20 carnivore chewed, and 8 rodent gnawed. The breakdown of the 20 tools is as follows: 8 metatarsal fragments used as 4 generic tools, 1 miscellaneous tool (flesher), 1 shaped bone, and 2 awls. Twelve metapodial fragments were made into 7 awls, 3 scrapers, and 2 generic tools. One tarsal was used as a hammer.

There were 17,099 undifferentiated long bone fragments (15+ mm long) and 6,825 were burned. There were 227 deer bone fragments that had been modified into tools/ornaments, and 258 had butcher marks. Ninety had been carnivore chewed, and 37 rodent gnawed. The breakdown of the 227 tools/ornaments was as follows: 114 awls (1 described as #16 in the Description of Select Bone Tools and Ornaments section), 72 generic tools (1 described as #21 in the Description of Select Bone Tools and Ornaments section), 23 scrapers, 2 abraders, 1 smoother, 4 gouges, 1 graver, 4 shaped or grooved tools, and 6 decorated pieces.

The phalanx group, including sesamoids, contained 352 of the deer bone fragments. There were 121 of the fragments burned, 3 modified into tools, 3 had butcher marks, 4 carnivore chewed, and 1 rodent gnawed. The 3 tools were 1 phalanx fragment bead, 1 generic tool made from a 2nd phalanx and 1 3rd phalanx awl. There were 31 of these fragments identified as sesamoid. Many of the bones in the phalanx group were unbroken.

UEA Cultural Period

There were 1,373 deer bone fragments in the UEA levels. There was an MNI of 2 deer associated with this cultural period. Five hundred twenty-three of these deer bone fragments were burned, 23 had butcher marks, 3 were carnivore chewed, and 3 were rodent gnawed. Twenty-one of the fragments were modified as tools; 11 of these tools were identified as awls, 7 were generic or expedient tools, 1 a scraper, and 2 were miscellaneous tools. One awl is described as #20 in Description of Select Bone Tools and Ornaments section.

There were 31 generic tooth fragments, 6 incisors, 5 premolars and 1 molar. This cultural period covers only Grids C, D, and E3S; and C, D, and E4S Levels 19, 20, and 21, giving a limited number of teeth with which to work. There was an MNI of 2 deer determined (Table 14.3). None of these tooth fragments were burned, one had been modified into a generic tool, and none had butcher marks or were carnivore chewed or rodent gnawed.

Table 14.3. Deer minimum number of individuals (MNI) and age range in the Upper Early Archaic.

Number of Deer	Age Range
1	2.5 years
1	8+ years

There were 27 skull fragments of which 7 were burned, none were modified, or had butcher marks, or were carnivore chewed or rodent gnawed. There were 10 mandible fragments. One was burned and 1 was modified. None of these fragments had butcher marks, had been carnivore chewed or rodent gnawed. The tool was called a generic tool. There was 1 antler fragment.

There were 168 rib fragments. Forty-five of these rib fragments were burned, 1 had butcher marks, and 1 was modified as a generic tool. None of the rib fragments were carnivore chewed and 1 was rodent gnawed.

There were 18 vertebrae fragments. Three had been burned, none had butcher marks, were modified, carnivore chewed, or rodent gnawed.

There were 3 fragments found in the innominate, pelvis, sacrum group. None of these bone fragments had been burned, had butcher marks, had been modified into a tool, or were carnivore chewed or rodent gnawed.

There were 3 deer scapula fragments. There was 1 burned fragment, and none of the fragments were butchered, modified, carnivore chewed, or rodent gnawed.

There were 9 forelimb bone fragments. None of these fragments were burned, 1 was modified into a tool, 1 had butcher marks, and none were carnivore chewed or rodent gnawed. The one tool was a generic tool made from an ulna fragment. The forelimb bone fragments were distributed as follows: 1 humerus, 5 radii, and 3 ulnae. None of these fragments could be determined to be right or left.

The deer metacarpal group of right and left and undifferentiated metacarpal, carpal and vestigial metacarpal contained 7 of the bone fragments. There were 5 metacarpals, 1 vestigial metacarpal, and 1 carpal. None of these were burned. No bones were modified into a tool. One had butcher marks, and none were carnivore chewed or rodent gnawed.

The hind limb group of bone fragments consisted of right and left femur and tibia, and lateral malleolus. There were only 3 fragments from this group which were 1 femur fragment, and 2 tibia fragments. None of these fragments had been burned, were modified as a tool, had butcher marks, or were carnivore chewed or rodent gnawed.

The group of bones containing metatarsals, patellas, tarsals, as well as undifferentiated metapodials contained 37 of the deer bone fragments. There were 19 undifferentiated metapodial fragments. There were 10 metatarsals and 8 tarsal fragments. Eight of the fragments were burned, 5 modified into tools, 3 had butcher marks, 3 were carnivore chewed, and none were rodent gnawed. The 5 tools were 1 metapodial awl, 1 metatarsal generic tool, and 3 tarsal tools. The tarsal tools were 2 generic tools and 1 miscellaneous tool called a hammer.

There were 1,030 undifferentiated long bone fragments that were 15+ mm. There were 452 fragments that had been burned, 11 were modified into tools, 16 had butcher marks, 4 were carnivore chewed, and 1 was rodent gnawed. The 11 long bone tool fragments were identified as awls.

The phalanx group including sesamoids contained 13 of the deer bone fragments. One of these was a sesamoid. Four fragments had been burned and 1 had been modified into a generic tool. None had butcher marks, were carnivore chewed or rodent gnawed.

LEA Cultural Period

In the LEA cultural strata, there were 550 deer bone fragments identified. Two hundred forty-one of these bones were burned. Eighteen were modified into tools, 15 had butcher marks, 2 had been carnivore chewed, and 9 had been rodent gnawed.

The 18 tools/ornaments found included 12 awls, 3 generic tools, 1 scraper, 1 smoother, and 1 decorated piece.

There were 11 generic tooth fragments, 2 incisors, 2 molars, and 1 premolar. An MNI of 1 deer 1.5-3 years old was determined. None of the generic teeth had been burned, had butcher marks, were modified as a tool, carnivore chewed, or rodent gnawed. There were 7 skull fragments found. They were not burned, had no butcher marks, were not modified as a tool, carnivore chewed, or rodent gnawed. There was 1 mandible fragment and 1 antler fragment.

There were 44 rib fragments found. Of these, 15 had been burned. None of the rib fragments had butcher marks, were carnivore chewed, or rodent gnawed. Two rib fragments were modified; one was a smoother and 1 was a decorated piece.

There were no deer vertebrae fragments found.

There were no deer innominate, pelvis, or sacrum fragments found.

There were 15 deer-sized scapula fragments found. Of these, 2 were burned, none had butcher marks, or had been modified as a tool, or carnivore chewed. One was rodent gnawed.

There were 2 deer-sized forelimb fragments found. Both of these were radius fragments. There was 1 burned fragment. One fragment had been modified into a scraper and none had butcher marks, were carnivore chewed, and 1 was rodent gnawed.

The deer-sized metacarpal group of right, left, and undifferentiated metacarpal, carpal and vestigial metacarpal contained only 2 of the deer bone fragments found. Both of these fragments were vestigial metacarpals. The 2 fragments were burned, had no butcher marks, not modified as a tool, carnivore chewed, or rodent gnawed.

The hind limb group of bones consisted of right and left femur, tibia, and lateral malleolus fragments. There were 9 deer bone fragments. Four of these fragments were identified as femurs, 4 undifferentiated tibia, and 1 left tibia. None of these fragments were burned or modified, 2 were butchered, none were carnivore chewed, and 2 were rodent gnawed.

The group of bone fragments containing metatarsal, patella, tarsal and undifferentiated metapodial fragments contained 14 of the deer-sized bone fragments. There was 1 undifferentiated metatarsal, 2 tarsal, and 11 undifferentiated metapodial fragments. Of these, 8 were burned, 2 modified, none were butchered or carnivore chewed, and 1 fragment was rodent gnawed. The 2 tools were both metapodial fragments made into awls.

There are 424 undifferentiated deer long bone fragments. Two hundred nine fragments were burned, 13 had been modified, and 13 had butcher marks. There were 2 carnivore chewed and 4 that had been rodent gnawed. The 13 deer long bone tools were 10 awls (1 described as #24 in the Tools and Ornaments section) and 3 generic tools (1 described as #25 in the Tools and Ornaments section).

The phalanx group, including sesamoid, contained 11 fragments of the deer bone. None of the fragments were sesamoid. Two of the fragments were burned, none had been modified, 1 had butcher marks, and none were carnivore chewed. One was rodent gnawed.

Antilocapra americana (Antelope)

Antelope were not abundant at this site. Their preferred habitat is the open prairie and the sagebrush plains of Colorado and they may not have been present in the area immediately around the Hogback valley. Their main predators are eagles, coyotes, bobcats and man. The hide, meat and bones were used.

There were 7 (0.01%) bone fragments identified as antelope at Swallow site.

There were only 2 bones identified as antelope in the EC levels. This gives an MNI of 1 antelope. The two antelope bones found were 1 calcaneum and 1 left trapezoid magnum. Neither of these bones had been burned, had butcher marks, was modified into tools, or carnivore chewed or rodent gnawed.

In the MLA levels, there were 5 fragments identified as antelope. This gives an MNI of 1 animal. None of these bones had been burned or modified into tools. One bone fragment had butcher marks, 1 had been carnivore chewed and 1 rodent gnawed.

There were no antelope bones identified in either the UEA or LEA cultural levels.

Ursus americanus (Black Bear)

The canines found were easily identified as black bear. The bears had few predators besides man and other bears. The teeth found in the site may have been used as decoration or as a pendant. Bear meat and bear grease were also useful. The hide of the bear may have been used as clothing, shelter, or blankets.

There were 2 (0.004%) fragments at Swallow site identified as bear giving an MNI of 2 bears. Both were canine teeth, but of different sizes, indicating two different animals. One was found in the MLA and the other in LEA levels. Neither tooth was burned, modified, butchered, carnivore chewed, or rodent gnawed.

Indeterminate Carnivore

The bones in the indeterminate carnivore group were possibly mountain lion, bobcat, canid, and dog. These bones were fragmented and cannot be put into a more specific category. Skulls, teeth, bone size, and thickness were used to identify these bones as indeterminate carnivore.

Fourteen (0.03%) bone fragments at the site were identified as indeterminate carnivore. In the EC levels, 9 bone fragments were identified as indeterminate carnivore. No MNI was determined. None of these fragments were burned, had butcher marks, were modified into tools, or were carnivore chewed or rodent gnawed.

In the MLA levels, 5 of the food/use animal bone fragments were identified as indeterminate carnivore. No MNI was determined. Two of these bones were burned. None were modified as tools, had butcher marks, or were carnivore chewed or rodent gnawed.

There were no indeterminate carnivore bones in the UEA or LEA levels.

Canis familiaris (Domestic Dog)

There was one mandible positively identified as domestic dog. The dog's predators were man, wolves, coyotes, mountain lions, bobcats, and foxes. The dog was probably a companion animal and possibly used as food, although a lack of burning or butchering on dog bone from the site gives no direct evidence for food use. Domestic dog bone is difficult to distinguish from that of coyote, but a number of features of the skull, mandible, and teeth can be used to differentiate them (Gilbert 1980:66).

There were 3 (0.006%) bone fragments identified as dog or possible dog at Swallow site.

There were only 2 bones identified as dog/coyote in the EC cultural levels. This gives an MNI of one dog. These were molars and could not be positively identified as domestic dog. None of these molars were burned, butchered, made into tools, carnivore chewed, or rodent gnawed.

A left mandible that was positively identified as domestic dog was recovered from the MLA levels, giving an MNI of 1 dog (Figure 14.1). The mandible had not been burned, had no butcher marks, was not modified as a tool, carnivore chewed, or rodent gnawed. It had evidently lain on the ground surface for some length of time before being covered with soil and became highly weathered on the exposed surface. The mandible was examined by Dr. Sargent, a veterinarian who said that

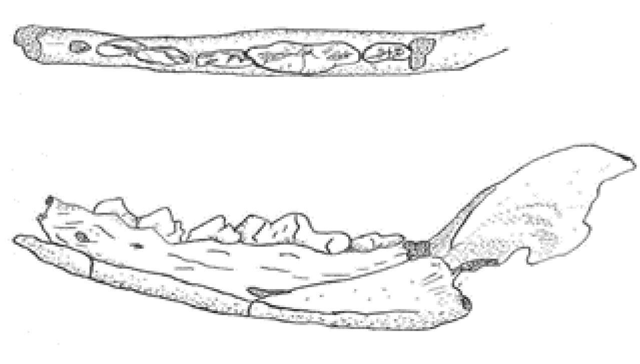

Figure 14.1. Nearly complete mandible that was positively identified as a domestic dog.

the dog was about 4 years old at the time of its death and weighed about 40 pounds (Personal Communication 2018).

There were no bone fragments identified as domestic dog in the UEA or LEA cultural levels.

Canis latrans (Coyote)

Coyote was the main predator of rabbits, jackrabbits, and rodents. The coyote is preyed upon by mountain lions, wolves, and man. Coyote hides were often used in ceremonies. Coyote tails were used to decorate clothing. Bone fragments that had been burned and had butcher marks indicate that the coyote may also have been a food source. Some bones were used to make tools.

There were 90 (0.2%) bone fragments at Swallow site identified as coyote.

There were 52 bone fragments identified as coyote in the EC levels, with an MNI of 2. Three of these bone fragments were burned, 3 had butcher marks, and 3 were modified as tools or ornaments (1 generic tool and 2 beads). None were carnivore chewed or rodent gnawed.

In the MLA cultural levels, there were 35 bone fragments identified as coyote. This represents an MNI of 1 coyote. There were 4 burned bones, 3 were modified as tools or ornaments (1 generic tool, 1 bead, 1 rasp), and 3 had butcher marks. None had been carnivore chewed and 1 was rodent gnawed.

No bones from UEA levels were identified as coyote, but 3 rib fragments in LEA levels could be identified as coyote, for an MNI of 1. None of these bones were burned, had butcher marks or were modified as a tool, carnivore chewed, or rodent gnawed.

Vulpes fulva (Red Fox) and *Vulpes velox* (Swift Fox)

Vulpes fulva and *Vulpes velox* were the only fox species found at Swallow site. The main predators of the fox include coyotes, eagles, and bobcats. The fox was used for food, tools, and fur, and tails may have been used as decoration.

There were 67 (0.1%) bone fragments identified as fox at Swallow site.

There were 37 fragments recovered from EC levels. This represented an MNI of 1 fox. Five of these bone fragments were burned. None of these fragments had butcher marks, were modified as tools, or carnivore chewed, or rodent gnawed.

In the MLA cultural levels, there were 29 bone fragments identified as fox. This gives an MNI of 1 animal. These fragments were not burned and had no butcher marks. Three of the bone fragments were modified into awls. None had been carnivore chewed and 1 had been rodent gnawed.

In the UEA cultural levels, 1 bone fragment was identified as fox. This represents an MNI of 1 fox. The bone was not burned, had no butcher marks, was not modified as a tool, carnivore chewed, or rodent gnawed.

No fox bone fragments were found in the LEA cultural levels.

Lynx rufus (Bobcat)

The predators of the bobcat include other bobcats and mountain lions. Very few bobcat bone fragments were found at the site. The hides may have been taken and the remaining carcasses left at the kill site.

There were 3 (0.006%) bone fragments at the site identified as bobcat.

In the EC cultural levels, 1 molar was identified as bobcat, for an MNI of 1. Two additional bobcat teeth were recovered from the MLA levels, for an MNI of 1. None of the teeth were burned, butchered, modified as a tool, carnivore chewed, or rodent gnawed.

Neither the UEA nor LEA cultural levels contained bobcat bone fragments.

Procyon lotor (Raccoon)

The predators of the raccoon include mountain lions, bobcats, coyotes, and foxes. Raccoons were used for their hides, tails, and claws. Some of the bone fragments were burned indicating that raccoons may have been eaten.

There were 33 (0.07%) bone fragments identified as raccoon at Swallow site.

In the EC cultural levels there were 13 bone fragments identified as raccoon, with an MNI of 1. One of these fragments was burned and none had butcher marks, were made into tools, or were carnivore chewed, or rodent gnawed.

In the MLA cultural levels there were 20 fragments identified as raccoon, with an MNI of 2. There were 2 burned fragments. None of the fragments had butcher marks, were modified as a tool, carnivore chewed, or rodent gnawed.

There were no raccoon bones identified in the UEA or LEA cultural levels.

Erethizon dorsatum (Porcupine)

Native predators of the porcupine include coyotes, bobcats, mountain lions, and black bears. The quills were dyed and used for decorating clothing and moccasins in historic times.

There were 8 (0.02%) bone fragments at Swallow site identified as porcupine: 1 in the EC levels (MNI=1), 4 in the MLA levels (MNI=1), 1 in the UEA levels (MNI=1), and 2 in the LEA levels (MNI=1). None had butcher marks, were modified as a tool, carnivore chewed, or rodent gnawed.

Ondata zibethicus (Muskrat)

Muskrats are preyed upon by raccoons, coyotes, foxes, and dogs. Muskrats have very shiny fur that was used as decoration and clothing.

There were 3 (0.006%) bone fragments at Swallow site identified as muskrat, all in the EC levels. The 3 fragments were a vertebra, a mandible, and a skull fragment. None of these were burned, had butcher marks, were made into tools, carnivore chewed, or rodent gnawed.

Marmota flaviventris (Marmot)

Marmot is a common mammal in higher elevations above 8,000 feet, but also ranges into the foothills. The predators of the marmot include coyotes, eagles, and badgers. Marmots could have been used as food or for tools or hides.

There were 6 (0.01%) bone fragments at Swallow site identified as marmot.

Four were recovered from the EC levels, giving an MNI of 1. The fragments were 1 phalanx, 1 tibia, 1 skull, and 1 left ulna.

In the MLA cultural levels, there were 2 bone fragments identified as marmot, a rib and a right humerus giving an MNI of 1. None of the marmot bone fragments at the site had been burned, butchered, modified, carnivore chewed, or rodent gnawed.

No marmot bone fragments were found in the UEA or LEA cultural levels.

Lepus californicus (Jackrabbit)

The jackrabbit and cottontail rabbit are the main food source of coyotes. It is said that the population of coyote increases and decreases in proportion to the availability of jackrabbits and rabbits. In addition to man and coyotes, the predators include dogs, foxes, badgers, weasels, eagles, owls, hawks, bobcats, and mountain lions. Snakes have been known to prey on young rabbits. The jackrabbits and cottontails were used for their fur, food, and for tools. Rabbit fur is soft and was probably used for blankets and clothing.

There were 83 (0.2%) bone fragments at Swallow site identified as jackrabbit.

In the EC cultural levels, there were 29 bone fragments identified as jackrabbit. An MNI of 3 jackrabbits was determined. There was 1 burned fragment, none had butcher marks or were modified. Two fragments had been carnivore chewed and none had been rodent gnawed.

In the MLA levels, there were 49 bone fragments identified as jackrabbit. An MNI of 3 jackrabbits was determined. There were 3 burned fragments. One of the fragments had butcher marks. One was modified as a bead. One fragment was carnivore chewed and none were rodent gnawed.

In the UEA levels, there were 3 bone fragments identified as jackrabbit. This gave an MNI of 1 jackrabbit. None of the fragments had been burned, had butcher marks or were modified as a tool. None of the fragments were carnivore chewed or rodent gnawed.

In the LEA levels, there were 2 bone fragments identified as jackrabbit, resulting in an MNI of 1 jackrabbit. One of these fragments was burned. Neither one was modified as a tool. None of the fragments had butcher marks, 1 was carnivore chewed, and neither was rodent gnawed.

Sylvilagus audubonii (Cottontail Rabbit)

There were 2,816 (5.7%) bone fragments at Swallow site identified as cottontail rabbit. Cottontails were the second largest food source at the site.

In the EC levels, there were 1,402 bone fragments identified as rabbit, for an MNI of 9. There were 277 burned bone fragments, 44 had butcher marks, 50 were made into tools/ornaments, 12 were carnivore chewed and 2 were rodent gnawed. There were 2 tools (#4, and #5 described in the Description of Select Bone Tools and Ornaments section). Most of the rabbit bone fragments that had been modified were described as beads. The breakdown of tools/ornaments is 1 awl, 2 generic tools, and 47 beads. Rabbits have hollow long bones like birds making them a good medium for producing beads.

In the MLA cultural levels, 1,286 bone fragments were identified as rabbit. There was an MNI of 12 rabbits determined. There were 264 burned bone fragments, 30 had been modified as tools/ornaments, 21 had butcher marks, 7 had been carnivore chewed, and 1 had been rodent gnawed. There was 1 bead (#21, see description in the Description of Select Bone Tools and Ornaments section). The breakdown of the tools/ornaments is as follows: 1 awl, 3 generic tools, and 26 beads.

In the UEA cultural levels, there were 91 of the food/use bone fragments identified as rabbit. There was an MNI of 2 rabbits. Twenty had been burned, 3 fragments had been modified as tools/ornaments, 2 had butcher marks, and none had been carnivore chewed or rodent gnawed. There is a bead (#31 in the Description of Select Bone Tools and Ornaments section). The breakdown of the tools/ornaments is 1 awl and 2 beads.

In the LEA cultural levels, there were 37 of the food/use animals identified as rabbit. There was an MNI of 4 rabbits determined. Six fragments were burned, 9 modified as tools/ornaments, 5 had butcher marks, and 3 were carnivore chewed. None of the fragments were rodent gnawed. The breakdown of the tools/ornaments is 2 generic tools and 7 beads (1 described as #23 in the Description of Select Bone Tools and Ornaments section). Some of the beads had incised decorations.

Sciuridae sp. (Squirrel)

There was one species of squirrel definitely identified at Swallow site - *Sciurus aberti* (Abert squirrel). Predators of these squirrels include man, great horned owls, dogs, foxes, and coyotes. The squirrel may have been used as food, tools, and decoration or clothing.

There were 111 (0.2%) bone fragments at Swallow site identified as squirrel.

In the EC cultural levels, 44 bone fragments were identified as squirrel. One of these bone fragments was identified as *Sciurus aberti* or Abert squirrel. The remaining squirrels could not be identified to species. This gave an MNI of 2 squirrels.

In the MLA levels, there were 57 bone fragments identified as squirrel. This represents an MNI of 1 squirrel. One of these fragments was burned.

In the UEA levels, there were 9 bone fragments identified as squirrel. This gave an MNI of 1.

In the LEA levels, there was 1 bone fragment identified as squirrel. This represented an MNI of 1 squirrel.

One of the squirrel bones at the site was burned. No bones had butcher marks, were modified as tools, or were carnivore chewed or rodent gnawed.

Mephitis mephitis (Skunk)

The skunks' predators include great horned owls, eagles, mountain lions, bobcats, badgers, coyotes, and foxes. The skunk was probably not used as a food source, but the fur may have been used. A skunk was seen at the site during the dig season.

There were 7 (0.01%) bone fragments identified as skunk, 2 in the EC and 5 in the MLA levels, for an MNI of 1 in each cultural division. None of these bone fragments were burned, butchered, modified, carnivore chewed, or rodent gnawed.

In the UEA and LEA cultural levels, there were no skunk bones identified.

Mustela frenata (Weasel)

Very few weasel bones were found in the site. Predators include man, foxes, coyotes, owls and snakes. The weasel fur is white in winter and at this time it is called ermine. This skin was often used as decoration.

There were 2 (0.004%) bone fragments identified as weasel at Swallow site, 1 in the EC and 1 in the MLA levels, for an MNI of 1 in the EC and 1 in the MLA levels.

Neither was burned, butchered, made into a tool, carnivore chewed, or rodent gnawed.

No weasel bone fragments were found in the UEA or LEA cultural levels.

Taxidae taxus (Badger)

There were few badger bones found at the site. Badgers have few natural enemies, although eagles, coyotes, and dogs can kill juveniles. Badgers may have been used for their hides and claws.

There were 2 (0.004%) bone fragments identified as badger at Swallow site, one in the EC levels (MNI=1) and 1 in MLA levels (MNI=1). Neither was burned, had butcher marks, was made into a tool, carnivore chewed, or rodent gnawed.

Cynomys ludovicianus (Black-Tailed Prairie Dog)

The predators of the black-tailed prairie dog include golden eagles, red-tailed and ferruginous hawks, coyotes, badgers, bobcats, foxes, black-footed ferrets, and rattlesnakes. The Swallow site contains many prairie dog bone fragments. The prairie dog was probably used as food, for hides, and for tools. There were prairie dogs seen in areas around the site during the excavation.

There were 262 (0.5%) bone fragments identified as prairie dog at Swallow site. With a total MNI of 17 for all levels combined, prairie dogs have the third highest representation by MNI at the site, after deer and cottontail rabbit.

In levels representing the EC cultural period, there were 94 bone fragments identified as prairie dog. This represented an MNI of 7 prairie dogs. There were 4 bone fragments that were burned. None of the fragments had butcher marks, were modified, or were carnivore chewed or rodent gnawed.

In the MLA levels, there were 118 fragments of the food/use animal bones identified as prairie dog, with an MNI of 8. Three fragments were burned. None of the fragments had butcher marks, were modified as a tool, or were carnivore chewed or rodent gnawed.

In the UEA cultural levels, there were 47 fragments identified as prairie dog and an MNI of 1. None of these fragments were burned, had butcher marks, were modified as tools, or were carnivore chewed or rodent gnawed.

In the LEA cultural levels, there were 3 fragments of prairie dog bone, an MNI of 1. None of these bone fragments had been burned, had butcher marks, were modified as tools, or were carnivore chewed or rodent gnawed.

Family *Chelydridae* (Turtle)

The majority of the turtle bones were carapace fragments. Predators include coyotes, raccoons, and foxes. Smaller carnivores seek out the eggs. Newly hatched turtles are more vulnerable to predation. Turtles may have been eaten as food. Turtle carapaces may have been used as decoration or as rattles.

There were 11 (0.02%) bone fragments identified as turtle at Swallow site. In the EC cultural levels, there were 4 fragments of the food/use animal bones identified as turtle. This represented an MNI of 1 turtle. The 4 bones fragments consisted of 3 rib fragments and 1 humerus fragment. None of these bones were burned, had butcher marks, were made into a tool, or were carnivore chewed or rodent gnawed.

Seven additional turtle bones were identified in the MLA levels. This represented an MNI of 1 turtle. There was 1 burned fragment. Three fragments were classified as miscellaneous tools. None of the fragments had butcher marks, were carnivore chewed, or were rodent gnawed.

In both the UEA and LEA cultural levels no turtle bone fragments were identified.

Aves (Birds)

Food/use birds at Swallow site include eagles, turkeys, turkey vultures, indeterminate medium and large birds, owls, mourning doves, hawks, crows or ravens, pigeons, falcons, geese, prairie chickens and gulls. These birds were preyed upon by other birds, coyotes, dogs, bobcats, man, and squirrels. Some of these birds may have been used as food. The feathers were probably used for decoration and fletching arrows. Owl and eagle feathers were often used in ceremonies. The thin and hollow bird bones were used for beads.

There were 160 (0.3%) food/use bird bone fragments identified at Swallow site.

In the EC levels, there were 90 bird bone fragments classified as food/use animals. The breakdown is shown in Table 14.4 with X indicating not determined.

There were 3 bird bone fragments that were burned; 2 were owl and 1 was a hawk bone. Ten of

Table 14.4. Food/use bird bone fragments in the Early Ceramic levels by number of individual specimens present (NISP) and minimum number of individuals (MNI) per species.

Taxa	NISP	MNI
Indeterminate Aves	8	X
Indeterminate large size	2	X
Corvus sp. (crow/raven)	13	2
Columba sp. (pigeon)	8	1
Zenaida sp. (mourning dove)	3	1
Buteo sp. (hawk and falcon)	6	2
Bubo sp. (owl)	16	3
Aquila sp. (eagle)	2	1
Cathartes aura (turkey vulture)	2	1
Tympanuhcus sp. (prairie chicken)	2	1
Meleagris gallopavo (turkey)	5	1
Larus sp. (gull)	1	1
Branta canadensis (goose)	1	1
Anas sp. (duck)	21	2

the bones had been made into beads including, 8 indeterminate Aves, 1 eagle, and 1 owl bone fragment. Only 2 of the bone fragments had butcher marks, including 1 eagle bone fragment and 1 owl bone fragment. None of these bones had been carnivore chewed or rodent gnawed. Some of these birds may have been used as food.

In the MLA cultural levels, there were 70 bird bone fragments classified as food/use animal bones. The breakdown is shown in Table 14.5 with “X” indicating not determined.

There were 2 burned duck bone fragments. Twelve of the fragments had been modified as beads, 1 indeterminate large bird, 1 indeterminate medium bird, 9 indeterminate birds (1 described in #14 in the Description of Select Bone Tools and Ornaments section) and 1 eagle bone fragment. Three bird bone fragments had butcher or cut marks evident. They were from 1 indeterminate large bird, 1 indeterminate bird, and one eagle bone fragment. None of the bird bones from levels in this cultural period were carnivore chewed or rodent gnawed.

In the UEA levels, there was 1 bird bone fragment found, identified as a turkey bone. This 1 bone gave an MNI of 1 turkey. The bone was not burned, had not been modified as a tool, and showed no butcher or cut marks. There was no carnivore chewing or rodent gnawing on this bone.

In the LEA levels, there were 4 bird bones. There was 1 indeterminate bird, 1 owl, and 2 hawk bone fragments identified. This represented an MNI of 1 owl and 1 hawk. None of these bones were burned. One indeterminate bird bone was modified into a bead. There were no butcher or cut marks on the bones. None these bone fragments had been carnivore chewed or rodent gnawed.

Table 14.5. Food/use bird bone fragments in the Middle-Late Archaic levels by number of individual specimens (NISP) and minimum number of individuals (MNI) per species.

Taxa	NISP	MNI
Indeterminate Aves	8	X
Indeterminate large sized Aves	4	X
Indeterminate medium sized Aves	2	X
Corvus sp. (crow/raven)	17	3
Columba sp. (pigeon)	1	1
Zenaida sp. (mourning dove)	2	1
Buteo sp. (hawk/ falcon)	5	1
Bubo sp. (owl)	17	3
Aquila sp. (eagle)	3	1
Cathartes aura (turkey vulture)	--	--
Tympanuheus sp. (grouse, prairie chicken)	2	1
Meleagris gallopava (turkey)	--	--
Larus sp. (gull)	--	--
Branta canadensis (goose)	--	--
Anas sp. (duck)	9	3

Intrusive Animals

Bones of animals that were unlikely to have been brought into the site to be used as food, ornament, clothing, or for other purposes by the human inhabitants were considered to be intrusive. Some of these animals used the site location for homes and did extensive burrowing into the soil at the site. Other intrusive animals were carried in by predators. Historic cattle ranching could also have resulted in some domestic cow bone. None could be positively identified in the assemblage but could be mixed with indeterminate large mammal bones.

There were 7,094 (14%) bone fragments in Swallow site that were identified as intrusive animals: 3,058 in the EC levels, 3,829 in the MLA levels, 143 in the UEA levels, and 64 in the LEA levels.

The 3,058 bones in the EC cultural levels from intrusive animals gave an MNI of 207 which included small rodents, snakes, frogs/toads, salamanders, and small- and medium-sized birds.

The 3,829 intrusive bone fragments in the MLA gave an MNI of 274 intrusive animals.

The 143 bone fragments provided an MNI of 13 intrusive animals in the UEA levels.

The 64 bone fragments from intrusive animals gave an MNI of 10 intrusive animals in the LEA cultural levels.

Small Rodents

A total of 5,615 (79%) of the intrusive animal bone fragments at the site came from small rodents. Identified species of rodents are listed below:

- *Indeterminate small rodents*. This group includes mice, voles, pocket gophers, woodrats, ground squirrels, and chipmunk-sized animals.
- *Thomomys talpoides* (northern pocket gopher). This group includes *cf. Thomomys*, and pocket gopher-sized animals.
- *Neotoma* sp. (woodrat). This group includes *Neotoma sp.* and woodrat-sized animals.
- *Spermophilus* sp. (thirteen-lined ground squirrel). This group includes ground squirrel-sized animals.
- *Dipodomys ordii* (Ord's kangaroo rat). This group included kangaroo rat-sized animals.
- *Eutamias* sp. (chipmunk). This group includes chipmunk-sized animals.
- *Microtus* sp. (vole). This group includes *cf. Microtus,* and vole-sized animals.
- *Peromyscus* sp. (mouse). This group includes *cf. Peromyscus* and mouse-sized animals.

These rodents were responsible for much of the soil disturbance, bioturbation through burrowing, throughout the site. Rodents also disrupted vertical distributions as they carry bones into burrows to gnaw on. Rodent gnawing was observed on bone throughout the site. Rodent gnawing can also be responsible for the complete destruction of small elements or fragments.

In the EC levels, 2,278 (74%) of the intrusive animal bones were from small rodents.

Number and MNI by taxa are shown in Table 14.6.

In the MLA levels, 3,176 (82%) of the intrusive animal bones were from small rodents. Number and MNI by taxa are shown in Table 14.7.

In the UEA levels, 117 intrusive animal bone fragments were from rodents. Number and MNI by taxa are shown in Table 14.8.

Table 14.6. Taxa of rodents in the Early Ceramic levels.

Genus/Species	NISP	MNI
Thomomys talpoides (pocket gopher)	707	64
Microtus sp. (vole)	430	30
Peromyscus sp. (mouse)	351	24
Spermophilus sp. (ground squirrel)	260	14
Indetermimate small rodent	223	NA
Neotoma sp. (woodrat)	221	17
Indeterminate medium rodent	72	NA
Dipodomys ordii (kangaroo rat)	8	1
Eutamias sp. (chipmunk)	6	2

Table 14.7. Taxa of rodents in Middle-Late Archaic levels.

Genus/Species	NISP	Percent of Intrusives
Thomomys talpoides (pocket gopher)	1140	30.0
Microtus sp. (vole)	676	18.0
Peromyscus sp. (mouse)	478	13.0
Spermophilus sp. (ground squirrel)	285	7.0
Indeterminate small rodent	277	7.0
Neotoma sp. (woodrat)	235	6.0
Indeterminate medium rodent	74	2.0
Dipodomys ordii (kangaroo rat)	11	0.3
Total	3176	83.8

Table 14.8. Taxa of rodents in Upper Early Archaic levels.

Genus/Species	NISP	MNI
Thomomys talpoides (pocket gopher)	48	3
Microtus sp. (vole)	16	1
Indeterminate small rodent	16	NA
Peromyscus sp. (mouse)	15	2
Spermophilus sp. (ground squirrel)	9	2
Neotoma sp. (woodrat)	6	1
Indeterminate medium rodent	7	NA

In the LEA cultural levels, 44 (69%) of the intrusive animal bone fragments were small rodents. Number and MNI by taxa are shown in Table 14.9.

Snakes

This group includes rattlesnakes, bullsnakes, garter snakes and hognose snakes. Many species of snakes prey on small rodents and/or occupy their abandoned burrows. The substantial rodent

Table 14.9. Taxa of rodents in Lower Early Archaic levels.

Genus/Species	NISP	MNI
Thomomys talpoides (pocket gopher)	20	2
Indeterminate small rodent	6	NA
Neotoma sp. (woodrat)	5	1
Peromyscus sp. (mouse)	5	1
Microtus sp. (vole)	5	1
Spermophilus sp. (ground squirrel)	3	1

activity evident in the shelter may be the primary reason snake bone occurred as intrusive bone at Swallow site.

There were 650 (9.2%) of the intrusive bone fragments in the site identified as snake.

In the EC levels, 277 bone fragments were identified as snake for an MNI of 4 snakes. The snakes at the site were mostly bullsnakes (*Pituophis* sp.) and some rattlesnakes (*Crotalus viridis*). There was 1 hognose snake (*Heterodon* sp.) and 1 garter snake (*Thamnophis* sp.) identified in the EC cultural levels. Only 1 bone was burned, none were butchered, made into a tool, carnivore chewed or rodent gnawed. There was no evidence of butchering or food processing of the snakes and most of the bones were whole and consisted of ribs or vertebra. The 1 burned bone was probably near a fire pit and was accidentally burned. The snakes were present at the site because of the small rodents, toads and other food sources. During excavation of the site both bullsnakes and rattlesnakes were observed. The random distribution of the snake bones was probably due to rodent activity after the death of the snakes.

In the MLA levels, there were 350 bone fragments identified as snake. This represented an MNI of 6 snakes. One complete rattlesnake skeleton was found in C3S level 10.

In the UEA levels, there were 10 bone fragments that were identified as snake. An MNI of 1 snake was determined.

In the LEA levels, there were 13 snake bone fragments for an MNI of 1 snake.

Bufo sp. (Frog/Toad)

This group includes frog/toad-sized animals. There were 435 (6.1%) of the intrusive animal bone fragments in the site identified as frog/toad.

The *Bufo* sp. frog/toad group may have contained the spade foot toad or the Woodhouse's toad. None of the bones from a specific frog or toad species were positively identified, but since their bones are similar, all of these bones were identified as frog/toad.

There were 305 of these bones found in the EC levels, giving an MNI of 20 frogs/toads. Only 1 of these bones had been burned. None of the frog/toad bones in the EC, MLA, UEA or LEA had been butchered, made into a tool, carnivore chewed or rodent gnawed. The frog/toad was a food source for the predators at the site such as snakes or owls. Owl pellets were found in various levels at the site containing frog/toad bones as well as various small rodent bones. Frogs and toads would have been at the site during the warmer months. Owls were nesting in the spring above the site.

In the MLA levels, 118 of the intrusive bone fragments were identified as frog/toad giving an MNI of 12 frogs/toads.

In the UEA levels, 12 bone fragments were identified as frog/toad, giving as MNI of 2 frogs/toads.

In the LEA levels, there were 2 bone fragments identified as frog/toad. This gives an MNI of 1 frog/toad.

Ambystoma tigrinum (Tiger Salamander)

This group includes salamander-sized animals.

Fifty-eight (0.8%) of the intrusive bone fragments were identified as tiger salamander.

In the EC levels, there were 16 bones identified as tiger salamander resulting in an MNI of 1 salamander. There were live salamanders seen at the site during the spring and summer.

In the MLA levels, 42 bones and bone fragments were identified as salamander with an MNI of 3 salamanders.

No salamander bones were found in the UEA or LEA levels.

Aves (Small- and Medium-Sized Birds)

This group includes robins, sparrows, finches, grosbeaks, towhees, juncos, crossbills, and wren-sized birds. Most small bird bones were unmodified, and this group was originally classified as intrusive. A small portion, however, showed burning or butcher marks, and five bones were made into beads, clearly indicating use. Small birds that were not used as food may have been a source of feathers for decoration or fletching. This list of birds therefore probably includes the remains of animals that were both utilized and intrusive, but the proportions of each are not clear. The majority of the bone is unmodified, and so as a whole it is included here with intrusive, acknowledging that some represent use, as noted.

There were 334 (4.7%) intrusive bird bones in the site.

The EC levels contained 182 of these bones. The MNI is 30 intrusive birds. There were 14 burned bird bones, 4 bones with butcher marks, and 5 bones that had been made into beads and were made from indeterminate small bird bones and robin-sized bones. None of the EC bird bones had been rodent gnawed or carnivore chewed. They are listed in Table 14.10.

Table 14.10. Intrusive bird bone fragments in the Early Ceramic levels by number of individual specimens (NISP) and minimum number of individuals (MNI) per species.

Genus/species	NISP	MNI
Indeterminate Aves	36	NA
Pica pica (magpie)	9	1
Turdus migratorius (robin)	43	5
Spizella sp. (sparrow)	17	3
Petrochelidon pyrrhonota (cliff swallow)	16	3
Bombycilla cedrorum (cedar waxwing)	7	1
Cyanocitta cristata (bluejay)	5	1
Pheucticus sp. (grosbeak)	6	2
Loxia sp. (crossbill)	1	1
Sturnella neglecta (meadowlark)	7	2
Junco hyemalis (junco)	5	1
Agelaius phoeniceus (black bird)	3	1
Carpodacus mexicanus (house finch)	8	2
Quiscalus quiscula (common grackle)	2	1
Pipilo erythrophthalmus (towhee)	5	1
Colaptes cafer (red-shafted flicker)	9	2
Charadrius vociferus (killdeer)	1	1
Chordeiles minor (common nighthawk)	1	1
Salpinctes obsoletus (rock wren)	1	1
Total	182	30

There were cliff swallows nesting in the rock cliffs above the site during the time of excavation. This is the reason that it was named Swallow site.

In the MLA levels, 143 intrusive bird bone fragments were found. There is an MNI of 25 intrusive birds. There was 1 burned bone, 3 bones had butcher marks, and 2 had been made into beads and were made from indeterminate small bird bones. None of the MLA bird bones had been rodent gnawed or carnivore chewed. They are listed in Table 14.11.

In the UEA levels, 4 bird bone fragments were found. This gives an MNI of 1 bird, a cliff swallow.

In the LEA levels, there were 5 intrusive bird bone fragments, and an MNI of 1 robin and 1 magpie.

Table 14.11. Intrusive bird bone fragments in the Middle-Late Archaic by number of individual specimens (NISP) and minimum number of individuals (MNI) per species.

Genus/Species	NISP	MNI
Indeterminate Aves	24	NA
Pica pica (Magpie)	4	1
Turdus migratorius (robin)	34	4
Spizella sp. (sparrow)	28	5
Bombycilla cedrorum (cedar waxwing)	10	2
Cyanocitta cristata (blue jay)	5	1
Pheucticus sp. (grosbeak)	3	1
Loxia sp. (cross bill)	1	1
Sturnella neglecta (meadowlark)	5	1
Junco hyemalis (junco)	3	1
Agelaius phoeniceus (blackbird)	10	1
Carpodacus mexicanus (house finch)	4	1
Quiscula quiscalus (common grackle)	1	1
Pipilo erythrophthalmus (towhee)	1	1
Colaptes cafer (red-shafted flicker)	6	1
Calamospiza melanocorys (lark bunting)	2	1
Salpinctes obsoletus (rock wren)	1	1
Calcarius sp. (longspur)	1	1
Total	143	25

None of the UEA or LEA intrusive bird bones had been burned, butchered, modified as tools, or rodent gnawed or carnivore chewed. The small number of beads (7) were the only ornaments found from the animals considered to be intrusive.

Taphonomic Processes

Taphonomic processes include human processes preceding artifact discard, such as butchering, skinning, and cooking. They also include biotic and abiotic modifications that occur after deposition, such as thermal alteration, rodent disturbances, gnawing, effects of soil ph, minerals, moisture, insects, and roots.

Bone Breakage and Weathering

Bones may become broken by the following methods: when food is produced by butchering, by carnivores, while creating tools, from trampling, and from surface weathering. Fracture patterns can be used to determine human versus non-human activity, as well as green versus dry bone breakage (Haynes 1983).

Force must be used to break bones. The epiphyseal ends of long bones usually do not fracture.

Dry bone fractures tend to be perpendicular, parallel, and diagonal breaks. A true spiral or helical break is the breakage of green or fresh bone. Bones can be fractured by a hammer stone. There may be scars from hammering evident on the bone. Long bone fragments broken by percussion show evidence of impact and flake scars, though similar impact scars can be created by hoof action of large ungulates. A circular or oval depression area with incipient ring cracks or crushed bone indicates an impact point (Lyman 1994:319).

Nearly all of the deer-sized long bones have curved green fractures indicating that they had been broken for marrow extraction near the time the animal had been killed.

Many of these same bone fragments had been further processed and possibly used for bone grease extraction. These bone fragments were approximately 5 cm along the long axis and 0.6 cm to 1.3 cm perpendicular to this direction. These bone fragments that had additional processing appear to have been subjected to more extensive weathering. Many of these fragments split longitudinally into splinters of width equal to the thickness of the bone. A few of the deer-sized long bone fragments exhibit exfoliation from the surface of the bone and this is suggested to be the result of freeze-thaw and wet-dry cycles of weather (Gilbert 1980). Most of these bones appear to have been covered with soil before the weathering occurred. No surface weathering was observed. The one significant exception was a dog's left mandible found in the MLA period in C3S Level 18. This bone evidently had been exposed to weathering on the surface of the soil for at least 2 years before burial.

Butchering

Butchering refers to the removal of hides, viscera, muscle, and other soft tissue (Lyman 1994:301). Evidence of butchering can be studied on the bones that were left after processing the carcass. There may be cut marks on the bone fragments from meat removal, cuts on the metapodials from skinning the animals, and cut marks near joints from disarticulation of the carcass. Not all the skeletal elements of larger animals were carried back to occupation sites. Lower limbs containing the least amount of meat are often removed from the carcass and left at the kill site and can result in the underrepresentation of large animals like elk and bison at a habitation site. The proximal limb bones contain more meat than the distal ones and are more likely to be brought back to camp for butchering. This results in many more of the smaller animal bones remaining at the site.

Approximately one-third of an animal's weight is lost when the head, hide, and hooves are removed from the carcass (Table 14.12).

Evidence of butchering was present on a number of deer-sized bone fragments as well as on bones of several other food/use animals (see Summary of Taphonomy by Period below for breakdown by cultural period).

Table 14.12. The weight of bison, elk, antelope, and deer, according to Reid (2006).

Animal	Weight in Pounds	Male Weight in Pounds	Female Weight in Pounds
Bison	800 – 1000		
Elk		700 – 1000	500 - 600
Mule Deer		125 – 400	100 - 150
Antelope	75 - 130		

Burning

Thirty percent of the bone fragments were burned. When bone fragments were exposed to excessive heat the bone was damaged, modified, and weakened. The fragments turn black when the bone collagen is carbonized. When the bone is burned for a longer time, it becomes bluish white and has a chalky consistency (Lyman 1994:385). Some of the bones may have been burned during the cooking of the meat or the disposal of food waste to keep away scavengers. Other bone fragments may have been burned by being in close proximity to a fire, grass fire or even a forest fire. Bone fragments that have been exposed to heat tend to break perpendicular to the collagen fibers and along the long axis of the bone (see Summary of Taphonomy by Period below for breakdown by cultural period).

Carnivore Damage

Some of the bone fragments showed evidence of being chewed by carnivores. The epiphyseal end of a bone that had been chewed showed furrows and puncture marks on the fractured edges. The shaft of the bone splinters longitudinally when it has been carnivore chewed. The damages to the bone occurred before the bone was buried.

Rodent Damage

Rodent gnawing was observed on some bone fragments. The rodent tooth marks were more evenly spaced than butcher marks. Butcher and cut marks differ from gnawing in that cut marks rarely follow the contour of the bone surface. There was plenty of rodent activity at the site. Voles and mice were seen during the excavation. The rodent gnawing may have occurred when the rodents burrowed into the soil and encountered a buried bone.

Dermestid Damage

Damage from dermestid beetles can be distinguished from puncture marks made by carnivore teeth because the beetle holes are larger. The holes made by beetles also have an absence of crushed bone particles (Lyman 1994:394). No dermestid beetle activity was observed on the bone fragments at this site.

Root Etching

A few of the bones were root etched. In the few locations on the bone where root etching was observed, the affected area was rather deep and circular. Occasionally the bone was partly covered with a layer of red clay and calcium carbonate coating. Root etching occurred after a bone had been buried in plant-supporting sediments. It is unknown which plant roots produce this etching. The soil needed to remain undisturbed for the roots to leave their mark (Lyman 1994:375). Minor root etching was observed on a few of the bone fragments at Swallow site, primarily on deer-sized long bone fragments. Many of the fragments were partially covered with a reddish calcium carbonate coating. This coating often occurred in a weaving line pattern and may have been the result of root activity.

Mineral Coating

Some of the bones had a coating consisting of calcium carbonate and clay minerals. This coating was often white to somewhat reddish in color due to the presence of iron oxide.

Summary of Taphonomy by Period

EC Period

In the EC levels, 6,887 (31%) of the food/use animal bone fragments were burned. The majority of the burned bone fragments were from deer-sized animals.

The remaining burned bone fragments in the EC food/use group contain less than 0.1% of the total burned bone. This includes 1 bison, 2 elk, 3 coyotes, 5 foxes, 1 raccoon, 1 jackrabbit, 4 prairie dogs, 2 owls, and 1 hawk (Table 14.13).

Two hundred eighty-five or 1.3% of the bone fragments in the EC levels had butcher marks. Deer comprised 217 (76.1%) of the butcher marked bone, and 44 (15.4%) were rabbit bone.

The remaining EC food/use bone fragments with butcher marks made up a trace or less than 0.1% of the 285 bone fragments showing butcher marks. These animals included 10 indeterminate large and 3 medium-sized mammals, 6 elk, 3 coyote, 1 eagle, and 1 owl (Table 14.14).

Table 14.13. Taxa of burned bone fragments in the Early Ceramic levels.

Genus/Species	NISP	Percent of Burned Bone
Odocoileus hemionus (mule deer)	6,477	94
Sylvilagus audubonii (cottontail rabbit)	277	4
Large indeterminate mammal	94	1.4
Medium indeterminate mammal	19	< 0.5

Table 14.14. Taxa of bone fragments with butcher marks in Early Ceramic levels.

Genus/Species	NISP	Percent of Butcher Marked Bone
Odocoileus hemionus (deer)	217	76.1
Sylvilagus audubonii (cottontail rabbit)	44	15.4
Large indeterminate mammal	10	3.5
Medium indeterminate mammal	3	1
Cervis elaphus (elk)	6	2.1
Canis latrans (coyote)	3	1
Bubo sp. (owl)	1	0.3
Aquila sp. (eagle)	1	0.3

The count of carnivore chewed bone in the food/use group during the EC period was 91 or 0.4%. Carnivore chewed bone from deer-sized animals comprised 72 of the 91 carnivore chewed bone fragments with the remaining 0.1% divided among 4 large indeteminate mammals, 1 elk, 12 rabbits, and 2 jackrabbits.

In the EC levels, 34 (0.2%) of the food/use animal bone fragments were rodent gnawed. Twenty-nine of the rodent-gnawed bone fragments were from deer-sized animals. The remaining rodent-gnawed bone fragments were from 2 large indeterminate mammals, 1 elk, and 2 rabbits.

MLA Period

In the MLA levels, 8,357 (33%) of the food/use bone fragments were burned. The majority of the burned bone fragments were from deer-sized animals.

The remaining burned bone fragments in the MLA food/use group contain less than 0.1% of the total burned food/use bone in this period. This included bison, elk, coyote, jackrabbit, turtle, prairie dog, squirrel, raccoon, indeterminate carnivore, and duck bone fragments (Table 14.15).

There were 395 (1.5%) of the food/use bone fragments in the MLA levels with butcher marks (Table 14.16).

There were 164 (0.6%) of the food/use bone fragments during the MLA period that were carnivore chewed. The carnivore-chewed bone fragments from deer-sized animals comprised 150 (91%)

Table 14.15. Taxa of burned bone fragments in Middle-Late Archaic levels.

Genus/Species	NISP	Percent of Burned Bone
Odocoileus hemionus (mule deer)	7927	95.0
Sylvilagus audubonii (cottontail rabbit)	264	3.0
Indeterminate large mammal	129	2.0
Indeterminate medium mammal	13	0.2

Table 14.16. Taxa of bone fragments with butcher marks in Middle-Late Archaic levels.

Genus/Species	NISP	Percent of Butcher Marked Bone
Odocoileus hemionus (mule deer)	344	87.0
Sylvilagus audubonii (cottontail rabbit)	21	5.0
Cervus elaphus (elk)	8	2.0
Indeterminate large mammal	9	2.0
Canis latrans (coyote)	3	0.8
Indeterminate medium mammal	5	1.0
Antilocapra americana (antelope)	1	0.3
Lepus californicus (jackrabbit)	1	0.3
Indeterminate large Aves	1	0.3
Indeterminate Aves	1	0.3
Aquila sp. (eagle)	1	0.3

with 7 (4%) from rabbit-sized animals. The remaining carnivore-chewed bone fragments were 1 antelope (0.6%), 2 (1.2%) indeterminate large mammal, 1 (0.6%) indeterminate medium mammal, 2 (1.2%) elk and 1 (0.6%) jackrabbit.

In the MLA period, 75 or 0.3% of the food/use animal bone fragments were rodent gnawed. There were 70 (93%) of these bone fragments that were deer sized. One (1%) fox, 1 (1%) rabbit, 1 (1%) antelope, 1 (1%) coyote and 1 (1%) bison-sized bone were also rodent gnawed.

UEA Period

The 1,567 bone fragments from the food/use group were found in the UEA cultural levels.

None of the animal bone fragments were present in an amount less than 0.1%.

In the UEA period 553 (35%) of the food/use bones were burned. The majority of the burned bone fragments were from deer-sized animals (Table 14.17).

There were 27 (2%) of the bone fragments with butcher marks (Table 14.18).

Table 14.17. Taxa of burned bones in Upper Early Archaic levels.

Genus/Species	NISP	Percent of Burned Bone
Odocoileus hemionus (mule deer)	523	95.0
Sylvilagus audubonii (cottontail rabbit)	20	4.0
Large indeterminate mammal	9	2.0
Medium indeterminate mammal	1	0.2

Table 14.18. Taxa of bones with butcher marks in Upper Early Archaic levels.

Genus/Species	NISP	Percent of Butcher Marked Bone
Odocoileus hemionus (mule deer)	23	85.0
Sylvilagus audubonii (cottontail rabbit)	2	7.0
Cervus elaphus (elk)	1	4.0
Indeterminate large mammal	1	4.0

Six (0.4%) of the bone fragments were carnivore chewed. Three (50%) of these fragments were from deer-sized mammals, 1 (17%) was from an indeterminate medium mammal, and 2 (33%) were from indeterminate large mammals.

Nine (0.5%) of the bone fragments were rodent gnawed. These were 3 (33%) deer bone fragments, 5 (55%) from indeterminate large mammals, and 1 (11%) from an indeterminate mammal.

LEA Period

There were 640 bone fragments from the food/use group found in the LEA cultural levels.

None of the animal bone fragments found in the LEA period were present in amounts less than 0.1%.

In the LEA assemblage, 269 (42%) of the food/use bone fragments were burned. The majority of the burned bone fragments were from deer-sized animals (Table 14.19).

Table 14.19. Taxa of burned bone fragments in Lower Early Archaic levels.

Genus/Species	NISP	Percent of Burned Bone
Odocoileus hemionus (mule deer)	241	90.0
Indeterminate large mammal	19	7.0
Sylvilagus audubonii (cottontail rabbit)	6	2.0
Indeterminate medium mammal	1	0.4
Erethizon dorsatum (porcupine)	1	0.4
Lepus californicus (jackrabbit)	1	0.4

There were 21 (4%) bone fragments with butcher marks (Table 14.20).

There were 6 (1%) food/use animal bone fragments that were carnivore chewed. There were 2 (33%) from deer-sized animals, 3 (50%) from rabbit-sized animals, and 1 (17%) from a jackrabbit.

There were 9 (1%) rodent-gnawed bone fragments. All of these rodent-gnawed bones were from deer-sized animals.

Table 14.20. Taxa of bone fragments with butcher marks in Lower Early Archaic levels.

Genus/Species	NISP	Percent of Butcher Marked Bone
Odocoileus hemionus (mule deer)	15	71.0
Sylvilagus audubonii (cottontail rabbit)	5	24.0
Indeterminate large mammal	1	5.0

Tools and Ornaments

Two categories of worked bone were present, tools and ornaments. Some bones had been modified by human agency to form identifiable tools, some with observable use-wear. Functional categories of bone tools, such as awls, scrapers, gouges, and abraders, were determined based on tool shape and wear patterns. Bone was also used to create ornaments such as beads or other decorative items.

Tools

The bones of various food/use animal species found at the site were used to manufacture bone tools. These artifacts were divided into categories that included awls, scrapers, and gouges (discussed below), and abraders (Table 14.21), smoothers (Table 14.22), gravers (Table 14.23), shaped and grooved bone (Table 14.24), and generic tools (Table 14.25).

Some tools were difficult to identify as the use-wear was not extensive and modification was slight. If these bone fragments could be called a tool they were called generic or expedient tools (Table 14.25).

Table 14.21. Comparison of bone fragments used to make abraders (percent based on total abraders per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)	4 (100.0)	4 (66.7)			8 (80.0)
Cervus elaphus (elk)		1 (16.7)			1 (10.0)
Bison bison (bison)		1 (16.7)			1 (10.0)
Total	4 (40.0)	6 (60.0)			10 (1.4)

Table 14.22. Comparison of bone fragments used to make smoothers (percent based on total smoothers per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)	1 (100.0)	1 (50.0)			2 (66.7)
Bison bison (bison)		1 (50.0)			1 (33.3)
Total	1 (33.3)	2 (66.7)			3 (0.4)

Table 14.23. Comparison of bone fragments used to make gravers (percent based on total gravers per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)		1 (100.0)			1 (100.0)
Total		1 (100.0)			1 (0.1)

Table 14.24. Comparison of bone fragments used to make shaped and grooved bone tools (percent based on total shaped and grooved tools per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Indeterminate large mammal		3 (30.0)			3 (16.7)
Odocoileus hemionus (deer)	8 (100.0)	6 (60.0)			14 (77.8)
Canis latrans (coyote)		1 (10.0)			1 (5.6)
Total	8 (44.4)	10 (55.6)			18 (2.5)

Table 14.25. Comparison of bone fragments used to make generic tools (percent based on total generic tools per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Large indeterminate mammal	4 (5.0)	7 (6.3)	2 (22.2)		13 (6.3)
Medium indeterminate mammal		1 (0.9)			1 (0.5)
Odocoileus hemionus (deer)	71 (88.8)	94 (84.7)	7 (77.8)	3 (60.0)	175 (85.4)
Sylvilagus audubonii (rabbit)	2 (2.5)	3 (2.7)		2 (40.0)	7 (3.4)
Cervus elaphus (elk)	2 (2.5)	2 (1.8)			4 (2.0)
Canis latrans (coyote)	1 (1.25)	1 (0.9)			2 (1.0)
Bison bison (bison)		3 (2.7)			3 (1.5)
Total	80 (39.0)	111 (54.1)	9 (4.4)	5 (2.4)	205 (28.6)

Bone Awls

The tools that were identified as awls (Table 14.26) were primarily made from the long bone of large artiodactyl, mostly deer. These awls were characterized by at least one end of the long bone fragment coming to a point. This pointed end was first formed by bone flakes being removed from the fractured end of the bone. There were often grooves or scratches that were perpendicular to the long axis of the bone along the length of the bone. These marks suggest that some sort of rough shaping had taken place before the pointed tip was finished. The pointed end was then refined further by shaping and rounding until the tip was cylindrical and tapered to a sharp and sometimes needle-like point. The outside surface was polished and use marks were often seen on the tip of the awl. There were many awl tips found that had been broken from the original awl. Some of the awls had one or two parallel grooves along the long axis of the bone. These grooves are of unknown use and were rounded at the bottom of the cut suggesting use wear. One notched awl had 4 notches that were parallel to each other and evenly spaced along the fractured edge. Two of these notches

Table 14.26. Comparison of food/use animal bone fragments used to make awls (percent based on total awls per period).

Genus/Species	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Indeterminate large mammal	6 (6.4)	8 (5.5)	1 (7.7)		15 (5.7)
Indeterminate medium mammal		1 (0.7)			1 (0.4)
Odocoileus hemionus (deer)	86 (92.5)	130 (89.7)	11 (84.6)	12 (100.0)	239 (91)
Sylvilagus audubonii (rabbit)	1 (1.1)	1 (0.7)	1 (7.7)		3 (1.1)
Cervus elaphus (elk)		2 (1.4)			2 (0.8)
Vulpes sp. (fox)		3 (2.1)			3 (1.1)
Total	93 (35.4)	145 (55.1)	13 (5)	12 (4.6)	263 (36.6)

were angled toward the tip and two were angled toward the distal end of the awl. There were some notches that had been removed after the bones were burned.

The fractured distal ends of some awls were rounded and polished. Some of the awls that had been broken lengthwise had use marks and high polish along their fractured edges. In some cases, the cancellous tissue of the bone showed use wear.

There were a few antler tip fragments found that were used as awls. One tip had been flattened on one side and use marks were evident.

Editor's note: One bone tool (Cat. #14244) was reported in the 1993 Interim Report (Bryant and Rathbun 1994:12) as being made from a human metatarsal. That tool was repatriated with human bone and was not available for further examination at the time of this report publication. It was not photographed, nor was it identified by an expert in human bone or with the use of a comparative human bone collection. A drawing of the tool appeared in the interim report. In fall 2023, Jeannette Mobley-Tanaka examined the drawing in comparison to the forensic teaching collection at Front Range Community College and found the identification to be problematic, as the curvature of the bone appears to be inconsistent with human metatarsals. As bear paws are often confused with human hands/feet, it is possible that the tool is made from a bear metacarpal or metatarsal, but a positive identification based solely on a drawing was not possible. For this reason, the identification has been removed from this report and it has been put into the "indeterminate mammal" category.

Bone Scrapers

Most of the tools that were classified as scrapers (Table 14.27) were made from the long bone of deer. Spiral fractures were rounded on the ends of the tools and small flakes of bone had been removed from the fractured edges. On many of the scrapers the polish from use was only on the top edge of the tool. The front and back edges of this type of tool showed little or no sign of polish. The original fractured edges along the long axis of the bone often remained sharp and unaltered. Some scrapers had polish on the inside surface of the bone on both of their fractured sides.

Table 14.27. Comparison of bone fragments used to make scrapers (percent based on total scrapers per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Large indeterminate mammal		1 (2.8)			1 (1.7)
Odocoileus hemionus (deer)	19 (86.4)	32 (88.9)	1 (100.0)	1(100.0)	53 (88.3)
Cervus elaphus (elk)	1 (4.5)	2 (5.6)			3 (5.0)
*Bison biso*n (bison)	2 (9.1)	1 (2.8)			3 (5.0)
Total	22 (36.7)	36 (60.0)	1 (1.7)	1 (1.7)	60 (8.4)

Bones that had serrations along one fractured edge may also have been scrapers and showed marks and polish along the entire length of the bone.

Bone Gouges

Gouges were also made from long bones with spiral breaks on one end. This blunt end of the bone often showed wear patterns on the inside and sometimes on the outside surface of the bone (Table 14.28).

Other Bone Tools

There were some bone fragments that had been broken resulting in pointed ends that were not classified as tools. These bones may have been expedient tools. There was no evidence of use or modification on these bones. Only bone fragments that had use wear, polish, or modification were called formal tools. Generic tools of unknown use show shaping, cut marks, scratch marks, butcher marks, and polish of some nature on the surface of the bone. The cut marks were often along a fractured edge, and most were perpendicular to the long axis of the bone. The proximal ends of some of these tools were flattened to make a working surface. Small flakes were removed from this end and polish and use were evident. Other fractured surfaces remained sharp and showed no wear. One tool had parallel cut marks on one side. These cuts were shallow cuts at one end and became deeper and spaced farther apart along the length of the bone. Some use marks on tools were both parallel and perpendicular to the long axis of the bone. Some tools had notches flaked into them. Some of these notches were flaked from the inside surface and some originated from the outside surface of the bone.

Table 14.28. Comparison of bone fragments used to make gouges (percent based on total gouges per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)	3 (100.0)	6 (66.7)			9 (75.0)
Cervus elaphus (elk)		1 (11.1)			1 (8.3)
Bison bison (bison)		2 (22.2)			2 (16.7)
Total	3 (25.0)	9 (75.0)			12 (1.7)

There were some bone fragments that had been shaped. These thick pieces of long bone had all broken edges rounded. The outside surface had abrasions from being ground down to flatten and shape the bone. One tear-drop shaped bone resembled a polished white watermelon seed, #25621 from F5S Level 3. One polished bone fragment was flat and had been polished to a high shine on one side only.

One tool made from a coyote long bone, #16029 from C1S Level 15, may have been used as a musical rasp. There were numerous deep and evenly spaced cuts along both fractured edges of the bone. These cuts were angled downward along one edge of the tool and there were straight cuts along the opposite edge. The tops of these cuts were flattened with use and showed some slight polish.

There were a few deer incisors that had been cut around the tooth root and this cut also extended across the enamel. The cuts usually went around the entire tooth. There was one piece of tooth enamel found with a cut across it. The cut tooth may have been a part of a necklace decoration.

Ornaments

Bone Beads

The majority of the 116 beads from this site were made from the long bones of rabbits (Table 14.29). Some bird bones, such as robin and eagle, were used. There were a few beads made from deer and coyote bones. Rabbit and bird bones are hollow and do not need to be drilled to be used as beads. Thick pieces of deer long bone had to be cut, ground into tubular shapes, drilled through the center, and then polished. There was one antler tip that had been drilled through its center to be worn on a leather string or thong as decoration. A stone tool was probably used to drill this type of bead. Many of the beads were cut on both ends with a beveled cut that was then smoothed and polished. There were other beads that had cut ends that were flattened and polished with no bevel. The outside surface of some beads had been highly polished and had striations along their length. There were some beads that had incised lines scratched onto them while others had the lines cut into them. The scratched and cut lines decorated the bead. Most of these incised lines were around

Table 14.29. Comparison of bone used to make beads (percent based on total beads per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Large indeterminate mammal	1 (1.6)				1 (2.6)
Medium indeterminate mammal		1 (2.4)			1 (0.9)
Odocoileus hemionus (deer)	4 (6.3)	2 (4.8)			6 (5.2)
Sylvilagus audubonii (rabbit)	47 (73.4)	26 (62.0)	2 (100.0)	7 (87.5)	82 (70.1)
Canis latrans (coyote)	2 (3.1)	1 (2.4)			3 (2.6)
Lepus californicus (jackrabbit)		1 (2.4)			1 (0.9)
Indeterminate Aves (bird)	10 (15.6)	11 (26.2)		1 (12.5)	22 (19.7)
Total	64 (55.2)	42 (36.2)	2 (1.7)	8 (6.8)	116 (16.2)

the circumference of the bead, but a few of the lines went end to end. A few bead fragments showed cuts around the circumference of the bone. These bones look like they were intended to be broken at the cuts to make several beads. One bead had incised lines that were on both sides and did not connect around the circumference of the bead. Beads that had been polished and showed wear on the inside of the bone were probably worn on a leather thong.

Some bone fragments had one cut end and one articular end. These were probably bead scraps where the central part of the bone became the bead and the ends were discarded.

One of the beads was a flat solid disk of deer long bone, #14239 from C3S Level 4. This disk had a hole drilled from both sides through its center. Both outside surfaces of this button or bead were polished. The edges of the center hole were smooth and worn as though it had been on a leather string.

A white mollusk shell bead found in the EC levels was similar to the deer long bone disk from the same EC period. The shell bead was round, polished and drilled through the center. It was larger in size and weighed more than the deer bone bead. Both beads were unbroken and approximately the same size. The deer bead measured 0.24 mm and the shell bead 0.32 mm in thickness.

In addition to formal bone beads there were miscellaneous modifications including incised bone, polished bone, incised teeth, drilled bone, and antler tips (Table 14.30).

Table 14.30. Comparison of bone used to make miscellaneous ornaments (percent based on total miscellaneous ornaments per period).

Animal	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)	4 (80.0)	1 (14.0)	2 (100.0)		7 (50.0)
Cervus elaphus (elk)	1 (20.0)	1 (14.0)			2 (14.3)
Large indeterminate mammal		2 (29.0)			2 (14.3)
Family Chelydridae (turtle)		3 (43.0)			3 (21.4)
Total	5 (36.0)	7 (50.0)	2 (14.0)		14 (1.9)

Decorated Bone Items

Seventeen fragments of decorated bone were found at this site that may have been ornaments (Figure 14.2).

No reference has been found in the literature to explain the technique used to decorate these bones. These pieces were referred to as being decorated bone.

All of these bone artifacts had been burned. When the bone collagen was carbonized it became

Figure 14.2. Decorated bone items. Most are burned and decorated with small holes. A faint etching of a porcupine is visible on catalog # 17616 (top row, third from left.)

black. Upon further burning the surface of the bone became bluish black with a chalky consistency. The outside surface of all the decorated bone artifact fragments at this site were bluish black to white. The inside portions on broken surfaces were black indicating less heat in this area of the bone. The bones were burned after the initial shaping and before the pits that formed the design were drilled, as indicated by the interior, black color showing in the pits. We suggest that the bone was intentionally burned to create the black/white color effect in the finished artifact.

The designs which decorate these artifacts consist of small drilled holes or dots. The dots appear black against the bluish-white outer surface of the bones. Some of the dots form patterns of half circles or possibly full circles. These dots were very small and closely spaced. The purpose of these decorated pieces was not evident; however, they appear to have been larger than artifacts identified as gaming pieces at nearby sites (Hammond et al. 2018).

Most of the bone fragments had designs on both sides. There were different patterns of dots on both sides of these fragments. Some of these patterns were in single rows of both straight and curved lines. A second pattern seen on these decorated pieces consists of two closely spaced lines of parallel dots in a serpentine pattern straight across the entire fragment.

One fragment found in D1S Level 18, #17616 had a small design that resembled a porcupine with small cuts that represented quills. The light scratches that form the design were stained with either red soil or pigment, suggesting the design may have been scratched on, then painted.

These decorated artifacts were made using flat pieces of cancellous bone, possibly deer rib fragments that had been split, and the cancellous bone removed. Most of the decorated bone artifacts were found in the MLA levels, though they were scattered from Levels 3 to 24, with matching pieces found in Levels 3 and 15, indicating a significant amount of vertical displacement. Horizontal displacement was also evident, with fragments found as far apart as 3 2-x-2-m grid squares. Despite this wide dispersal on the site, the overall consistency of the design suggests that these fragments come from only a few objects, and their concentration in the Middle Archaic levels, as well as a radiocarbon date of 4760±60 radiocarbon years BP with calibrated age range (1-sigma) of 3635-3386 BC (PRI-6018 – Date 22 in Chapter 5) indicate that they were created and used in the Middle Archaic.

One decorated bone artifact was found in the LEA levels B2S Level 32/32A. This artifact had a design of random lines carved into it. These marks were incised into the bone suggesting a different purpose for the artifact than that for the dotted artifacts found in the MLA period.

There were 3 fragments that may have been broken from pendants or ornaments since a single hole was drilled through them from both sides. All 3 of these artifacts were broken at the drilled hole. Two were decorated with the punctate design.

In an effort to determine a possible use for the decorated pieces, a search for an association with beads was conducted. There was no concentration of beads found in conjunction with the pieces. In the EC period E2S Level 3, 1 decorated piece was glued to another fragment from D1S Level 16 in the MLA period. This decorated piece was then considered to be a MLA artifact.

In E2S Levels 2, 3 and 4, there were 5 beads found. These were 2 rabbit bone beads in Level 2, 1 in Level 3 and 1 in Level 4. One deer bone bead and 1 eagle bone bead were found. These 5 beads were not considered to be connected with the decorated piece that had been found in the EC levels.

There were 3 beads found near decorated pieces in the MLA levels. They were 2 rabbit bone beads, one each in B1S Level 14 and Level 15, with decorated piece # 37227 (B1S Level 15). The other bead was in D1S Level 14 and the decorated piece in D1S Level 15. This bead was made from an indeterminate mammal and indeterminate bone.

There were not enough drilled fragments found with these decorated pieces to say if they could have been part of a necklace.

Descriptions of Select Bone Tools and Ornaments

Included below are descriptions of selected bone tools, as illustrated in Figures 14.3-14.5. These tools were selected as examples that illustrate the kinds of tools found throughout the site in all cultural levels.

Bone Tools and Ornaments: EC Period (Figure 14.3)

Figure 14.3. Early Ceramic tools and ornaments: Top Row: #1, #2, #3, #4, #5, #12. Middle Row: #7, #8, #9, #10, #11. Bottom: #6.

1. Button or bead. C3S Level 4 #14239
   Length = 1.08 cm, Thickness = 0.24 cm, Weight = 0.2 g
   Indeterminate large mammal indeterminate bone, unburned.

   This button or bead was identified as from an indeterminate mammal and indeterminate bone but probably is deer-sized bone because of the way the artifact was made. It was made from a solid slice of bone and rounded into a circle. It had been broken in half and resembled a half circle. There was a central hole drilled into the bone. The bone was highly polished on the inside as if it were worn on a string or piece of leather. The edges of this bead or button were also highly polished.

2. Bead, E2S Level 5 #7460
   Length = 1.09 cm, Width = 0.43 cm, Thickness = 0.22 cm, Weight = 0.1 g
   Deer-sized long bone, unburned.

   This bead had been broken in half. The bone had been shaped into a disk and had been drilled through the center. All of the edges and flat sides had been polished to a high shine.

3. Bead. E2S Level 4 #2732
   Length = 1.12 cm, Width = 1.03 cm, Thickness = 0.15 cm, Weight = 0.3 g
   Deer-sized indeterminate bone, burned.

   This bone had been split in half lengthwise. There was evidence that both ends of the bone had been cut. Both of the cut ends had been rounded and polished. The outside surface of the entire bead had also been polished.

4. Bead. D2S Level 4 #23571
   Length = 0.92 cm, Width = 0.45 cm, Thickness = 0.14 cm, Weight = <0.1 g
   Rabbit-sized metapodial, unburned.

   This bone had been split in half. Both ends of the bone had been rounded and polished. The outside surface had been incised with 3 lines that probably went around the entire bead.

5. Bead. E3S Level 6 #7633
   Length = 1.48 cm, Width = 0.63 cm, Thickness = 0.11 cm, Weight = 0.2 g
   Rabbit-sized long bone, burned.

   This bone had been cut on both ends and the cut ends were beveled. The bone had 1 line incised into it. The incised line was in the center of the bone and extends around the bead. This line had been cut deep enough that the intention may have been to make this bone into 2 beads.

6. Double end awl. D3S Level 3 #1219
   Length = 10.3 cm, Width = 0.89 cm, Thickness = 0.61 cm, Weight = 5.6 g
   Indeterminate large mammal long bone, unburned.

   The awl had been sharply pointed on one end and dulled on the opposite end. The bone widened to 0.89 cm by 0.7 cm at a distance of 4.0 cm from the dulled, used edge. It had been beveled on one side, to a depth of 0.2 cm longitudinally from a steep angle of 23 degrees to an angle of 40 degrees to 0.8 cm from the beveled edge. The angle was 9 degrees on both the wide and narrow side of the tool and no more than 5 degrees to the center. These angles were followed on the narrow side and on the pointed side of the tool. Six facets were seen on both pointed ends of the tool. The entire surface was highly polished. Rodent gnawing was evident 3.5 cm from the pointed end. Two facets were seen on the center of both narrow sides while the wider side was rounded. The use scratches, longitudinal and the parallel grooves, were 53 degrees from longitudinal direction to 1.48 cm from the pointed end and continued 20 degrees from there to the end of the tool. This tool had been root etched.

7. Awl tip. B2S Level 5 #5997
   Length = 3.23 cm, Width = 0.47 cm, Thickness = 0.48 cm, Weight = 0.5 g
   Deer-sized long bone, unburned.

   This bone had been cylindrically shaped and tapered to a point. The wide end is 0.47 cm and tapered to 0.17 cm. The sharp tip had been broken off. There were 4 notches cut along one side. The bone was broken at the fourth notch. The last 2 notches were angled toward the tip. There was high polish along the whole length of the tool.

8. Awl. E2S Level 5 #2852
   Length = 6.16 cm, Width = 1.02 cm, Thickness = 0.68 cm, Weight = 2.7 g
   Deer-sized long bone, unburned.

   This bone had been shaped. The fractured edges had been rounded and shaping marks were visible on 3 edges. These marks were perpendicular to the long axis of the bone. The bone tapered from 1.02 cm to 0.12 cm. The pointed end was cylindrical and sharp. The last 1.94 cm of the tip was highly polished.

9. Smoother. C2S Level 3 #9591
   Length = 5.04 cm, Width = 2.61 cm, Thickness = 0.78 cm
   Bison-sized rib, unburned.

   The rounded top of the rib had some butcher marks at one end. The large flat side of the rib was smoother to the touch than the opposite side. The tool was evenly polished along its length. The opposite side had a long scratch across the width of the bone. At one end of this scratch a small piece of lithic material was imbedded in the bone.

10. Generic tool. B2S Level 5 #27018
    Length = 7.1 cm, Width = 2.36 cm, Thickness = 0.41 cm, Weight = not recorded

Deer-sized long bone, unburned.

This tool had a spiral fracture that formed a rounded tip. The fractured edge was smoothly polished and rounded from use. There were 3 cuts along this same fractured edge near the bottom of the tool. These cuts were perpendicular to the broken edge. The opposite edge had many large flakes removed from the outside surface of the bone.

11. Generic tool. C4S Level 6 #17159
    Length = 8.29 cm, Width = 1.36 cm, Thickness = 0.42 cm, Weight = 3.5 g
    Deer-sized rib, unburned.

    One end of this tool had been broken straight across while the other end had been broken to a rounded shape. This rounded end had smooth edges across the top. There were small scratches on the flat surface that were parallel to the long axis of the bone. The flat side of the rib was polished smooth. The rounded side of the rib had one edge that had been worn along its entire length. This edge had been worn down exposing the rougher inner cancellous tissue of the bone.

12. Incised tooth. D2N Level 5 #32761
    Length = 2.14 cm, Width = 0.53 cm, Thickness = 0.11 cm, Weight = 0.3 g
    Deer-sized tooth, unburned.

    There were 4 evenly spaced cuts on this piece of tooth root. These cuts were about 0.29 cm apart. They extended across the tooth root and were perpendicular to the long axis of the tooth. The cuts were sharp on one end and irregular on the other.

Bone Tools and Ornaments: MLA Period (Figure 14.4)

13. Bead. C2S Level 11 #16423
    Length = 1.88 cm, Width = 0.57 cm, Thickness = 0.10 cm, Weight = 0.3 g
    Rabbit-sized long bone, unburned.

    This piece of bone shaft appeared to be broken and not cut. The inside surface of the bone was very smooth. Both ends of the bone had their edges reduced by wear. The ends were sharp and polished. The bone had been worn very thin but had not broken. The outside surface had a high polish.

14. Bead. C4S Level 10 #17885
    Length = 3.38 cm, Width = 0.32 cm, Thickness = 0.36 cm, Weight = 0.69 g

Figure 14.4. Middle and Late Archaic tools and ornaments: Top Row: #13, #14, #15. Bottom Row: #16, #17, #18.

Indeterminate Aves long bone, unburned.

This bead was broken. Both ends of the bead had been cut at an angle. The two cut ends had been rounded and polished. The outside surface of the bead was highly polished.

15. Awl. B1N Level 9 #20636
Length = 8.38 cm, Width = 3.93 cm, Thickness = 2.4 cm, Weight = 12.3 g
Odocoileus hemionus ulna, unburned.

    This awl was made from the proximal end of an ulna. The distal end of the tool had been broken to an angled tip. This tip had been thinned down by tapering. There were use marks on the angled edge. The top edge of the bone had parallel scratches from use. Two places on the bone had been cut to form slight notches. The proximal end of the tool had butcher marks.

16. Awl. B3S Level 15 #27548
Length = 10.62 cm, Width = 1.8 cm, Thickness = 0.46 cm, Weight = 11.1 g
Deer long bone, unburned.

An impact fracture had formed a 3.56 cm long tip on this awl. The inside edge of this fracture had several small bone flakes removed along its entire length. The outside surface of the bone along this edge had butcher marks of various lengths (0.2 cm - 0.6 cm) along the length of the bone. These cut marks were perpendicular to the long axis of the bone. The fractured edge of the long side of the bone had cut marks 2.15 cm from the tip.

17. Generic tool. E3S Level 13 #8608
    Length = 4.09 cm, Width = 1.21 cm, Thickness = 0.43 cm, Weight = 2.6 g
    Deer-sized metacarpal, unburned.

    The straight unbroken end of the bone had a large V-shaped groove in it. There were very small use scratches below these grooves. The fractured edge that was 1.55 cm had very tiny use marks along its entire length. There was some polish on the grooved end.

18. Possible musical rasp, shaped. C1S Level 15 #16029
    Length = 9.23 cm, Width = 1.50 cm, Thickness = 0.95 cm, Weight = 10.05 g
    Coyote-sized left radius, unburned.

    There were 6 deep cuts: 0.28 cm, 0.23 cm, 0.68 cm, 0.73 cm, 0.48 cm, and 0.70 cm long starting at the thickest end and 0.12 cm, 0.1 2 cm, 0.12 cm, 0.15 cm, 0.17 cm, and 0.11 cm deep. One side of these cuts went straight into the bone and the other side angled down. The distance between the holes is 0.38 cm, 0.81 cm, 0.62 cm, 0.42 cm, and 0.61 cm and was flattened and somewhat polished. The sides of the bone were weathered with numerous longitudinal fractures.

Bone Tools and Ornaments: UEA Period (Figure 14.5)

19. Bead. D4S Level 19 #1050
    Length = 1.22 cm, Width = 0.46 cm, Thickness = 0.10 cm, Weight = 0.1 g
    Rabbit-sized metapodial, unburned.

    This bead is whole. Both ends had been bevel cut and rounded. The outside surface was polished.

20. Awl. C4S Level 20 #18669
    Length = 2.13 cm, Width = 0.96 cm, Thickness = 0.47 cm, Weight = 1.09 g
    Deer-sized long bone, burned.

    The wider end of this bone had been cut. There were 2 v-shaped cuts

Figure 14.5. Early Archaic tools and ornaments. Top Row: Upper Early Archaic #19, #20, #21 (MLA), #22. Bottom Row: Lower Early Archaic #23, #24, #25.

approximately 0.3 cm wide at the top of the artifact. One of the cuts was slightly worn on the inside surface of the cut.

21. Generic tool. B3S Level 21 #32941 (*This tool is from the MLA period)
    Length = 4.6 cm, Width = 1.45 cm, Thickness = 0.65 cm, Weight = 4.5 g
    Deer-sized long bone, unburned.

    A straight longitudinal break had formed this tool. Several spiral fractures had created points on both ends of the bone. One of the pointed ends was blunted from use. There were wear grooves that were perpendicular to the long axis of the bone on both inside and outside surfaces. The wear patterns had formed facets on the bone. Polish was evident. One of the parallel split fractures was rounded and polished. An impact fracture had flakes removed and polish on the inside surface.

22. Incised bone. C3S Level 19 #15463
    Length = 1.11 cm, Width = 0.57 cm, Thickness = 0.21 cm, Weight = 0.2 g

    Indeterminate large mammal and indeterminate bone, unburned.
    Both ends of this bone showed no signs of being cut. There was a grooved incision along the entire length of the bone.

Bone Tools and Ornaments: LEA Period (Figure 14.5)

23. Bead. C2S Level 30 #24769
    Length = 2.9 cm, Width/diameter = 0.36 cm, Thickness = 0.6 cm, Weight = 0.5 g
    Rabbit-sized long bone, unburned.

    This was a whole bead. Both ends of the bead were rounded and polished. There were some cut marks at one end. The outside surface of the bone had been polished.

24. Awl. C1S Level 32 #21303
    Length = 6.52 cm and 2.33 cm (2 fragments), Width = 1.36 cm, Thickness = 0.66 cm, Weight = 8.8 g
    Deer-sized long bone, unburned.

    This awl was calcium carbonate coated. The 2 fragments do not fit together. The smaller fragment had exfoliation on one edge. The opposite edge and inside surface of this awl had high polish. The larger fragment had high polish along the longitudinally fractured edges. There were cuts or scratch marks along one of these edges that were present before polishing occurred. The outside and inside surfaces of this bone showed a high polish. Both ends of the bone had been broken. One of these breaks was a modern break.

25. Generic Tool. B2S Level 33 #32957
    Length = 2.15 cm Width = 1.25 cm Thickness = 0.34 cm Weight = 1.3 g
    Deer-sized long bone, burned.

    Both edges of this bone that were parallel to the long axis had been rounded. These edges had abrasions along their entire length. The cancellous tissue on the inside of the bone had been ground flat resulting in a very smooth surface.

Summary of Tools and Ornaments by Period

Of the 718 worked bone items in the entire site, 283 (39%) were in the EC levels, 378 (53%) were in the MLA levels, 29 (4%) were from the UEA levels, and 28 (4%) were found in LEA levels.

EC Cultural Period

In the EC levels, the 201 deer-sized bone tools represented 71% of the food/use tools. The 50 rabbit bone fragments were 18% of the EC bone tools. The 12 tools made from indeterminate large mammal bone fragments represented 4.2% of the EC bone tools. The remaining 7% of the food/

use bone tools were divided among *Bison/bos* (1%), coyote (1%), elk (1%), and birds (3.5%). The birds included indeterminate Aves, eagle, owl, and robin (Table 14.31).

The most common EC tool type was the awl, followed in frequency by generic tools, beads, and scrapers. Other types were relatively uncommon. Deer bone was the most common material for tools, making up 92% of awls, 89% of generic tools, 86% of scrapers, 50% of the smoothers, and all 3 of the gouges. Only beads were not made predominantly of deer bone. Beads were most commonly made of rabbit bone (73%) and bird bone (16%) as these species have small, light, hollow bone more appropriate for stringing beads. Only 6% of the beads were made of deer bone, with coyote and indeterminate mammal bone making up the remaining 5%.

MLA Cultural Period

There was a total of 378 (53%) bone tools in the MLA levels.

In the MLA levels, the 284 deer-sized bone tools represented 75% of the tools. The remaining tools were 30 (8%) rabbit bone, 24 (6%) indeterminate large mammal, 3 (1%) indeterminate medium mammal, 9 (2%) elk bone, 7 (2%) bison bone, 3 (1%) coyote bone, 3 (1%) fox bone, 1 (1%) jackrabbit bone, 3 (1%) turtle carapace, and 11 (3%) bird bones (Table 14.32).

Use of various taxa for bone tools and ornaments was similar in the MLA assemblage to what was seen in the EC assemblages. Of the 145 awls, 90% were made from deer-sized bone, 5% from large mammal, 2% from fox, and 1% each from medium-sized mammal, rabbit, and elk. Generic tools and scrapers were primarily made from deer (85% and 89% respectively), with rabbit, bison, elk, and coyote making up between 1-3% each. Sixty-seven percent of abraders and gouges were made from deer bone, as well as 60% of shaped and grooved bone. Of the 42 beads, 62% were made from rabbit, 26% from bird, 5% from deer, and 2% from coyote, jackrabbit, and medium mammal each. Sixty percent of the 5 miscellaneous tools were turtle carapace, while others were made of elk (20%) and deer (20%).

UEA Cultural Period

A total of 29 (4%) bone tools were found in the UEA levels.

In the UEA levels, 21 (72%) of the bone tools were manufactured from deer-sized bone, 3 (11%) from rabbit bone and 5 (17%) from indeterminate large mammal bone(Table 14.33).

Bone usage for tools was again similar in the UEA levels. Of the 13 awls recovered, 85% were deer bone and 78% of generic tools were also deer. Eight percent of awls were rabbit bone, and all other tools were made of indeterminate large mammal bone. All of the beads found in these levels were made of rabbit bone.

Table 14.31. Taxa of worked bone in the Early Ceramic period.

Genus/Species	Awl	Bead	Generic	Scraper	Abrader	Smoother	Gouge	Graver	Shaped Bone	Misc.	Decorated	Total
Large indeterminate mammal	6	1	4								1	12
Odocoileus hemionus (mule deer)	86	4	71	19	4	1	3		8	4	1	201
Sylvilagus audubonii (cottontail)	1	47	2									50
Cervus elaphus (elk)			2	1						1		4
Bison bison (bison)				2		1						3
Canis latrans (coyote)		2	1									3
Aves (bird)		10										10
Total	93	64	80	22	4	2	3	0	8	5	2	283

Table 14.32. Taxa of worked bone in Middle-Late Archaic period.

Genus/Species	Awl	Bead	Generic	Scraper	Abrader	Smoother	Gouge	Graver	Shaped & Grooved	Misc.	Decorated	Total
Odocoileus hemionus (mule deer)	130	2	94	32	4	1	6	1	6	1	7	284
Sylvilagus audubonii (cottontail)	1	26	3									30
Indeterminate large mammal	8		7	1					3		5	24
Indeterminate medium mammal	1	1	1									3
Cervus elaphus (elk)	2		2	2	1		1			1		9
Bison bison (bison)			3	1	1		2					7
Canis latrans (coyote)		1	1						1			3
Vulpes sp. (fox)	3											3
Lepus californicus (jackrabbit)		1										1
Family Chelydridae (turtle)										3		3
Family Aves (bird)		11										11
Total	145	42	111	36	6	1	9	1	10	5	12	378

Table 14.33. Taxa of worked bone in Upper Early Archaic period.

Genus/Species	Awl	Bead	Generic	Scraper	Shaped & Grooved	Miscellaneous	Decorated	Total
Odocoileus hemionus (mule deer)	11		7	1		2		21
Sylvilagus audubonii (cottontail rabbit)	1	2						3
Indeterminate large mammal	1		2			1	1	5
Total	13	2	9	1		3	1	29

LEA Cultural Period

A total of 28 (4%) of the bone tools were found in the LEA levels (Table 14.34).

In the LEA levels, all of the tools were made from deer or similar-sized mammal bone with the exception of 2 generic tools made from rabbit bone. The beads were made from 1 indeterminate bird and 7 rabbit bone fragments.

Table 14.34. Taxa of worked bone in Lower Early Archaic period.

Genus/Species	Awl	Bead	Generic	Scraper	Smoother	Shaped	Decorated	Total
Indeterminate Aves (bird)		1						1
Odocoileus hemionus (mule deer)	12		3	1	1		1	18
Sylvilagus audubonii (cottontail rabbit)		7	2					9
Total	12	8	5	1	1	0	1	28

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15

Faunal Analysis: Discussion and Synthesis

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Archaeological faunal assemblages provide useful data to inform on a number of topics. Most importantly, they provide direct evidence of subsistence practices, but bones can also be used to help reconstruct environment, suggest seasonality, and reveal other aspects of site use. Taphonomic processes provide evidence for both human behavior and post-depositional impacts to the site and the associated assemblages.

The faunal assemblage from Swallow is a relatively rich one, with tens of thousands of specimens, spanning a long period of occupation, and has the potential to address many of these topics.

A total of 49,845 food/use animal bone fragments was recovered from Swallow site. Table 15.1 indicates that 95% of the food/use animal bones occur in the Early Ceramic (EC) and Middle to Late Archaic (MLA) levels and over one-half of them were in the MLA levels. Three percent of the remaining food/use bone elements were associated with the Upper Early Archaic (UEA) cultural period and 1% found in the Lower Early Archaic (LEA) (see Tables 15.2, 15.3, 15.4, and 15.5 below for a breakdown by period). The total minimum number of individuals (MNI) was 166 food/use animals in the site. Sixty-six were in the EC, 73 in the MLA, 12 in the UEA, and 15 in the LEA cultural period. Taken together, this suggests a much lighter occupation in the Early Archaic than in later times.

A list of the fauna currently found on the Ken-Caryl Ranch was compiled by Mark Ludlow as part of the Colorado Archaeological Society's (CAS) Ken Caryl work (1997:161). Most of the animals reported on this list were found throughout all the cultural periods at Swallow site, indicating a thorough knowledge and utilization of the environment by Swallow inhabitants.

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Table 15.1. Distribution of the number of individual specimens (NISP) of food/use animal bone fragments in Swallow site (percent based on the total NISP in the site).

Period	NISP	Percent
Early Ceramic	22,150	44
Middle-Late Archaic	25,488	51
Upper Early Archaic	1,567	3
Lower Early Archaic	640	1
Total	49,845	99

Subsistence Practices

To understand food practices at the site, bone was designated as food/use bone and intrusive species bone. Only the food/use species are used here to discuss subsistence practices at Swallow. By far, the largest group of food/use animal bone fragments was deer (*Odocoileus hemionus*), indicating the importance of deer as a food source. Of the 49,845 food/use animal bone fragments in the site, 44,786 (90%) were identified as deer or deer size. Deer were represented by nearly all skeletal elements, including skulls, vertebrae, ribs, pelvic fragments, and upper and lower limb bones, indicating that they were brought to the site whole.

After deer, cottontail rabbits (*Sylvilagus audubonii*) were the second largest food/use group of animals in the site. Rabbits would have been hunted for food, clothing, and bones for tools. There were 2,816 rabbit bone fragments found at the site, comprising 5.6% of the assemblage. Taken together, these two taxa make up nearly 96% of the total site assemblage, the remaining 31 taxa making up only 4% combined. Clearly, hunting practices were focused primarily on these two species, with most other species being acquired on relatively rare occasions, either when there were specific needs (for example, feathers, porcupine quills, or fox fur desired for the construction of specific clothing items), or as opportunistic hunting. Deer and rabbit may have filled complementary roles in food acquisition, with rabbit being locally available immediately around the site, and easy to take when longer distance hunting forays were limited by weather or other activities closer to home. Deer would have been a more significant food source, with a single kill feeding the group for longer, and with a surplus that could be dried for consumption at lean times of year. Thus, it is easy to imagine hunting parties setting out from Swallow to obtain deer in the surrounding area when the weather allowed, while the local rabbit population was culled locally to provide fresh meat when deer could not be taken, or the supply was running low.

Other large mammal taxa recorded at the site included bison, elk, and antelope, but in far smaller numbers than deer/deer size. Thus, it is the absence of these species that is more notable than their presence (though some antelope could be intermixed with deer-size bone.) A total of 145 (0.3%) elk bone fragments was recovered, and only 7 antelope bone fragments. Elk and bison were found associated with all time periods at the site, but antelope were only found in the Early Ceramic (2 bones) and Middle/Late Archaic (5 bones) levels. According to the Ludlow list (1997:161), no

Table 15.2. Number of individual specimens (NISP), minimum number of individuals (MNI), and NISP/MNI of food/use animals found in the Early Ceramic levels.

Genus/species	NISP (Percent)	MNI	NISP/MNI
Odocoilius hemionus (deer)	19,748 (89.2)	11	1795
Sylvilagus audubonii (cottontail rabbit)	1,402 (6.3)	9	156
Large indeterminate mammal	433 (2)	ND	ND
Cynomys ludovicianus (prairie dog)	94 (0.42)	7	14
Canis latrans (coyote)	52 (0.23)	2	26
Sciuridae sp.(squirrel)	44 (0.2)	2	22
Antilocapra americanus (antelope)	2 (0.009)	1	2
Procyon lotor (raccoon)	13 (0.06)	1	13
Erethizon dorsatum (porcupine)	1 (0.004)	1	1
Ondatra zibethicus (muskrat)	3 (0.013)	1	3
Mephitis mephitis (skunk)	2 (0.009)	1	2
Mustela frenata (weasel)	1 (0.004)	1	1
Taxidae taxus (badger)	1 (0.004)	1	1
Canis familiaris (dog)	2 (0.009)	1	2
Indeterminate carnivore	9 (0.04)	ND	ND
Lynx rufus (bobcat)	1 (0.004)	1	1
Family Chelydridae (turtle)	4 (0.18)	1	4
Indeterminate medium mammal	85 (0.38)	ND	ND
Bison bison (bison)	31 (0.14)	2	15
Lepus californicus (jackrabbit)	29 (0.13)	3	10
Cervus elaphus (elk)	62 (0.28)	1	62
Vulpes sp.(fox)	37 (0.17)	1	37
Marmota flaviventris (marmot)	4 (0.18)	1	4
Bubo sp. (owl)	16 (0.07)	3	5
Zenaida sp. (mourning dove)	3 (0.13)	1	3
Aquila sp. (eagle)	2 (0.009)	1	1
Cathartes aura (turkey vulture)	2 (0.009)	1	2
Galliform sp. (grouse, prairie chicken)	2 (0.009)	1	2
Meleagris gallopavo (turkey)	5 (0.02)	1	5
Larus sp. (gull)	1 (0.004)	1	1
Branta canadensis (goose)	1 (0.004)	1	1
Anas sp. (duck)	21(0.09)	2	10
Indeterminate large Aves	2 (0.009)	ND	ND
Indeterminate medium Aves	2 (0.009)	ND	ND
Indeterminate Aves	8 (0.04)	ND	ND
Corvus sp. (crow/raven)	13 (0.59)	2	7
Columba sp. (pigeon)	8 (0.04)	1	8
Buteo sp. (hawk/falcon)	6 (0.03)	2	3
Total	22,150	66	

Table 15.3. Number of individual specimens (NISP), minimum number of individuals (MNI), and NISP/MNI of food/use animals in the Middle-Late Archaic levels.

Genus/species	NISP (%)	MNI	NISP/MNI
Odocoileus hemionus (mule deer)	23,115 (91.0)	19	1,216
Sylvilagus audubonii (cottontail rabbit)	1,286 (5.0)	12	107
Indeterminate large mammal	478 (2.0)	ND	
Cynomys ludovicianus (black-tailed prairie dog)	118 (0.5)	8	15
Indeterminate medium mammal	87 (0.3)	ND	
Cervus elaphus (elk)	77 (0.3)	1	77
Sciuridae sp. (squirrel)	57(0.2)	1	57
Lepus californicus (jackrabbit)	49 (0.2)	3	16
Canis latrans (coyote)	35 (0.14)	1	35
Bison bison (bison)	33 (0.13)	1	33
Vulpes sp. (fox)	29 (0.11)	1	29
Ursus americanus (bear)	1 (0.004)	1	1
Antilocapra americana (antelope)	5 (0.02)	1	5
Indeterminate carnivore	5 (0.02)	ND	
Canis familiaris (dog)	1 (0.004)	1	1
Lynx rufus (bobcat)	2 (0.008)	1	2
Procyon lotor (raccoon)	20 (0.08)	2	10
Erethizon dorsatum (porcupine)	4 (0.016)	1	4
Marmota flaviventris (marmot)	2 (0.008)	1	2
Mephitis mephitis (skunk)	5 (0.02)	1	5
Mustela frentata (weasel)	1 (0.004)	1	1
Taxidae taxus (badger)	1 (0.004)	1	1
Family Chelydridae (turtle)	7 (0.027)	1	7
Indeterminate large Aves	4 (0.016)	ND	
Indeterminate medium Aves	2 (0.008)	ND	
Corvus sp. (crow/raven)	17 (0.67)	3	6
Columba sp. (pigeon)	1 (0.004)	1	1
Zenaida sp. (mourning dove)	2 (0.008)	1	2
Buteo (hawk/falcon)	5 (0.02)	1	5
Bubo sp. (owl)	17 (0.67)	3	6
Aquila sp. (eagle)	3 (0.01)	1	3
Galliform sp. (prairie chicken)	2 (0.008)	1	2
Anas (duck)	9 (0.035)	3	3
Indeterminate Aves	8 (0.03)	ND	
Total	25,488	73	

antelope exist in the Swallow site area in modern times. Antelope are primarily a plains animal and would have been killed some distance from Swallow site. With only a few bone fragments identified at the site, the fragments were probably brought back with the associated meat or hides.

A few other notable species are absent from the site assemblage. There was no evidence of black-footed ferret or wolf among the bone fragments excavated at the site or on the Ludlow report.

Table 15.4. Number of individual specimens (NISP), minimum number of individuals (MNI), and NISP/MNI of food/use animals in the Upper Early Archaic levels.

Genus/species	NISP (percent)	MNI	NISP/MNI
Odocoileus hemionus (mule deer)	1,373 (87.0)	2	686
Sylvilagus audubonii (cottontail rabbit)	91 (6.0)	2	45
Cynomys ludovicianus (black-tailed prairie dog)	47 (3.0)	1	47
Indeterminate large mammal	31 (2.0)	ND	ND
Sciuridae sp. (squirrel)	9 (0.6)	1	9
Lepus californicus (jackrabbit)	3 (0.2)	1	3
Indeterminate medium mammal	7 (0.4)	ND	ND
Cervus elaphus (elk)	2 (0.1)	1	2
Bison bison (bison)	1 (0.1)	1	1
Vulpes sp. (fox)	1 (0.1)	1	1
Erethizon dorsatum (porcupine)	1 (0.1)	1	1
Meleagris gallopavo (turkey)	1 (0.1)	1	1
Total	1567	12	

Table 15.5. Number of individual specimens (NISP), minimum number of individuals (MNI), and NISP/MNI from the Lower Early Archaic levels.

Genus/species	NISP (percent)	MNI	NISP/MNI
Odocoileus hemionus (mule deer)	550 (86.0)	1	550
Sylvilagus audubonii (cottontail rabbit)	37 (6.0)	4	9
Indeterminate large mammal	31 (5.0)	ND	ND
Cynomys ludovicianus (black-tailed prairie dog)	3 (0.5)	1	3
Cervus elaphus (elk)	4 (1.0)	1	4
Canis latrans (coyote)	3 (0.5)	1	3
Lepus californicus (jackrabbit)	2 (0.3)	1	2
Indeterminate medium mammal	2 (0.3)	ND	ND
Erethizon dorsatum (porcupine)	2 (0.3)	1	2
Indeterminate Aves	1 (0.2)	ND	ND
Buteo sp. (hawk/falcon)	2 (0.3)	1	2
Ursus americanus (black bear)	1(0.2)	1	1
Bison bison (bison or buffalo)	2 (0.3)	1	1
Sciuridae sp. (squirrel)	1 (0.2)	1	1
Bubo sp. (owl)	1 (0.2)	1	1
Total	641	15	

These animals probably existed in the area during the time of occupation. The site contained an abundance of prairie dog bone fragments. Prairie dogs have always been a favored food source for black-footed ferrets, so it might be expected that ferrets were encountered and taken by hunters in pursuit of prairie dogs; however, no ferret bones were found at the site. Wolves also were known to be in the area prehistorically, though the last of the wolves disappeared from the area in the

1930s. With the abundance of deer in the site area, wolves probably were present during the time of occupation; however, no wolf bones were identified. These species may have eluded hunters or may not have been considered prey species.

A variety of carnivores and scavengers was recovered, including bobcat, badger, raccoon, coyote, fox, bear, weasel, skunk, and dog, all in relatively small numbers. These species may have been hunted for their fur as much as for food. Many of these bones showed no evidence of use (burning or butcher marks), though some fox and coyote bone, which occurred with greater frequency than other carnivore bone, showed both cut marks and burning indicative of butchery and cooking, and burning was also present on raccoon bone. The lack of evidence on the other taxa may be more a factor of sample size than use; however, it is also possible that animals like badgers, weasels, and skunks may have come into the shelter as scavengers, hunters, or prey and do not represent human activities. Bear (*Ursus americanus*) was represented by only two canine teeth. One of the canine teeth was larger than the other one and indicated that one of the bears was a much larger and older animal. Since a bear is a very large and formidable animal, most of the bones would have been left at the kill site. No other bone fragments were identified as bear at the site. Bear teeth, especially canine, were often used for display and may have been carried for some time from another location, rather than representing local hunting.

Evidence of use was found on a variety of small species as well, including squirrel, prairie dog, jackrabbit, porcupine, and turtle, confirming their economic value. Though small, these may have been locally available animals that were easily taken with passive hunting strategies like snares and played a role in subsistence that allowed occupants at the site to extend their stay without exhausting a single preferred food resource. Burrowing, colony-dwelling animals like prairie dogs and ground squirrels can be predictably found in a known location and could be strategically harvested to provide fresh meat when deer could not be found, or when other activities, such as the harvest of an abundant plant resource, made a hunting foray inconvenient. Taphonomy indicating use cannot be confirmed for muskrat, marmot, skunk, weasel and dog. Muskrat and marmot are not likely to have occurred at the site location naturally, as it was not an environment those species favor, but it is not impossible that they arrived in the shelter as prey of another species such as a large raptor or coyote. The presence of domestic dog bones and the lack of cut marks or burning on them suggest that dogs may have contributed economically more through hunting, guarding and carrying loads than serving as a food source.

A variety of avian taxa was also recovered. Birds likely served a variety of economic roles: they were eaten, and bird bones were modified into beads. Feathers were commonly used by indigenous people for decoration and arrow fletching. There were 165 (0.33%) food/use bird bone fragments found at the site, 90 in the EC, 70 in the MLA, 1 in the UEA, and 4 in the LEA levels (see Tables 15.2-15.5 for number and MNI of taxa by cultural period). Though some bird bones, such as turkey, goose, and prairie chicken, are well known for their food value, none of the bird bones from the following taxa were burned or human modified:

- Six (0.001%) turkey (*Meleagris gallopavo*) bone fragments were found.
- Two (0.001%) turkey vulture (*Cathartes aura*) bone fragments were found.
- Nine (0.002%) pigeon (*Columba sp*.) bone fragments were found.
- One (0.001%) goose (*Branta canadensis*) bone fragment was found.
- Four (0.008%) prairie chicken (*Tympanuhcus sp*.) bone fragments were found.
- One (0.001%) gull (*Larus sp*.) bone fragment was found.
- Five (0.001%) dove (*Zenaida sp*.) bone fragments were found.
- Thirty (0.59%) crow (*Corvus sp*.) bone fragments were found.
- Two (0.01%) medium sized indeterminate bird bone fragments were found.

Burning and/or butchering was evident, confirming use of eagle, owl, hawk/falcon, and duck. In addition, these and other avian species bones were used in the manufacture of beads (discussed below under site activities).

A variety of small birds, not generally considered food species, was also recovered from the site. On the whole, these were classified as intrusive animals; however, as with most small species, it is difficult to distinguish use from intrusion. While small birds were classified as intrusive, some small bird bone was burned, and some was manufactured into beads, indicating that some of it was, in fact, used. A more detailed analysis of intrusive bone is undoubtedly warranted, but beyond the scope of the current report. This issue is discussed more thoroughly in the Intrusive Taxa section below.

Relative Abundance and Diversity

Because of differences in size, Number of Individual Specimens Present (NISP) can pose difficulty when comparing the relative abundance of taxa that make up a highly fragmented assemblage like that of Swallow site. A single deer skeleton can fragment into far more pieces than the skeleton of a chipmunk. For this reason, the Minimum Number of Individuals (MNI) statistic is used to evaluate relative abundance of different taxa at a site.

MNI for all taxa identified at Swallow are shown on Tables 15.2 through 15.5. It is important to note that MNI has been calculated separately for each time period, which potentially elevates MNI, as it is possible that bones from one animal may cross over between stratigraphic units (see

Hesse and Wapnish [1985:114] for more details on this effect). While there is nothing wrong with this approach, it should be noted before MNI is compared to other sites where it is calculated for the site as a whole.

When comparing MNI, deer and rabbit remain the dominant species; however, it is quickly apparent that the MNI are much more similar than the NISP, with an MNI of 33 for deer and 27 for cottontail rabbit. The relative importance of prairie dog is notable as well, with an MNI of 17, followed by jackrabbit with an MNI of 8. All other taxa have fewer than 5 for all four time periods combined. This suggests that rabbit was taken with a frequency roughly equivalent to deer, and that prairie dog and jackrabbit were more systematically captured than the NISP numbers might imply. NISP, however, probably gives a better representation of the role of each in the diet, as one deer could feed more people for much longer than a single rabbit or prairie dog might. The very low MNI of all other species implies that they were taken infrequently, a similar conclusion to that drawn from NISP.

While relative frequency of most taxa is quite low, from a presence/absence standpoint, the overall diversity of the faunal record at Swallow is relatively high. Even in small quantities, the presence of this wide array of animals speaks to the catchment area accessed by hunters. Duck, goose, turtle, and muskrat demonstrate the utilization of wetland areas. Antelope, prairie dog, prairie chicken, and to a lesser extent bison suggest hunting on the open plains, while porcupine is a forest species and marmot a mountain animal. Given the location of Swallow in the Hogback valley, a location strategically situated in easy reach of all of these environments, it isn't surprising that hunters exploited them all, but the presence of these species in the faunal record confirms it.

Processing and Cooking Practices

In addition to information about what animals were hunted and eaten, human-caused taphonomic processes observed in the faunal assemblage contain a wealth of information about how meat was processed and prepared. The presence or absence of elements can indicate whether animals were processed at the site or before being brought to the site. Cut marks on bone show evidence of butchering practices, including disarticulation and removal of meat from bone. Burning can indicate cooking practices, and breakage patterns can indicate extraction of marrow or bone grease.

Elements Present

The presence or absence of different elements at a site can indicate whether animals were brought to the site whole or partially processed. Given the fragmentary nature of the assemblage at Swallow, a detailed analysis of elements present or absent isn't possible for all species, but it can be discussed for deer.

Relatively large numbers of all elements for deer, including skulls, vertebrae, metapodials, and phalanges were recovered, evidence that deer were brought to the camp whole. For example, in the

Late/Middle Archaic levels, 44 femurs and 35 tibia fragments were identified, while 85 metatarsal fragments were also identified. Tibia and femurs are among the most productive meat-bearing elements, while metatarsals have very little meat on them and are often left behind at processing sites when animals are partially processed before transport.

By contrast, well-known game species that are larger than deer, bison and elk, are underrepresented in the bone assemblage. Only 67 bison bone fragments were identified throughout the site, making up only 0.1% of the assemblage, while only 145 elk bones were present. The very small number and small size of bone fragments representing bison and elk suggest that the bison may have not been brought back to the site whole, as predicted by schlep effect theory. Schlep effect theory means the majority of the bones would not have been moved very far from where the bison died (Lyman 1994:224). The schlep effect can be defined as "the larger the animal and the further away from the point of consumption it is killed, the fewer of its bones will get schlepped back to camp." Therefore, if schlep effect accounts for the low number of bones for animals larger than deer, it should be testable through an examination of elements present; meat bearing bones (upper limbs, ribs, etc.) would be expected in greater frequencies than non-meat bearing portions (most notably skulls, lower limbs).

Unfortunately, elements were not reported for these species for all levels. In the Lower Early Archaic levels, bison bone consisted of a skull fragment and a vertebra, while elk was represented by a fragment of antler. One nearly complete bison scapula, found in E5S Level 9 of the MLA period, may have been saved and brought to the site for some purpose. In MLA and EC levels, much of the bone identified as bison and elk consisted of long bone fragments, but the proportion of upper to lower limb bones is not clear (some of this may have been recorded, and a more thorough examination of the bone lab records could be revealing in this context but was not possible at the time of this writing).

The elements found, as far as they are known, do not necessarily support the hypothesis of meat transport, but the evidence is too sparce to be of much use. Antler is useful material that might be brought back to camp from a kill site. The presence of skull bones runs counter to the schlep effect argument, but vertebrae could be brought in with hump and rib meat, which were prized portions, and the scapula would also be present on a dressed carcass. Further support for schlep effect comes from the blood residue analysis on projectile points, which found blood residue from both bison and elk. Eight tools, comprising 25% of those with blood residue, tested positive for bison, suggesting active hunting of the species by site residents.

While schlep effect may account for the assemblage at Swallow, alternate explanations are possible. It could be that these species were not locally available at the time of year that people inhabited Swallow. Prehistoric migration patterns for elk and bison are not well understood, but it is possible that neither species was in great abundance around Swallow in the late fall/winter when the site was most likely occupied. It is noteworthy that Massey Draw, a nearby animal processing site with quantities of bison, shows consistent evidence of spring hunting (Anderson et al. 1994), drawing into question whether the two sites were in use at the same time or whether they represent different seasonal activities in the area. Elk and antelope are also present at Massey Draw in relatively higher amounts than seen at Swallow. Of the bison and elk bone present at Swallow, 13 elk bones and 10 bison bones (9% and 15% of the species totals respectively) were made into tools, indicating that they may well have arrived at the site as already-manufactured tools, made from animals acquired at a different point in the seasonal round of Swallow site occupants. Such a hypothesis could also account for the blood residue on projectile points.

Bison and elk are both larger than deer and therefore their absence may be explained by schlep effect theory, but the lack of antelope seems more likely to reflect hunting preference or a lack of animals in the area. Antelope are smaller than deer, so it would stand to reason that antelope would not likely be under-represented due to schlep effect if deer were not. Antelope remains are the least common of any big game (only 7 bones total), although it is possible that some portion of the deer-size bone contains antelope bone intermixed.

Small species, such as rabbits and prairie dogs, were likely brought back whole as well, as they are small, easy to transport, and most likely hunted in close proximity to the camp.

Butchering

Cut marks, or butchering marks, were present on 728 (1.5%) of the 49,845 food/use animal bone fragments at the site, indicating human use. This value is equal to the percentage of butcher marked bone fragments from the EC and MLA cultural periods. The UEA and LEA cultural periods contain 2.5% bone fragments with butcher marks. Bone fragments with butcher marks were dominated by

Table 15.6. Comparison of the number of food/use animal bones with butcher marks in the Early Ceramic, Middle-Late Archaic, Upper Early Archaic, and Lower Early Archaic levels (percent based on total number of butchered bone fragments per period).

Genus/species	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (Deer)	217 (76.1)	344 (87.1)	23 (85.2)	15 (71.4)	599 (82.3)
Sylvilagus audubonii (Rabbit)	44 (15.4)	21 (5.3)	2 (7.4)	5 (23.8)	72 (9.9)
Large indeterminate mammal	10 (3.5)	9 (2.3)	1 (3.7)	1 (4.8)	21 (2.9)
Medium indeterminate mammal	3 (1.0)	5 (1.3)			8 (1.1)
Cervus elaphus (Elk)	6 (2.1)	8 (2.0)	1 (3.7)		15 (2.1)
Canis latrans (Coyote)	3 (1.0)	3 (0.8)			6 (0.8)
Lepus californicus (Jackrabbit)		1 (0.3)			1 (0.1)
Antilocapra americana (Antelope)		1 (0.3)			1 (0.1)
Bubo sp. (Owl)	1 (0.3)				1 (0.1)
Aquila sp. (Eagle)	1 (0.3)	1 (0.3)			2 (0.3)
Indeterminate large Aves		1 (0.3)			1 (0.1)
Indeterminate Aves		1 (0.3)			1 (0.1)
Total	285 (39.1)	395 (54.3)	27 (3.7)	21 (2.9)	728

deer, followed by rabbit. Number and percent of bones with butcher marks for taxa by cultural period are shown in Table 15.6.

While the presence of butcher marks clearly indicates human use, their absence does not preclude it. Butcher marks generally result from dismemberment and/or filleting meat from bone, both of which are more necessary when processing large animals than small. Small animals can easily be roasted whole and pulled apart after the meat and connective tissues are softened by cooking, much as we might with a roast chicken today. It is therefore not surprising that butcher marks are more common on deer bone and largely absent from smaller animals found at the site. Cut marks on bird bone, particularly on wings can also be indicative of removal of feathers. The only bird bone in the assemblage with cut marks are owl and eagle, which may indicate this activity rather than butchering for food.

Burning

Burning can occur on bone post-use, as a result of waste bone being dropped into fires after meals (either deliberately or accidentally), but it can also be evidence of cooking practices. Roasting meat portions still on the bone in hearths or earth ovens, where exposed bone is in contact with direct heat sources, results in burning to bone, while cooking practices such as boiling meat, where heat is applied indirectly, does not burn bone. Burning due to cooking over direct heat is most likely to occur on parts of the bone where meat is thin or absent, such as on the epiphyses of disarticulated joints, or on elements like skulls or lower legs where flesh is thin. Unfortunately, due in part to the highly fractured nature of the assemblage, location of burning and element burned was not always evident and was not recorded. Thus, it is difficult to know how much of the bone was burned while fleshed versus after all meat was removed from it.

Of the food/use animal bone fragments in the site 16,066 (32%) were burned. The majority of the burned bone was deer; however, the overall percentages of burned bone are in part a function of overall frequencies of different species present at the site (the majority of bone was deer, so it is not surprising that the majority of burned bone was also deer). More enlightening than overall percentages, therefore, are different rates of burning as it occurs in different species (Table 15.7).

Table 15.7. Percent of burned deer and rabbit bone in each time period.

Time Period	Species	Burned	Total	Percent
Early Ceramic	Deer	6,477	19,748	33
	Rabbit	277	1,402	20
Middle-Late Archaic	Deer	7,927	23,115	34
	Rabbit	264	1286	21
Upper Early Archaic	Deer	523	1,373	38
	Rabbit	20	91	22
Lower Early Archaic	Deer	241	550	44
	Rabbit	19	37	51

Comparing deer and rabbit, the two species that make up the majority of the assemblage of both bone and burned bone (and the two species with high enough totals to be statistically valid), a consistent pattern emerges in the Upper Early Archaic through the Early Ceramic. Through these time periods, 33-38% of all deer bone showed burning, while only 20-22% of rabbit bone was burned, with only slight variation through time. This suggests that deer was more frequently roasted on the bone in hearths or earth ovens, while rabbit was more frequently cooked in ways that did not produce burning on bone, such as boiling. This pattern persists from the Archaic into the Early Ceramic levels, suggesting that the introduction of pottery did not significantly alter cooking strategies, at least not where meat was concerned.

In contrast, the Lower Archaic levels, occurring below the rockfall, show a different pattern, in which more of both deer and rabbit bone was burned, with 44% of the deer bone burned, while 51% of the rabbit was burned. This suggests different cooking strategies at the site in the Lower Early Archaic, with both small and large animals being cooked over direct heat. It may be that different cooking traditions were practiced at the beginning of the Archaic, shifting into a more consistent pattern later in time. Alternatively, it might indicate a different usage of the site. For example, in a short-term camp, hunters might spit and roast a rabbit rather than engage in the more labor-intensive practice of stone boiling a soup or stew. The lack of constructed hearth features below the rockfall and the relatively small amount of fire-cracked rock in the lower Early Archaic levels support an interpretation of more expedient cooking practices, such as roasting disarticulated parts of both large and small game directly over a fire. Whether that difference was due to different site usage (shorter term, for example) or due to different traditions common to the period is not clear.

Breakage

Another human taphonomic process that is quite evident in the Swallow assemblage is bone breakage. Humans deliberately break bones for a variety of reasons—to dismember a carcass, manufacture tools, extract marrow, and extract bone grease. In addition, bone can be broken by trampling, a process likely to occur at a site that sees continuous use or frequent reuse through time, as Swallow did, and by non-human post-depositional processes, which are discussed below.

The bone at Swallow shows a high level of breakage, with fragments measuring on average around 5 cm in length and 0.6-1.3 cm in width. Another way to evaluate the degree of breakage is by comparing NISP to MNI. Bone breakage increases NISP, but typically decreases MNI, as the more fragmentary the bone, the harder to identify elements and verify different individuals. At Swallow, the NISP per MNI is high—for deer, it is 1062 NISP/MNI and for rabbit 105 NISP/MNI—indicating substantial breakage.

This high level of breakage is not unusual for residential sites in the area, and is frequently attributed to bone grease extraction, a process in which bone is deliberately fractured into small pieces and boiled, then the grease skimmed off (Vehik 1977). Bone grease was reported to be consumed straight or used in the manufacture of pemican (Bamforth 2011:27) or as a flavorful addition to soups or gruels. The possibility of extensive grease processing at the site is supported by the dense levels of fire-cracked rock. These rocks could be the accumulated waste from episodes of stone boiling, in which hot rocks were moved from fires to bags or baskets filled with water and bone to heat them. Metcalf and Black (1991) and Speth and Speilmann (1983) suggest that bone grease extraction is indicative of winter camps, where harsh conditions make game scarce and very lean when it is captured. The fat that can be extracted from bone can therefore be an important source of calories and fat-soluble nutrients in winter. Some ethnographic accounts suggest that bone grease extraction was not limited to any particular season (Leechman 1951:355), but accounts of Ojibwa and Crow practices suggest it was a winter activity for those tribes (Vehik 1977:169).

Another human process that can result in high breakage of bone is trampling. At sites where occupation is continuous for long periods, foot traffic can break bone litter into smaller and smaller pieces over time. In addition, in a site like Swallow that may have been occupied seasonally, bone from previous occupations would dry out and weather during times when the site was unoccupied, then be vulnerable to dry breakage when people returned to the site and trampled it. While it is difficult to know how much of the breakage was due to processing versus trampling, the assemblage does show evidence of both green and dry breaks. Green breaks, especially spiral or percussive breaks dominate in the assemblage. These are more likely evidence of deliberate breakage for processing but can result from trampling as well (Binford 1981:77). Dry breaks, by contrast, indicate post-depositional damage.

The NISP/MNI ratio is substantially higher in the Early Ceramic and Late/Middle Archaic layers than in the Early Archaic Layers, peaking in Early Ceramic times when features, artifact densities, and soil staining all indicate higher populations and/or more frequent occupation at the site, suggesting that some of the breakage is due to human trampling. This is corroborated by the distribution patterns of highly fragmented bone that could not be identified to taxa. This bone was sorted into two categories, fragments that were larger than 15 mm and those smaller than 15 mm, then counted and recorded for each level. Units/levels with more than 500 small fragments were then plotted on the site map (Figure 15.1). The greatest concentration of these bone fragments during the Early Ceramic cultural period is seen in the C and E grids in Levels 3 through 6. The only concentration seen in Level 2 occurs in C2N. In Level 3, concentrations are seen in C2N, C2S, and in E2S, E3S, and E4S. In Level 4, concentrations are seen in C2N and C4S as well as in E2S, E3S and E4S. In Level 6, the concentrations occur in C3S and C4S and in E2S and E3S. A concentration of these bone fragments occurs rather consistently in E2S, E3S, and E4S, but shrinks in volume to only in E2S and E3S in Level 6.

This concentration pattern falls roughly along the line of features and through the central part of the site, where foot traffic would be heaviest. It also correlates with the densest layer of fire-cracked rock at the site and may represent fragments of bone removed from roasting pits or boiling bags along with those rocks, then further crushed by foot traffic in the shelter. The gap in distribution through the middle (primarily the D grid squares) follows the drip line of the shelter. This gap is therefore likely the result of natural processes, as runoff from the shelter washed small bone downslope to

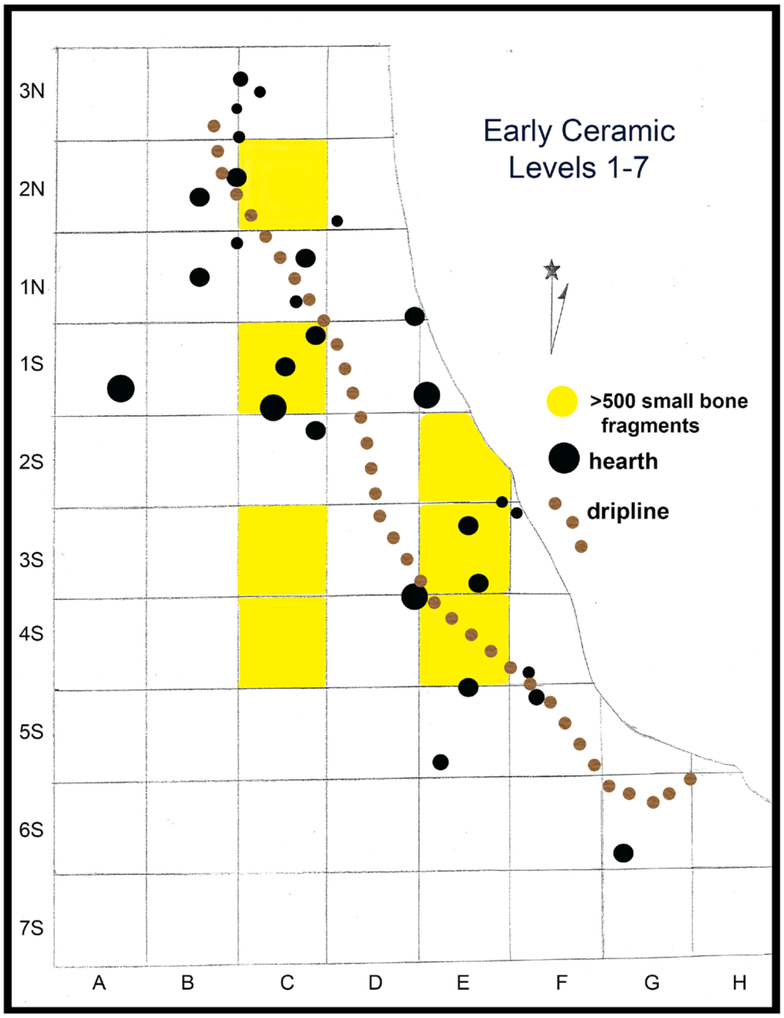

Figure 15.1. Areas with high concentrations of small bone fragments, suggesting trampling in high traffic areas. The gap in the distribution through the center of the site may be due to the effects of water washing off the rock overhang.

the west. It should be noted that cattle sheltered on the site in modern times, and the resulting hoof action undoubtedly broke bone and other materials in the upper levels (Early Ceramic), so some of the dry bone breakage should be considered recent, post-depositional, and non-cultural in nature, but as green bone breakage is also common, human trampling clearly occurred.

The only other concentrations of more than 500 small fragments outside of the Early Ceramic levels occurred in two units in the MLA levels. The first of these is in C1N, Level 8, and may represent material from the above Early Ceramic levels that was pushed downward by trampling, but may also represent the final occupations of the Late Archaic. The second MLA concentration occurs in Levels 16 and 18 in C3S, on the outer edge of a concentration of features in the central/southern part of the site and may indicate foot traffic patterns around this busy activity area. Fewer bone fragments occur in the Early Archaic levels and no concentrations can be identified.

Site Usage

In addition to what they tell us about foodways, faunal remains offer insight to other aspects of site occupation as well. The first of these is seasonality. While the evidence is limited, there is at least a suggestion in the faunal assemblage that Swallow was occupied in the fall and/or winter. One skull fragment with the antler still attached was found, indicating that the deer had not yet shed its antlers at the time it was killed. Since antlers mature in fall and are usually shed in May to June, this suggests a winter kill. In addition, two fragments of bone from juvenile deer were recovered, one in the Early Ceramic and one in the Middle/Late Archaic layers. Both were aged around 2- 4 months old. Mule deer typically give birth in June to early July, which suggests a late summer to fall kill.

Site Activities

There are two basic ways of accumulating bones that are found at a site, active and passive. Active accumulation involves moving skeletal parts away from where the animal was killed. Areas with human habitation and animal dens are examples of active sites. These sites have large numbers of teeth and bone fragments present. An example of a passive site would be a bison kill site (Lyman 1994:224). The large number of deer bone fragments brought into the site as well as fire pits and

Table 15.8 Comparison of total number of worked bone items made from the various food/use animal bone fragments in the Early Ceramic, Middle-Late Archaic, Upper Early Archaic, and Lower Early Archaic levels (percent based on total number of items per period).

Genus species	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (deer)	201(71)	284 (75.1)	21 (72.4)	18 (64.3)	524 (73.0)
Large indeterminate mammal	11 (3.9)	24 (6.3)	5 (17.2)		40 (5.6)
Medium indeterminate mammal		3 (0.8)			3 (0.4)
Sylvilagus audubonii (rabbit)	50 (17.7)	30 (7.9)	3 (10.3)	9 (32.1)	92 (12.8)
Cervus elephus (elk)	4 (1.4)	9 (2.4)			13 (1.8)
Homo sapiens (human)	1 (0.4)				1 (0.1)
Bison bison (bison)	3 (1.1)	7 (1.8)			10 (1.4)
Canis latrans (coyote)	3 (1.1)	3 (0.8)			6 (0.8)
Vulpes sp. (fox)		3 (0.8)			3 (0.4)
Lepus californicus (jackrabbit)		1 (0.3)			1 (0.1)
Family Chelydridae (turtle)		3 (0.8)			3 (0.4)
Indeterminate Aves (bird)	10 (3.5)	11 (2.9)		1 (3.6)	22 (3.1)
Total	283(39.3)	378 (53)	29 (4.4)	28 (3.9)	718

stone artifacts indicate active accumulation at a multiple activity occupation site as opposed to a kill site or limited activity site.

Modified bone (tools and decorative objects) also speak to a range of activities. A total of 718 items of worked bone was recovered (Table 15.8). The most common tool type was the awl; 263 awls were recovered from all cultural levels at the site. Use wear studies and ethnographic accounts indicate that awls were used for a variety of purposes, including hide processing, leather work, quill work, basketry, matting, and textile plaiting and weaving. Plains ethnographies identify bone tools, especially awls, as essential elements of a woman's tool kit, to the extent that awls were symbolic of womanly virtue in a variety of contexts (Sundstrom 2002), and a comparison of use wear on archaeological and historic bone tools conducted by LeMoine (1994) found that prehistoric assemblages showed use patterns similar to their historic counterparts, indicating the validity of ethnographic analogies for the use of bone awls (though not for other types of bone tools). Awls remain connected to women's work into contemporary times; an awl case is part of powwow regalia for traditional female dancers and symbolizes industriousness (St. Pierre and Long Soldier 1995).

Awls found at Swallow showed a variety of use wear in terms of polish, rounding of edges and surfaces, worn notches, and fine striae consistent with use on a variety of materials. Notching on awls is attributed to basket and textile working, while polish and striae can result from use on a variety of materials. Their presence at Swallow suggests women's work at the site, including the manufacture of leather goods and baskets.

The second most common tool type was the "generic" tool. These are expedient tools, formed from sharp splinters of bone that functioned primarily as awls with minimal modification. In a use wear study of bone tools from the American Southwest, Mobley-Tanaka and Church (1989) reported that such expedient tools more frequently showed wear from multiple activities while more formal awls showed wear from fewer uses. Expedient tools also more frequently had attrition scars on their tips, suggesting they were used in activities likely to damage the tool, while more finely crafted awls were preserved for less damaging activities. (Anyone who has gotten caught using a seamstress's best sewing scissors on paper can probably imagine a scenario where a favorite basketry awl was NOT to be used for punching holes in tough hide.)

Griffitts (1997) examined both expedient and formal bone tools from a short-term bison processing site in Texas and found use-wear indicative of both plant and animal materials, suggesting that bone tools had varied uses even at short term, limited activity sites. While such detailed wear analysis has not been done on the Swallow assemblage, the presence of both formal and expedient tools speaks to a variety of activities, undertaken by people, quite possibly women, who had the time and forethought to make and use tools best suited for the tasks at hand, crafting quick expedient tools for activities likely to damage the tool and using more finely crafted tools for the more delicate, skilled work.

The third most frequently occurring tool in the assemblage is the scraper, many of which had high polish. Two varieties of scrapers were recorded. Ones with rounded, spatulate ends, frequently called "fleshers" in the archaeological literature, have often been considered hide-working tools by archaeologists, but a use wear analysis by Mobley-Tanaka and Griffitts (1997) on fleshers recovered from several southwestern sites found that they, too, were multifunction tools, showing wear indicative of use on silica-rich plants, leather, and even clay or soil. While they are used on materials similar to the materials awls are used on, their flat, spatulate blade, as opposed to the sharp point on awls, indicates different activities, such as defleshing or removing hair from hides, stripping pulp from fibrous leaves (such as yucca, cattails, or grasses that produce fibers suitable for string when stripped), digging, or smoothing clay (in Ceramic times).

A second variety of scraper was also recorded in the Swallow assemblage. These tools have a serrated edge, rounded from use. In the same use wear study, Mobley-Tanaka and Griffitts (1997) found that these tools were exclusively used to strip fibrous plant leaves in order to prepare fibers for textile production. The presence of both scrapers and awls at the site suggests that all stages of manufacture took place there, from preparing the initial materials (both leather and plant materials) to fashioning the prepared materials into baskets, bags, clothing, mats, and other useful household items. Awl and scrapers were found in all cultural levels at the site. Other bone tools included gravers, gouges, and abraders or smoothers, which only occurred in small numbers in EC and MLA levels but indicate that a wide variety of activities occurred at the site. These are activities that may have been best completed at winter camps when less frequent moves, longer periods of cold weather that limited activity, and less work collecting and preserving plant foods provided the opportunity to engage in craft production.

Bone ornaments were also relatively abundant at the site and found through all periods of occupation. Bone beads of at least two forms were present; flat disc beads, frequently made of deer bone, and tube beads made from the shafts of rabbit and bird long bone. Unfinished tube beads or cut ends of bone from the manufacture of tube beads indicates that these ornaments were both made and used at the site. In addition, grooved elk and deer teeth were recovered which were probably attached to clothing or worn as pendants. Two bear canines were found, despite the lack of any other bear bone, suggesting they were curated for ornamentation. Worked turtle shell and a single mollusk shell shaped into a bead were also found.

Finally, 17 fragments of bone decorated with punctate designs were recovered, primarily from the Middle/Late Archaic levels. A sample from one fragment was radiocarbon dated to 4760 ± 60 14C yr BP – 3635-3386 BC (1 sigma) (PRI 6018 – Date 22 in Chapter 5), confirming a Middle Archaic age, though fragments were found scattered from Levels 3-24. All items were made from flat bone that had been carefully prepared through burning, removal of cancellous tissue, and smoothing and polishing the surfaces before series of small holes were drilled to create linear punctate designs. The bone appears to have been intentionally burned to produce a light gray exterior and a black interior portion of the bone, so that the drilled dots penetrate the gray exterior and expose the black interior, creating a line of black dots. Four pieces (two of which could be connected) had larger holes drilled through, indicating they were designed to be attached or suspended in some way; however, the fragments could not be reconstructed into a recognizable object, nor could the number of objects they represent be ascertained. One fragment had an incised/painted porcupine image beside the punctate design, suggesting that the item(s) originally had other embellishment beyond the lines of dots. (For more detailed descriptions and illustrations, see Hammond et al. 2018.)

In a literature review from the Hogback valley and vicinity, nothing analogous to these fragments was found. Decorated bone was found at two nearby sites, Bradford House III (Johnson and Lyons 1997:68) and LoDaisKa (Irwin and Irwin 1959:69); however, in both cases the pieces were small, rectangular and unbroken, and were identified as gaming pieces. The Swallow fragments appear to have made up something larger and the drilled holes indicate they served a different purpose. This unusual technique of creating designed bone items appears to be either a Swallow site invention or an import from outside the area. It is a feature that distinguishes the people who occupied Swallow site from those at nearby rock shelters in the same cultural period.

The frequency of ornaments at the site may indicate that social or ritual gatherings occurred during the site occupation. It is quite possible that the cluster of rock shelters on the Ken-Caryl Ranch were ideal for winter aggregation of groups that were widely scattered through the summer months. Ethnographically, social gatherings were important activities in such aggregated winter camps, resulting in more effort on ornamentation and social display. It is also possible that long stays at winter camps afforded more time for people to engage in the manufacture of nonutilitarian items.

Post-Depositional Processes

In addition to human usage, the faunal assemblage has been significantly impacted by post-depositional processes, including the action of a variety of intrusive species, the most impactful being rodents and carnivores, as well as weathering, and in the recent past, cattle trampling. All of these have undoubtedly added to the overall fracturing of bone, to the removal of small bone from the assemblage, and to the presence or absence of bone in various levels.

Intrusive Taxa

The remains of intrusive species arrived at the site for a variety of reasons. Most were animals that inhabited the location. Burrowing rodents frequently colonize human habitations, attracted by the soft, disturbed sediments and food remains. Snakes, frogs, and toads utilize rodent burrows for shelter, and in the case of snakes, utilize the rodents for food. A variety of birds, both large and small, make use of the sandstone shelter for nesting and shelter. Rodent and frog/toad bone fragments were found in owl pellets such as the one found in D1S Level 5. Owls nested on the rocks above the site during some dig seasons and probably found the area appealing due to the presence of a food supply such as the rodents, frog/toads, and young cliff swallows. Large eggshells, probably from the owls' nests, were found in the soil at the site. The eggs could have been eaten by the human inhabitants at the site or dropped out of the nest when it was cleaned by the owls. Domestic cattle (*Bos taurus*) are known to have been an intrusive species present at the site in historic times. Quantities of cattle dung were present on the surface and in the upper levels of the site, and churning of the surface levels due to hoof action was evident. Cattle must therefore be considered as an intrusive species at the site that did impact it, even though no identifiable cattle bone was found. It is possible that a small amount of cattle bone is intermixed with the unidentifiable large mammal bone.

Relying on lists of known use animals and typical intrusive animals at archaeological sites, the Swallow bone lab identified all rodents, snakes, amphibians, and most small birds as intrusive species, regardless of condition of the bone. Some burning, cut marks, or other modification on intrusive bone was observed, however, indicating that some of the animals identified as intrusive were, in fact, utilized. This problem was particularly evident for small birds. Swallows and other small birds nested on the rock overhang of the shelter, making the inclusion of their intrusive bones at the site inevitable; however, some small bird bone bore cut marks or were fashioned into beads, clear evidence of use. In general, more work is needed in archaeology to better identify utilization of small species like songbirds and rodents; the latter frequently occur burned in hearths, and some ethnographic examples can be found of their utilization. Small birds may have been utilized for such things as colored feathers. Efforts to differentiate possible used versus truly intrusive small species at Swallow is beyond the scope of the present analysis. Intrusive species are discussed here with the caveat that the list undoubtedly contains some creatures that were utilized by humans but cannot be clearly differentiated from those that were not.

A total of 7,094 bones and bone fragments was identified as from intrusive animals. Seventy-nine percent of the intrusive bone (NISP=5,615) was from rodents such as woodrat, ground squirrel, kangaroo rat, chipmunk, pocket gopher, mouse, vole, and indeterminate rodents. Sixteen percent (NISP=1,145) were snake, frog/toad, and salamander bones and bone fragments, and the remaining 5% (NISP= 334) were from small birds. Most (97%) of the intrusive animal bones were found in the EC and MLA cultural periods, and only the remaining 3% in the UEA and LEA cultural periods. This may indicate that most of the intrusive taxa entered the deposits after the site was no longer occupied and filtered down into deeper levels through rodent tunneling and other forms of bioturbation; however, it should be noted that 95% of use bone also occurred in the EC and MLA levels, so this presence of intrusive taxa in similar proportions to non-intrusives does not strongly support that conclusion. Certainly, rodents and other creatures attracted to human occupations were likely to have made use of the location between and even during episodes of human occupation, when the fresh debris provided by humans was a tempting food source.

Mice, voles, and pocket gophers were the most abundant rodents found, accounting for 55% of all rodent bones. The remaining 24.4% were indeterminate small and medium rodents, woodrats, ground squirrels, kangaroo rats, and chipmunks.

The 650 snake bones consisted mostly of whole ribs and vertebra, indicating that they were

Table 15.9. Intrusive animals bone fragments in the Early Ceramic, Middle-Late Archaic, Upper Early Archaic, and Lower Early Archaic levels (percent based on total bone fragments per period).

Genus species	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Bos Taurus (cow)	--	--	--	--	--
Indeterminate medium rodent	72 (2)	74 (1.9)	7 (5.0)	--	153 (2.0)
Indeterminate small rodent	223 (7)	277 (7.0)	16 (11.0)	6 (9.0)	522 (7.4)
Neotoma sp. (woodrat)	221 (7)	235 (6.1)	6 (4.0)	5 (8.0)	467 (6.6)
Spermophilus sp. (ground squirrel)	260 (8.5)	285 (7.4)	9 (6.0)	3 (5.0)	557 (8.0)
Dipodomys ordii (kangaroo rat)	8 (0.3)	11 (0.3)	--	--	19 (0.3)
Eutamius sp. (chipmunk)	6 (0.2)	--	--	--	6 (0.08)
Thomomys talpoides (pocket gopher)	707 (23)	1,140 (30.0)	48 (34.0)	20 (31.0)	1,915 (27.0)
Peromyscus sp. (mouse)	351 (12)	478 (12.5)	15 (10.0)	5 (8.0)	849 (12.0)
Microtus sp. (vole)	430 (14.0)	676 (18.0)	16 (11.0)	5 (8.0)	1,127 (16.0)
Snake	277 (9.0)	350 (9.0)	10 (7.0)	13 (20.0)	650 (9.0)
Frog/toad	305 (10.0)	118 (3)	12 (8.0)	2 (3.0)	437 (6.0)
Ambystoma tigrinum (salamander)	16 (0.5)	42 (1.1)	--	--	58 (0.8)
Indeterminate Aves	36 (1.0)	24 (0.6)	3 (2.0)	1 (2.0)	64 (0.9)
Pica pica (magpie)	9 (0.3)	4 (0.1)	--	2 (3.0)	15 (0.2)
Turdus migratorius (robin)	43 (1.0)	34 (0.9)	--	2 (3.0)	79 (1.0)
Spizella sp. (sparrow)	17 (0.5)	28 (0.7)	--	--	45 (0.6)
Petrochelidon pyrrhonota (cliff swallow)	16 (0.5)	--	1 (1.0)	--	17 (0.2)
Bombycilla cedrorum (cedar waxwing)	7 (0.2)	10 (0.3)	--	--	17 (0.2)
Cyanocitta cristata (bluejay)	5 (0.2)	5 (0.1)	--	--	10 (0.1)
Pheucticus sp. (grosbeak)	6 (0.2)	3 (0.08)	--	--	9 (0.1)
Loxia sp. (crossbill)	1 (0.03)	1 (0.03)	--	--	2 (0.03)
Sternella neglecta (meadowlark)	7 (0.2)	5 (0.1)	--	--	12 (0.2)
Junco hyemalis (junco)	5 (0.2)	3 (0.08)	--	--	8 (0.1)
Agelaius phoeniceus (black bird)	3 (0.1)	10 (0.3)	--	--	13 (0.2)
Carpodacus mexicanus (house finch)	8 (0.3)	4 (0.1)	--	--	12 (0.2)
Quiscalus quiscala (common grackle)	2 (0.06)	1 (0.03)	--	--	3 (0.04)
Pipilo erythrophthalmus (towhee)	5 (0.2)	1 (0.03)	--	--	6 (0.08)
Calaptes cafer (red-shafted flicker)	9 (0.3)	6 (0.1)	--	--	15 (0.2)
Charadrius vociferus (killdeer)	1 (0.03)	--	--	--	1 (0.01)
Chordeiles minor (common nighthawk)	1 (0.03)	--	--	--	1 (0.01)
Calamaspiza melanocarys (lark bunting)	--	2 (0.05)	--	--	2 (0.03)
Salpinctes absoletus (rock wren)	1 (0.03)	1 (0.02)	--	--	2 (0.03)
Calcarius ornatus (longspur)	--	1 (0.02)	--	--	1 (0.01)
Total	3,058(43.1)	3,829 (54.0)	143 (2.0)	64 (0.9)	7,094

intrusive and not food/use bone. The snakes at the present time and during the occupation periods at the site consisted of mostly rattlesnakes and bull snakes. The frog/toad and salamander bones accounted for 6.8% of the intrusive bone. Frog/toad bones could not be identified to the species level, but given the dry environment in the rock shelter, Woodhouse's toad is the most likely native species to have occupied the site. The remaining intrusive animal bones found at the site were from small birds which account for 4.5% of the intrusive animal bones and bone fragments. These were primarily bones from robins and sparrows, although a number of small bird taxa were identified as intrusive (Table 15.9).

Intrusive bone fragments from the EC period totaled 3,058 fragments or 11% of the total bone in the EC levels. Intrusive bone fragments in MLA levels totaled 3,829 or 13% of all recovered bone in those levels. Intrusive bones identified from the UEA totaled 143 or 8% of all bone, and in the LEA totaled 64, or 9% of all bone in those levels. In all cases, the assemblage is dominated by rodents, most notably pocket gopher, followed by vole and mouse. Ground squirrels, woodrats, and frogs/toads are also relatively common, while a wide variety of other species are represented in much smaller numbers (Table 15.9).

Intrusive species, particularly rodents, can be useful in environmental reconstructions, since rodents seldom travel far from their place of birth and different species within a genus or family can be environmentally sensitive. Unfortunately, at Swallow, rodent identification to the species level was not possible, and even if it had been, bioturbation of the site and other rodent impacts (see below) undoubtedly moved small bones in ways that make comparisons of different levels suspect. Therefore, while this list of intrusive species might be fertile ground for more detailed future analyses of environment, the overall difficulties of both identification and stratigraphy make such interpretations impossible at this time.

Rodent Impacts

Rodents are not only the most common intrusive taxa at the site, but they are also the most responsible for post-depositional modifications to the site and the faunal assemblage. Rodent tunnels and the associated displaced sediment and soil from rodent tunnels created significant mixing of materials (see Chapters 4 and 5 for more detail). In addition, rodents move and damage bone because of their need to gnaw, which they do to grind down their incisors. Not only does gnawing damage the bone itself, potentially eliminating small bone fragments from the record all together, but rodents also transport and store bones in the burrows to gnaw on, which means the active displacement of bone fragments vertically in the site.

One hundred twenty-seven (0.3%) of the 49,845 food/use animal bone fragments in the site were rodent gnawed. This percentage is seen in the EC, MLA and UEA levels. In the LEA levels, the percentage increased to 1.5%.

At Swallow site, deer bone makes up the majority of gnawed bone. Of the 127 identified food/use animal bone fragments that were rodent gnawed, 111 were deer bone fragments. With the exception of one squirrel bone, all of the rodent gnawed bone was that of medium- to large-sized mammals. This is most likely because the denser, thicker bone of large mammals provided tougher material for grinding the teeth than light, fragile bone of birds or small mammals.

Gnawing activity was most prevalent in the MLA levels. The animals that were probably responsible for the gnawing were the invasive rodent species identified above, which colonized the site both during and after its occupation. While rodents will gnaw bone in any state of aging/weathering, they do show a preference for fresh or greasy bone (Marginedas et al. 2023), yet another attraction for burrowing rodents to colonize a human camp site very quickly after the human occupants leave. No rodent bones were gnawed on. Number and percent of rodent gnawed bone by taxa and cultural period are shown in Table 15.10.

Carnivore Damage

The last type of taphonomic processes distinguished in the faunal assemblage is carnivore chewing. Carnivore chewing is potentially post-depositional, with discarded bone scavenged by animals such as coyotes and foxes during periods of human absence, but some of it quite likely was the result of domestic dogs on the site that were given bones by their human companions. Domestic dog bone was found in the assemblage, indicating that dogs were occupants of the site along with humans. Like rodents, canines will chew bone in any state of weathering, but prefer fresh bone, suggesting that much of the carnivore damage, if not done by domestic dogs, was done soon after humans vacated the site. It is also possible that some carnivore chewed bone is the result of carnivores that brought their kills into the shade of the rock at times when humans were not present; however, the similar frequencies of species between chewed and non-chewed bone (dominated by deer, then rabbit, etc.) suggests that the chewed bone is mostly human food waste at the site.

Carnivore chewing was slightly more common than rodent gnawing, with 267 (0.5%) of the identified food/use animal bone fragments carnivore chewed. Carnivores identified at the site that could have been responsible for chewing bone included coyote, dog, fox, possibly bobcat and bear. Interestingly, none of the carnivore bone fragments at the site had been chewed by carnivores.

Table 15.10. Comparison of rodent gnawed food/use animal bone fragments in the Early Ceramic, Middle-Late Archaic, Upper Early Archaic, and Lower Early Archaic levels (percent based on total rodent gnawed bone per period).

Genus/species	EC (Percent)	MLA (Percent)	UEA (Percent)	LEA (Percent)	Total (Percent)
Odocoileus hemionus (Deer)	29 (85.3)	70 (93.3)	3 (33.3)	9 (100)	111 (87.4)
Sylivagus audubonii (Rabbit)	2 (5.9)	1 (1.3)			3 (2.4)
Large indeterminate mammal	2 (5.9)		5 (55.6)		7 (5.5)
Medium indeterminate mammal			1 (11.1)		1 (0.8)
Cervus elaphus (Elk)	1 (2.9)				1 (0.8)
Canis latrans (Coyote)		1 (1.3)			1 (0.8)
Vulpes sp. (Fox)		1 (1.3)			1 (0.8)
Bison bison (Bison)		1 (1.3)			1 (0.8)
Antilocapra americana (Antelope)		1 (1.3)			1 (0.8)
Total	34 (26.8)	75 (59.1)	9 (7.1)	9 (7.1)	127

Table 15.11. Comparison of number of food/use animal bone carnivore chewed in the Early Ceramic, Middle-Late Archaic, Upper Early Archaic and Lower Early Archaic levels (percent based on total carnivore chewed bone per period).

Genus/species	EC (percent)	MLA (percent)	UEA (percent)	LEA (percent)	Total (percent)
Odocoileus hemionus (Deer)	72 (79.1)	150 (91.5)	3 (50)	2 (33.3)	227 (85.0)
*Sylvilagus audubonii (*Rabbit)	12 (13.2)	7 (4.3)		3 (50.0)	22 (8.2)
Large indeterminate mammal	4 (4.4)	2 (1.2)	2 (33.3)		8 (3.0)
Medium indeterminate mammal		1 (0.6)	1 (16.7)		2 (0.7)
Cervus elaphus (Elk)	1 (1.1)	2 (1.2)			3 (1.1)
Lepus californicus (Jackrabbit)	2 (2.2)	1 (0.6)		1 (16.7)	4 (1.5)
Antilocapra americana (Antelope)		1 (0.6)			1 (0.4)
Total	91 (34.1)	164 (61.4)	6 (2.25)	6 (2.25)	267

They concentrated their activity on deer and other large species. This is typical of canine species that derive pleasure from chewing large bones even after most of the meat is gone from them. Carnivores will chew small animal bones, but their powerful jaws will often crush small bone completely, removing it from the record while larger bones remain intact but gouged by teeth, to be counted as chewed bone. The number and percent of carnivore-chewed bone by taxa and cultural period are shown in Table 15.11.

Conclusions

A substantial faunal assemblage was recovered from Swallow site and holds insights into subsistence and site use practices. The faunal assemblage suggests a somewhat tentative early occupation of the site that, toward the end of the Early Archaic, settled into a stable, effective strategy that then persisted through the remainder of site occupation. Deer and rabbits were most likely the staple foods in that adaptation, though mammals larger than deer may have been brought back to the site already butchered and are therefore underrepresented in the bone assemblage. Deer and animals smaller than deer were clearly brought back whole, as all elements are represented for deer, including those that were not prime meat-bearing portions. In addition to deer and rabbit, prairie dogs also contributed meaningfully to the diet. Throughout most of the occupation, cooking practices apparently centered on roasting deer in direct heat, while rabbit was more frequently cooked in ways that limited burning on bone.

The faunal assemblage also addresses other aspects of site use. A late fall or winter occupation is suggested, albeit tentatively, by a few bones of juvenile animals, a skull fragment with antlers, and the suggestion of intensive bone grease processing. Bone tools and ornaments at the site suggest a wide range of activities took place beyond subsistence activities, indicating a habitation site that may have been occupied for extended times through fall and winter, times when social and/or ritual gatherings may have been important activities.

Finally, evidence of carnivore and rodent damage and dry bone breakage indicate post-depositional damage to the assemblage that warrants consideration. Evidence for rodent tunneling combined with rodent gnawing on bone indicate that dirt and bone were moved around by rodents enough to confuse the stratigraphy, and therefore fine-grained temporal comparisons at the site must be undertaken with caution, particularly where small items, like bone fragments, are concerned.

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16

Pollen and Starch Analysis of Groundstone

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Introduction

Twelve metate fragments and a single ceramic sherd from the Swallow site in central Colorado were examined to provide evidence of vegetal foods that might have been processed. These metates were recovered from Levels 3 through 20, representing much of the stratigraphic sequence of occupation at this site. Radiocarbon ages associated with these levels range from 1150 to 6345 BP; however, there has been substantial bioturbation and mixing of deposits. The age of the levels ranges from the Early Ceramic period to mixed Early and Middle Archaic periods.

Methods

Pollen

A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for the removal of the pollen from the large volume of sand, silt, and clay with which they are mixed. This particular process was developed for extraction of pollen from soils where preservation has been less than ideal and pollen density is low.

Dilute hydrochloric acid was used to remove calcium carbonates present in the soil, after which the samples were screened through 150-micron mesh. The samples were rinsed until neutral by adding reverse osmosis deionized (RODI) water, letting the samples stand for 2 hours, then pouring off the supernatant, using Stoke's Law to calculate the settling appropriate time. A small quantity of sodium hexametaphosphate was added to each sample once it reached neutrality, then the rinsing was repeated every 2 hours. This step was added to remove clay prior to heavy liquid separation.

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Next, the samples were dried then pulverized. Sodium polytungstate (density 2.1) was used for the flotation process. The samples were mixed with sodium polytungstate and centrifuged at 2000 rpm for 5 minutes to separate organic from inorganic remains. The supernatant containing pollen and organic remains was decanted. The heavy liquid separation process was repeated, decanting the supernatant into the same tube that was used for the first separation. This supernatant was then centrifuged at 2000 rpm for 5 minutes to allow any silica remaining to be separated from the organics. Following this, the supernatant was decanted into a 50 ml conical tube and diluted with distilled water. These samples were centrifuged at 3000 rpm to concentrate the organic fraction in the bottom of the tube. After rinsing the pollen-rich organic fraction obtained by this separation, all samples received a short (10-15 minute) treatment in hot hydrofluoric acid to remove any remaining inorganic particles. The samples were then acetylated for 3 minutes to remove any extraneous organic matter.

A light microscope was used to count the pollen to a total of approximately 100 to 200 pollen grains at a magnification of 500x. Pollen preservation in these samples varied from good to poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen and may be interpreted to represent pollen dispersal over short distances or the introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram. Pollen diagrams are produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum. Pollen concentrations are calculated in Tilia using the quantity of sample processed (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted.

Indeterminate pollen includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These grains are included in the total pollen count, as they are part of the pollen record.

Groundstone were washed with distilled water and dilute hydrochloric acid to recover any pollen from the ground surfaces. Concentrations of pollen from the ground surfaces may represent plants ground using manos and metates. The ground surfaces had no appreciable quantity of dirt adhering to them. All ground surfaces were cleaned using pressurized air to remove modern contaminants. The ground surfaces were washed with distilled water and dilute hydrochloric acid and scrubbed with a brush to release all trapped pollen. The resulting liquid was saved and processed in a similar manner to the soil samples, with the exception that the heavy liquid separation was not used.

Ceramic Residue

Charred, organic residue recovered from ceramic sherds should represent residue of foods cooked in the vessel. A small ceramic rim sherd and adhering organic residue were cleaned of all visible dirt, then were cleaned using pressurized air to remove any modern contaminants. Following this, the ceramic sherd with organic residue was placed in a 600 ml beaker containing RODI water and placed in a sonicator to remove as much sediment from the porous residue as possible. Sonication removed some visible fine debris. Using a dental pick, the charred organic residue was removed from two small indentations or score marks along the rim of the ceramic sherd. This charred, organic residue was sieved through 150-micron mesh to help break it into smaller fragments, then placed in a centrifuge tube. The supernatant was removed by centrifuging and decanting. The charred, organic residue was treated with Schulze solution, a mixture of concentrated nitric acid and potassium chlorate, to which small quantities of concentrated (35%) hydrogen peroxide were added. The tube containing the sample and Schulze solution was placed in a beaker of hot sand to speed the chemical reaction designed to remove carbonized organic debris. When the reaction appeared to be complete, the tube was removed from the hot sand and centrifuged. The supernatant was decanted and RODI water was added to rinse the sample. Several RODI water rinses and centrifuge/decant cycles were completed; then the sample was rinsed with alcohol to prepare it for mounting on a microscope slide. A single microscope slide was made with the residue using a mixture of cinnemaldehyde and immersion oil. The sample was examined with a Nikon light microscope at a magnification of 500x. Phytolith diagrams are produced using Tilia.

Ethnobotanic Review

It is a commonly accepted practice in archaeological studies to reference ethnological (historic) plant uses as indicators of possible or even probable plant uses in prehistoric times. It gives evidence of the exploitation, in historic times, of numerous plants, both by broad categories, such as greens, seeds, roots, and tubers, etc. and by specific example, i.e., seeds parched and ground into meal which was formed into cakes and fried in grease. Repetitive evidence of the exploitation of resources indicates a widespread utilization and strengthens the possibility that the same or similar resources were used in prehistoric times.

Ethnographic sources outside the study area have been consulted to permit a more exhaustive review of potential uses for each plant. Ethnographic sources do document that, with some plants, the historic use was developed and carried from the past. A plant with medicinal qualities very likely was discovered in prehistoric times and the usage persisted into historic times. There is, however, likely to have been a loss of knowledge concerning the utilization of plant resources as cultures moved from subsistence to agricultural economies and/or were introduced to European foods during the historic period. The ethnobotanic literature serves only as a guide indicating that the potential for utilization existed in prehistoric times--not as conclusive evidence that the resources were used. Pollen and macrofloral remains, when compared with the material culture (artifacts and features) recovered by the archaeologists, become indicators of use. Plants represented by pollen are discussed in the following paragraphs in order to provide an ethnobotanic background for discussing the remains.

Native Plants

Apocynum *(Dogbane, Indian Hemp)*

Apocynum (dogbane) has numerous medicinal and fiber uses. As a medicine, a decoction of root has been used as an anticonvulsive, a cold remedy, an ear medicine, heart medicine for palpitations, as a psychological aid (for insanity), for vertigo, as an eye medicine, a gynecological aid, a liver aid, a kidney aid, and more. In addition, dogbane is used to bathe dogs for mange. Fiber is obtained from dried, pounded stems to make twine or cordage. Both fine and coarse cordage could be made from Indian hemp. Both the inner and outer fibers are noted to have been used to make cordage and thread, while the inner fibers appear to have been used for making garments (Moerman 1998:78-79).

Cheno-Ams

Cheno-ams are a group of plants that include *Amaranthus* (pigweed) and members of the Chenopodiaceae (goosefoot) family, such as *Atriplex* (saltbush), *Chenopodium* (goosefoot), *Cycloloma atriplicifolium* (winged pigweed), *Monolepis* (povertyweed, patata), and *Suaeda* (seepweed). These plants are weedy annuals or perennials, often growing in disturbed areas such as cultivated fields and site vicinities. Plants were exploited for both their greens and seeds, which are very nutritious. Young shoots and stems can be eaten fresh or cooked as greens, either alone or with other foods. The greens are most tender in the spring when young but can be used at any time. The small seeds can be eaten raw, but most often they were ground into a meal and used to make a variety of mushes and cakes. The seeds usually are noted to have been parched prior to grinding. The red fleshy fruit clusters of *Chenopodium capita tum* (strawberry blite) and *Monolepis* roots were eaten raw or cooked. The ashes of *Atriplex canescens* (four-wing saltbush) make a good substitute for baking powder, while a black dye can be obtained by soaking *Suaeda* stems and leaves in water for many hours. Various parts of the cheno-am plants are noted to have been gathered from early spring (greens) through the fall (seeds) (Harrington 1964:55-62, 69-71, 80-82, 234-236; Harrington 1972:68-71, 82-84; Kirk 1975:56-63; Sweet 1976:48; Tilford 1997:14-15, 88-89).

Ephedra *(Ephedra, Mormon Tea, Joint-Fir)*

Ephedra (ephedra, Mormon tea, joint-fir) is a shrub with jointed stems or needles measuring 2-12 in long. The stems most often were used to make a tea, although the seeds may be parched and ground into a meal. *Ephedra* tea was a very useful medicinal resource. The tea was drunk as a diuretic, for mild kidney inflammations, weak kidneys, weak lungs, as a decongestant for head colds and hay fever, and as a mild tonic. The tea also was used to treat syphilis and the painful urination gonorrhea. Navajo are reported to have boiled the tops of E. *viridis* (green ephedra) into a drink for use as a cough medicine. *Ephedra* is found in arid parts of the western United States, including desert scrub, grassland, chaparral or brush, and pinyon-juniper woodland (Elmore 1976:92; Kirk 1975:21; Moore 1990:26-27; Shields 1984:64; Sweet 1976:22).

Opuntia *(Prickly Pear Cactus)*

All species of *Opuntia* (prickly pear cactus) produce edible fruit. The fruits were eaten raw, stewed, or dried for winter use. Seeds were eaten in soups or dried, parched, and ground into a meal to be used in gruel or cakes. Juice from the fruit or the fuzz-like spines (glochids) were rubbed on warts or moles to remove them. Young stems or pads were peeled and eaten raw or roasted. The spines might have been burned off both the fruit and stems in preparation for consumption (Harrington 1967:24). Peeled pads were used as a dressing on wounds, and a tea made from the pads was used to treat lung ailments. Cactus plants are found throughout the western United States on arid, rocky, or sandy soils. They are occasionally found growing east to New York and Massachusetts, and west to British Columbia and Washington (Foster and Duke 1990:88; Harrington 1964:382-384; Kirk 1975:50-52; Medsger 1966:61; Moerman 1998:365-369; Muenscher 1987:317). Members of the cactus (Cactaceae) family, such as prickly pear, were important food resources because cactus fruits, buds, and stems provided some essential nutrients not available in most native foods (Gasser 1981:224).

Petalostemum, Petalostemon, or Dalea *(Prairie Clover)*

Dalea and *Petalostemum* roots and compounds of the plants have been used medicinally by the Navajo and Pawnee for a variety of purposes including for pain, loose bowels, stomachache, fever and as a panacea or "life medicine" or prophylactic to prevent disease. Some species are used as emetics or as a hair wash to prevent hair from falling out. Sometimes a decoction of leaves and blossoms was taken for heart trouble or diarrhea. The roots are noted to have been eaten as a delicacy or candy by some and dried and ground into meal by others. There seems to be a uniform opinion that the roots are sweet and can be used as sweetener or ground into meal (Moerman 1998: 192-3).

Plantago *(Plantain, Indian Wheat)*

Plantago (plantain, Indian wheat) is an annual or perennial herb with a low-growing rosette of broad leaves. Plantain leaves are high in vitamins C, A, and K, and young leaves may be eaten fresh or cooked as potherbs. The seeds have a mucilaginous coat, and may be eaten raw, parched. or ground into a meal. The seeds make a good laxative when soaked in water and eaten raw. Crushed, fresh leaves may be applied to wounds, insect bites, and stings. They also were used to draw out splinters, to cure and prevent infections, and to treat arthritis. The large leaves also make useful natural bandages. Fresh leaves and fresh or dried roots contain proteolytic enzymes and are useful for treating mild infections. The fresh juice may be used for bladder infections and mild stomach ulcers. Native groups are noted to have applied the powdered root to toothaches. *Plantago* is found in a variety of habitats. It is abundant on disturbed ground and also may be found in plains, hills, fields, waste places, wet meadows, moist ground, and along streams (Angier 1986:235;238; Kirk 1975:65; Moore 1982:129; Tilford 1997:112).

Poaceae *(Grass Family)*

Members of the Poaceae (grass) family have been widely used as a food resource, including *Agropyron* (wheatgrass), *Hordeum* (barley), *Elymus* (ryegrass), *Eragrostis* (Iovegrass), *Oryzopsis* (ricegrass), *Poa*, *Sporobolus* (dropseed), and others. Grass grains normally were parched and ground into a meal to make various mushes and cakes. Several species of grass contain hairs (awns) that were singed off by exposing the seeds to flame. Young shoots and leaves may have been cooked as greens. Roots were eaten raw, roasted, or dried and ground into flour. Grass also is reported to have been used as a floor covering, tinder, basketry material, and to make brushes and brooms. Grass seeds ripen from spring to fall, depending on the species, providing a long-term available resource (Chamberlin 1964:372; Harrington 1967:322; Kirk 1975:177-190; Rogers 1980:32-40).

Rosaceae *(Rose Family)*

The Rosaceae (rose family) includes numerous shrubs and herbaceous plants that produce edible fruits or berries. *Rubus* (raspberry and thimbleberry) produces an edible berry frequently consumed fresh or dried for winter storage (Ebeling 1986:44-47; Kirk 1975:94; Moerman 1986:486- 494; Tilford 1997:122-123). *Amelanchier* (serviceberry) produces a berry that is often dried for storage or used in pemmican. The Blackfeet used the green inner bark of the serviceberry plant for anti-inflammatory eyewash and eardrops (Ebeling 1986:46-47; Kirk 1975:97-99; Moerman 1986:67-70; Sweet 1976:26; Tilford 1997:134-135). *Fragaria* (strawberry) is also a member of this family, and the berries are eaten fresh or the green leaves are used to prepare tea (Ebeling 1986:46-47; Kirk 1975:90; Moerman 1986:234-236; Tilford 1997:162-163). *Prunus* (chokecherry) has an edible berry that was eaten raw. The Apache used the inner bark of this plant to treat diarrhea, sore throats, worms, headaches, and heart conditions. In addition to chokecherry, American plum produces a fruit that is considered a delicacy. The Cheyenne use the medicinal branches in the Sun Dance ceremony (Ebeling 1986:46-47; Kirk 1975:95-97; Moerman 1986:439- 448; Sweet 1976:20; Tilford 1997:34-35). *Rosa* (wild rose) produces a fruit referred to as rosehips, that may be consumed either raw or cooked. The Shoshone used wild rose to make a poultice of various plant parts to apply to burns (Kirk 1975:94-95; Moerman 1986:482-486; Sweet 1976:29). *Cratageous* (hawthorn) produces berries that were eaten fresh or cooked. The Cheyenne made a decoction of dried berries as a laxative (Kirk 1975:99-100; Moerman 1986:183-184; Tilford 1997:70-71). *Cercocarpus* (mountain mahogany) is not noted in any ethnobotanic studies to have been eaten. Instead, the inner bark of this plant was used medicinally by the Paiute and Shoshone for stomach aches and diarrhea (Kirk 1975:92; Moerman 1986:149-150; Sweet 1976:25).

Rhus *(Sumac, Squawbush, Skunkbush)*

Rhus (sumac, skunkbush, squawbush) berries are noted to have been used by several Native American groups. *Rhus trilobata*, *R. glabra*, and *R. integrifolia* all have edible berries that were eaten both green and, when ripe, either raw or cooked. Berries sometimes were pounded into cakes that were sun-dried for future use. Berries also were dried whole and ground. Berries ripen in September, then dry and remain on the bushes throughout the winter. *R. trilobata* and *R. typhina* (stag horn sumac) berries were used to make a drink similar to lemonade. Species of *Rhus* are native shrubs or small trees found on dry open sites, dry to mesic slopes, and along creeks and rivers (Albee et al. 1988:6; Angell 1981; Harrington 1967:261; Kirk 1975:16).

Sphaeralcea *(Globe Mallow)*

Sphaeralcea (globe mallow, desert mallow) is a perennial herb that is covered with starshaped hair tufts and has slimy, mucilaginous leaves when crushed. This plant was utilized for a variety of medicinal and ceremonial purposes. The contrary medicine men of the Dakota, called *heyoka*, chewed *Sphaeralcea* leaves into a paste that was spread over their hands and arms to protect them from scalding water. *Sphaeralcea* plants were chewed and applied to sores or wounds. Crushed leaves were used as a poultice for skin inflammations and for sore, blistered feet. The plant may be chewed, or the dried plant brewed as a tea to treat sore throats, hoarseness, and minor stomach irritability. The Cheyenne Contrary Society used a *S. coccinea* (scarlet globe mallow) tea to make bad-tasting medicine more palatable. Comanche groups made a tea to reduce swellings. Shoshone groups used a root decoction for upset stomach, as an emetic, as a contraceptive, and applied the crushed root to swellings. A leaf decoction was taken for colds and used as an eyewash. A leaf tea also was used as a hair rinse. A strong tea is noted to curl hair if not rinsed out. *Sphaeralcea* is found in dry plains, prairies, and hills (Dorn 1992:202; Kindscher 1992:208-209; Moerman 1986:465; Moore 1982:166-168).

Typha *(Cattail)*

Typha (cattail) are perennial marsh or aquatic plants with creeping rhizomes. This plant is a rich source of nutrients. Indian groups are noted to have used various parts of the cattail plant throughout the year. In the spring, young shoots were peeled and the inner portion eaten raw or cooked as potherbs. During the summer, young flower stalks were taken out of their sheaths and cooked. Flowers were eaten alone or added as a flavoring or thickening for other foods. Pollen-producing flowers and the pollen itself were collected and used as flour, either alone or mixed with other meal. In the fall, the rootstalks were collected, the outer peel removed, and the white inner cores of almost pure starch were eaten raw, boiled, baked, or dried and ground into flour. Cattail roots were richer in starch during the fall. Cattail starch flour is noted to be similar in quantities of fats, proteins, and carbohydrates to flour from rice and corn. The seed-like fruits also were collected and eaten in the fall. Indian groups are noted to process these seeds by burning off the bristles. The seeds were then parched and could be more easily rubbed off the spike. The slightly astringent flower heads were sometimes used to relieve diarrhea and other digestive disorders. Cattail down was used as dressing for wounds and padding in cradleboards. Leaves and stems were used for weaving mats. These mats may have been used as sleeping mats. Cattails are found in marshy habitats in or near swamps, ponds, sloughs, and edges of streams (Harrington 1967:220-224; Kirk 1975:171; Sweet 1976:8; Tilford 1997:28-29).

Discussion

Swallow site is nestled in the foothills southwest of Denver, Colorado in an Upper Sonoran vegetation community. Local vegetation includes grasses (Poaceae), prickly pear cactus (*Opuntia*), sagebrush (*Artemisia*), Gambel's oak (*Quercus gambelli*), serviceberry (*Amelanchier*), lemonadeberry (*Rhus aromatica*, *Rhus diversiloba*), a variety of composites (Asteraceae), and a variety of other forbs. Deer Creek provides the closest regular source of water. Riparian vegetation communities are associated with this creek.

Metate fragments were selected for analysis from as many levels as possible within Swallow site. Twelve metate fragments represent eleven different cultural levels that range in age from 1150 to 6345 BP (Table 16.1). Pollen types observed in the samples are listed in Table 16. 2, and diagrammed in Figure 16.1. It is interesting to note that quantities of *Pinus* pollen fluctuate in these samples, with peaks noted in Levels 6, 7, and 16, which are associated with radiocarbon ages of 1040, 1200, and 5335 BP, respectively. These might represent seasonal differences in deposition or perhaps times in prehistory when pines were particularly abundant in the foothills. For this record, *Pinus* pollen is interpreted as part of the paleoenvironmental signal or background pollen. Other

Table 16.1. Provenience data for samples from site 5JF321, Swallow site.

Sample Number	Grid	Level	Provenience/Description	Radiocarbon Age (RCYBP) / Period	Analysis
1528a	D3	3	Deeply worn basin of a two-sided metate	1150, 1240,1370 / Early Ceramic	Pollen wash
12511	F6S	4	Metate fragment	Early Ceramic	Pollen wash
1433	D3	4	N ½, Sherd	Early Ceramic	Phytolith
7700	E3S	6	Metate fragment	1040, 1230 / Early Ceramic	Pollen wash
4347	D1S	7	Metate fragment	1200 / Early Ceramic	Pollen wash
26500	B2N	9	Metate fragment	3940 / Mixed Late & Middle Archaic	Pollen wash
15772	C1S	11	Metate fragment, Pecked, not very smooth	1650, 2760, 3990 Mixed Archaic	Pollen wash
13767	F3	13	Large basin metate	4610 / Mixed Archaic	Pollen wash
8601	E3S	13	Metate fragment, Wood charcoal on working surface towards edge	4610 / Mixed Archaic	Pollen wash
10346	E3S	16	Metate fragment	1880, 5335 / Mixed Archaic	Pollen wash
16147	C1S	17	Protein residue sample of caliche, not surface (Marlar), metate fragment	2390, 4590 / Mixed Archaic	Pollen wash
16201	C1S	18	Metate fragment	3150, 6345 / Mixed Archaic	Pollen wash
15531	C3S	20	2-sided metate fragment	3150 / Mixed Archaic	Pollen wash

Table 16.2. Pollen types observed in samples from 5JF321, Swallow site.

Pollen Group	Scientific Name	Common Name
Arboreal Pollen	*Acer*	Maple
	Betula-type	Birch
	Fraxinus	Ash
	Juniperus	Juniper
	Pinaceae	Pine family
	Picea	Spruce
	Pinus	Pine
	Pseudotsuga	Douglas fir
	Platanus	Sycamore
	Quercus	Oak
	Salicaceae	Willow family
	Populus	Poplar
	Salix	Willow
	Ulmus	Elm
	Apocynum-type	Dogbane
Non-Arboreal Pollen	Asteraceae	Sunflower family
	Artemisia	Sagebrush
	Low-spine	Includes ragweed, cocklebur, etc.
	High-spine	Includes aster. rabbitbrush, snakeweed, sunflower, etc.
	Tubuliflorae	Includes eroded Low- and High-spine
	Liguliflorae	Includes dandelion and chicory
	CaryophylJaceae	Pink family
	Cheno-am	Includes amaranth and pigweed family
	Amaranthaceae -type	Pigweed family
	Sarcobatus	Greasewood
	Convolvulus arvensis	Bindweed
	Corylus-type	Hazel
	Cucurbita	Squash, Pumpkin, Gourd
	Cyperaceae	Sedge family
	Ephedra nevadensis-type	Mormon tea
	Eriogonum	Wild buckwheat
	Euphorbia	Spurge
	Fabaceae	Bean or Legume family
	Astragalus-type	Milkvetch, Rattleweed, Locoweed
	cf. *Petalostemum*	Prairie Clover
	Lonicera-type	Honeysuckle
	Onagraceae	Evening primrose family
	Opuntia	Prickly pear cactus
	Plantago	Plantain
	Poaceae	Grass family
	Polygonum sawatchense-type	Sawatch knotweed
	Rhus aromatica-type	Poison ivy
	Rosaceae	Rose family
	Sphaeralcea	Globemallow
	ct. Solanaceae	Potato/tomato family

Table 16.2 (*continued*). Pollen types observed in samples from 5JF321, Swallow site.

Pollen Group	Scientific Name	Common Name
	Typha angustifolia-type	Cattail
	Typha latifolia-type	Cattail
	Unidentified (TCP Retic)	
	Indeterminate	Too badly deteriorated to identify
Starches	Lg Ang WI Diff & X	Large angular starch with diffuse hilum and X
	Lg Gumdrop WI ECC Dot & X	Large gumdrop starch with eccentric dot hilum and X
	Med Ang WI Diff & X	Medium angular starch with diffuse hilum and X
	Sbang Med WI Fiss & X	Subangular medium starch with fissure hilum and X
	Sm Rd WI Diff & X	Small round starch with diffuse hilum and X
Spores	*Cryptogramma crispa*-type	Mountain parsley
	Monolete (Psiiate/Fine Scabrate)	Fern
	Selaginella densa	Little clubmoss
	Sphagnum-type	Sphagnum moss
	Trilete (Psiiate/Fine Scabrate)	Fern
	Sporormiella (Fungal Spore)	Dung fungus

pollen representing trees includes *Acer, Betula-type, Fraxinus, Juniperus, Picea, Pseudotsuga, Platanus, Quercus, Populus-type, Salix,* and *Ulmus. Quercus* pollen probably represents local Gambel's oak growing in the vicinity of Swallow site. *Juniperus* pollen represents juniper growing locally in the foothills or along the hogback. Recovery of *Acer, Betula-type, Fraxinus, Platanus, Populus-type, Salix,* and *Ulmus* pollen represents maple, birch, ash, sycamore, cottonwood, willow, and elm trees, all probably associated with Deer Creek. Recovery of small quantities of *Picea* and *Pseudotsuga* pollen represents wind transport of spruce and Douglas fir pollen from the foothills or even at higher elevations in the mountains.

Pollen representing local shrubby or herbaceous plants is diverse. Only a few pollen types are abundant in this record. *Artemisia* pollen, representing local sagebrush, is moderately abundant to abundant in most samples. Low-spine Asteraceae pollen is most abundant in metate washes from the upper two levels, as well as the lowest level. High-spine Asteraceae pollen is moderately abundant and probably represents diverse plants including rabbitbrush, sunflower, asters, and others. Tubuliflorae pollen represents members of the Asteraceae family that cannot be distinguished, with certainty, between Low-spine and High-spine. Morphologically it most closely resembles High-spine Asteraceae pollen. Usually, the problem is one of deterioration of the pollen in the ground, often including abrasion of the spines as part of that problem. Liguliflorae pollen represents the chicory tribe of the Asteraceae or sunflower family. It is likely that many members of the sunflower family were present in the local vegetation surrounding Swallow site, although evidence from the pollen record does not suggest that any of them were processed using these metates.

Apocynum-type pollen noted in Sample 26500, collected from Level 9, indicates the presence of dogbane or Indian hemp, a plant noted for its medicinal use and fibers. Recovery of this pollen

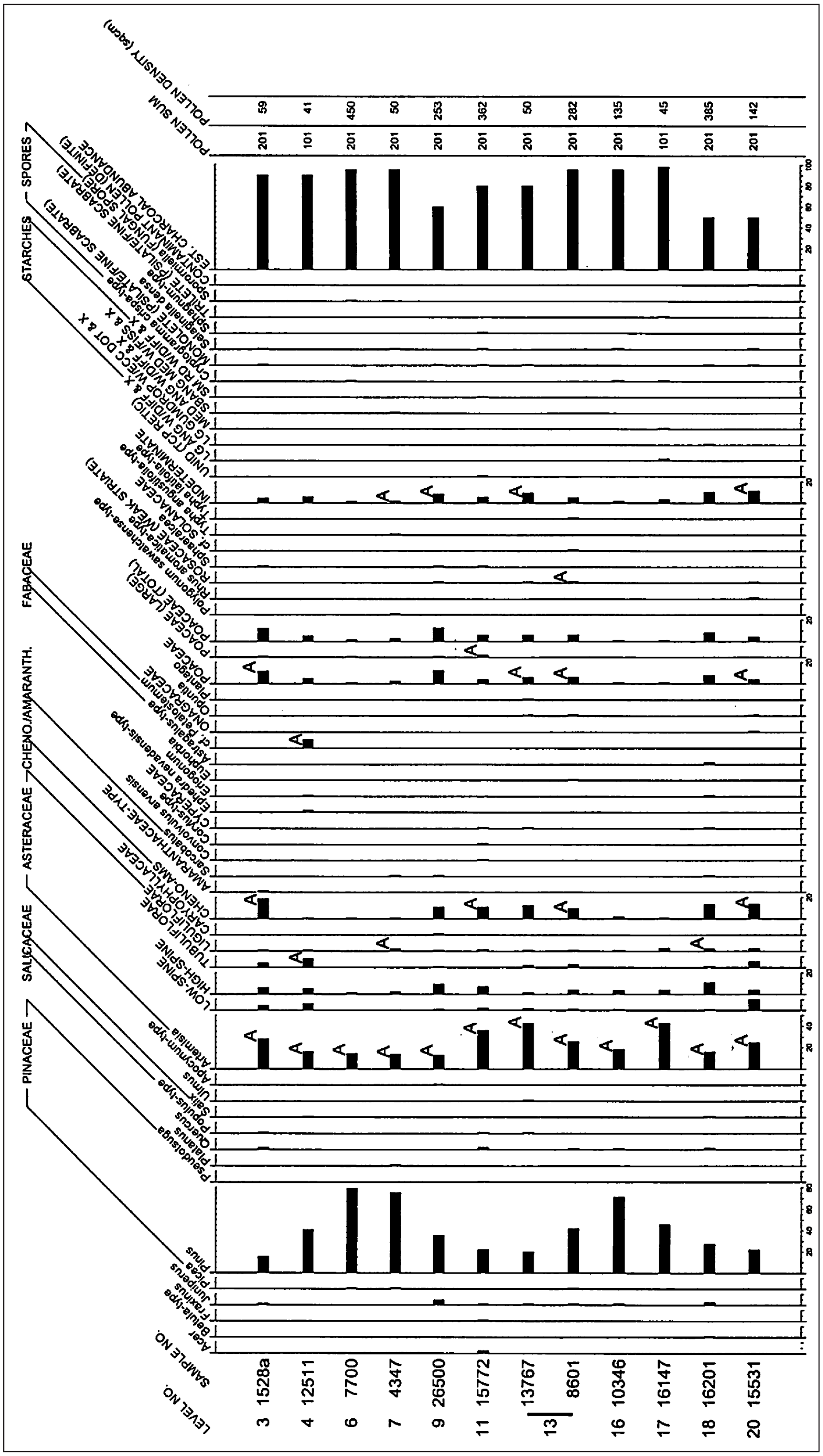

Figure 16.1. Pollen diagram for Swallow site 5JF321.

indicates only that this plant was present and should not be interpreted to indicate any processing using this metate, although fiber processing cannot be ruled out.

Cheno-am pollen is abundant in seven samples, representing Levels 3, 9, 11, 13, 18, and 20. Cheno-am pollen aggregates were noted in four of these samples, representing Levels 3, 11, 13, and 20. It is likely that cheno-am seeds were ground using these metates. Only in Sample 1528a, representing a metate from Level 3, was probable Amaranthaceae pollen reported. Cheno-am pollen includes various members of the Chenopodiaceae family, as well as the genus *Amaranthus*. Pollen produced by other genera in the Amaranthaceae family have pollen that is slightly different and separated from the cheno-am group. Some of this pollen was recovered in Sample 3. *Sarcobatus* pollen was noted rarely, representing greasewood in the local or regional vegetation community.

Convolvulus arvense-type pollen was noted only in Sample 15772, representing Level 11. It is likely that this pollen was introduced from more recent deposits or perhaps during excavation, since it represents bindweed, which was introduced into the area by Anglo occupation (Harrington 1964:438-439).

Cucurbita pollen was observed only in Sample 10346 from Level 16. Since both the native *Cucurbita foetidissima* (buffalo gourd) and the cultivated *Cucurbita pepo* and other cultivated *Cucurbita* species have very similar pollen, it is not possible to identify whether the *Cucurbita* pollen noted in this sample represents the native buffalo gourd or a cultivated squash/pumpkin. Therefore, although it is tempting to interpret the presence of *Cucurbita* pollen as representing cultivated squash/pumpkin, this interpretation is not 100% secure. Therefore, the possibility that this pollen represents accidental inclusion of pollen from locally growing buffalo gourd must be considered.

Recovery of a small quantity of *Corylus*-type pollen in Sample 15772, representing Level 11, indicates the presence of shrubby hazel, probably growing in a local riparian vegetation community. Cyperaceae pollen was noted in a few samples and might represent sedges growing as part of the xeric vegetation community, where it grows mixed with grasses, or might represent sedges growing in a local riparian vegetation community.

Ephedra nevadensis-type pollen was noted only in Sample 12511, representing Level 4. Ephedra is likely a component of the local vegetation in the foothills or along the hogback. It is surprising that this pollen is not observed more frequently. Small quantities of *Eriogonum* pollen were noted in Samples 16201, representing Level 18, and 12511, representing Level 4. Wild buckwheat is part of the local vegetation and this scant evidence does not suggest that this resource was collected and processed. A small quantity of *Euphorbia* pollen was noted in Sample 8601, representing Level 13, and probably represents spurge growing in a disturbed area.

Fabaceae (legume family) is represented by at least two pollen types. *Astragalus*-type pollen represents local astragalus growing as part of the local vegetation community and is associated with Level 18. *Astragalus* roots have medicinal properties and might have been collected and processed. Probable *Petalostemon*/*Dalea* pollen was noted in Sample 12511, representing Level 4. Prairie clover probably grew as part of the local vegetation community. It is surprising to find this quantity of *Petalostemon*/*Dalea* pollen in a single sample, as it is not wind pollinated, but rather insect pollinated. Ethnographic information that the roots are prized for their sweetness is a good indication that these plants were exploited. In addition to using roots, recovery of a larger quantity of this pollen type suggests either grinding roots that had been collected while the plant was in flower, into meal or perhaps preparation of tea from flowers.

Lonicera-type pollen was noted only in one sample (10346) while scanning the slide. It probably represents native honeysuckle. This pollen probably is present as a result of honeysuckle growing in the vicinity of Swallow site.

Onagraceae pollen was noted only in Sample 15531, representing Level 20. Evening primrose probably grew as part of the local vegetation community. *Opuntia* pollen is noted in small quantities in Sample 15531, representing Level 20, and in Samples 8601 and 13767, both representing Level 13. Prickly pear cactus is expected as part of the local vegetation community. Recovery of small quantities of *Opuntia* pollen in these few samples might be the result of processing prickly pear cactus, although this interpretation is not certain. It is equally possible that prickly pear cactus merely grew in the vicinity of this area and is present here because *Opuntia* pollen was present in the sediments surrounding the metates.

Plantago pollen represents plantain, a plant with edible leaves and seeds. Recovery of a small quantity of this pollen in only a single sample (13767, representing Level 13) is supportive of presence in the local vegetation community and not particularly indicative of processing. Poaceae pollen frequencies varied considerably in these metate washes. Elevated Poaceae pollen frequencies in samples representing Levels 3, 4, 9, 11, 13, 18, and 20 might reflect grinding grass seeds in these metates. Most of these samples also yielded Poaceae pollen aggregates.

Recovery of a small quantity of *Polygonum sawatchense*-type pollen in a single sample merely represents the presence of this type of knotweed in the local vegetation community. Recovery of a small quantity of *Rhus aromatica*-type pollen in Sample 15531, representing Level 20, indicates the presence of lemonadeberry in the local vegetation community even towards the beginning of occupation at Swallow site. It is possible, but not necessarily indicated, that lemonadeberry was processed.

Recovery of Rosaceae pollen exhibiting weak striae indicates the presence of any of several members of the rose family including *Prunus* (chokecherry), *Purshia* (bitterbrush), or others. Chokecherry might have been processed and all members of this family are preferred forage by deer and other browsers.

Sphaeralcea pollen was noted occasionally in small quantities, indicating the presence of globe mallow in the local vegetation. Recovery of Solanaceae pollen in a single sample probably reflects the presence of a weedy nightshade. Alternatively, it is possible that a member of this family was collected and processed, either as food or medicine.

Two types of *Typha* pollen were noted occasionally, indicating that cattails grew in drainages or along a creek within a few miles of the site. Certainly, cattails could have been collected and processed, although recovery of these few pollen grains is not strong evidence for definite use of this resource.

A variety of starches was observed in these samples. Most can be found in grass seeds, and some can be found in a few other plants. Not all of the samples displaying evidence of starches also contained large quantities of Poaceae pollen, making interpretation of the starch record difficult. Gumdrop-shaped starches are typical of roots of several plants, including those in the Apiaceae (umbel family). It is possible that the metate represented by Sample 16201 was used to grind a member of the umbel family. Other plants that produce gumdrop-shaped starches usually don't produce large starches, so it is most likely that this starch represents a member of the umbel family.

It is interesting to note the estimated charcoal abundance for these metates. Throughout most of the prehistory of Swallow site charcoal particles appear to have been abundant. The biggest exception is the smaller quantities of charcoal in the lowest two levels represented, Levels 18 and 20. Recovery of smaller quantities of charcoal in these early levels is consistent with an interpretation that early occupation of Swallow site, as represented here, might not have supported as many people as later occupations.

Examination of charred residue removed from a single ceramic sherd recovered in Level 4 yielded an abundance of festucoid and chloridoid phytolith short cells, representing cool season and short grasses (Figure 16.2). Cool season grasses grow in the cooler portions of the spring and fall, while short grasses grow during the hotter, drier summer months. Recovery of nearly equal quantities of phytoliths from these two types of grasses indicates a strong environmental signal, possibly from sediment that infiltrated the porous charred residue. Most other phytolith forms noted during this analysis are typical of those in grass communities. Bilobate forms represent tall grasses and buliforms represent the cells that are responsible for leaf rolling in response to drought in all grasses. Trichomes represent leaf hairs on the grasses. Elongate forms are present in a variety of grasses. Diatoms often are recovered in sediments. The surprising element of this sample is recovery of a 3-dimensional "sand-dollar"-shaped phytolith. This phytolith represents a dicot rather than a grass but has not yet been reported from any plant reference specimens. At this writing it remains unidentified. There is no evidence of processing any particular plant through recovery of phytoliths from this residue. None of the phytoliths observed in these samples appeared typical of those produced by *Zea mays* glumes, so this particular ceramic does not appear to have been used to cook maize.

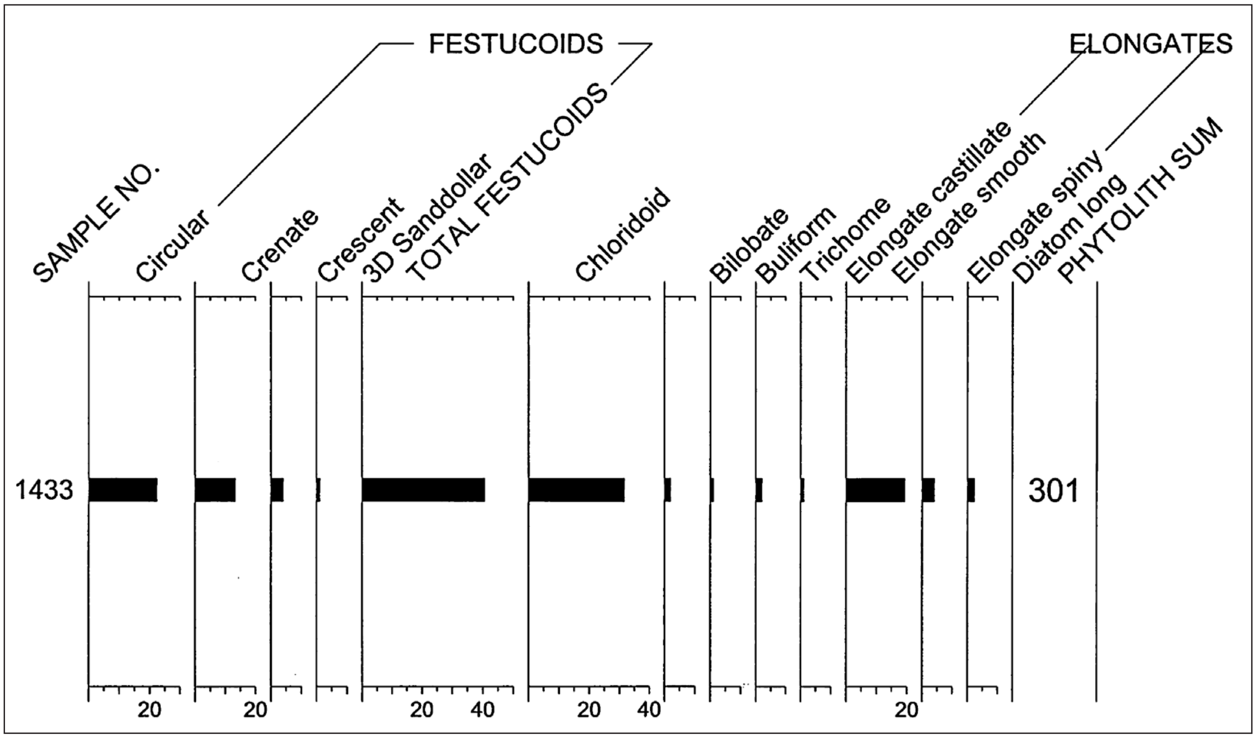

Figure 16.2. Phytolith diagram for site 5JF321, Swallow site.

Summary And Conclusions

The pollen record from twelve metates examined from Swallow site indicates that grass seeds and cheno-am seeds probably were valuable resources ground on these tools. It is interesting to note that when cheno-am pollen frequencies were elevated, so were Poaceae pollen frequencies (Levels 3, 9, 11, 13, 18, and 20) with the addition that Poaceae pollen was slightly elevated in a sample from Level 4. This suggests that both cheno-am and grass seeds were ground using the same tools. It leaves open for interpretation what the other metates might have been used to grind. Several types of starches were noted in these samples. Starches typical of grass seeds include large angular, medium angular, subangular, and round. Only the gumdrop shape is indicative of a different plant. Gumdrop shaped starches with eccentric hila are produced by Apiaceae (umbel family) roots, which are edible. Gumdrop starches were observed in Sample 16201, collected from Level 18 and might indicate grinding roots/tubers from a member of the Apiaceae (umbel family) with this metate. *Apocynum*-type pollen was noted in a sample collected from a metate in Level 9, indicating that dogbane or Indian hemp, known for its use as a medicine and also as a source of fibers that can be used to make twine, thread, and rope, was present, suggesting this plant was processed with this metate.

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17

Blood Residue

Richard Marlar and
Bill Hammond

Blood residue analysis was performed on 154 lithic specimens and one potsherd from Swallow site. This is one of the largest assemblages studied by this technique as to year 2000. Traces of hemoglobin (the oxygen-carrying protein of blood) were identified by a sensitive immunologic assay technique, enzyme-linked immunosorbent assay (ELISA).

Methods

In order to optimize the detection of residues, specimens were handled as little as possible in the field and the lab and were not washed or otherwise cleaned of dirt. They were given field numbers and placed in individual paper bags for transport to the lab. To detect contamination by spilling of blood on discarded artifacts in the adjacent dirt, samples of the dirt close to the specimens were taken as controls with many of the specimens. Blood residue for deer, bison, sheep, turkey, and human was identified.

Blood residue analysis was carried out in the immunochemistry laboratory of one of the authors (Marlar). Polypropylene containers were used to prepare and store the artifact residue solutions at all times. Potential blood residues were extracted from each artifact by immersing it in a buffer (0.02 M Tris, 0.05 M NaCl , 0.5% Triton X-100), and sonicated for two hours. The resulting solution was centrifuged at 3000 rpm for 15 minutes and then concentrated five-fold. This concentrated solution was diluted 1:500 in 5 M Carbonate buffer and assayed by ELISA, a standard, highly sensitive immunochemical method. Each artifact and its soil control were tested for blood residue of deer, bison, sheep, antelope, elk, rat, dog, turkey, rabbit, snake, and human. No cross-reactivity was present for hemoglobin of these species. For more details on the technique employed, see Marlar, Puseman, and Cummings (1995).

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Results

Blood residue was identified on 32 of 154 lithic artifacts (21%), with 3 artifacts testing positive for more than one species, for a total of 37 positive reactions. None of the 60 control soil samples was positive. The one potsherd tested was also negative. Nineteen of the 37 positives (51%) were for deer blood, 8 were for bison (21.6%), 5 for sheep (14%), 3 for turkey (8%), and 3 for human (8%). Rabbit blood was not identified on any of the artifacts.

The proportion of specimens positive for blood residue may decrease slightly with time, although the statistical significance of this hypothesis is weak. Specifically, 10 of 42 (24%) of the artifacts from the Early Ceramic period (Levels 1-7) were positive for blood, while 10 of 57 (18%) from the Archaic period were similarly positive. To assess if the difference in these percentages is statistically significant, a p-value of 0.56 was obtained by calculating a chi-square.

A higher percentage of orthoquartzite than cryptocrystalline tools (including petrified wood) was positive for blood. Fifteen of 48 (31%) quartzite tools were positive, while 16 of 98 (16%) of cryptocrystalline tools were positive for blood residue. This difference is highly statistically significant (p=.96). This may be the result of trapping of red blood cells in the interstices between the grains of orthoquartzite. Cryptocrystalline tool surfaces are smoother, with no such grains and interstices.

There is a roughly even distribution of positives for blood residue analysis among the various types of tools. Thirteen of 52 (25%) projectile points or point fragments were positive, as were 8 of 32 knives or other bifaces (25%), 2 of 11 (18%) scrapers, and 8 of 52 flakes (15%). There is no statistically significant difference in the occurrence of blood residue on different categories of tools (p=.39).

Appendix G provides the data on tested artifacts and samples.

Editors' Note: The editors were unable to locate a comprehensive list of catalog numbers for tested items, and such a list probably doesn't exist. The data on Appendix G were put together from several partial lists and handwritten notes, and there are gaps and uncertainties in the data.

Discussion

Blood (hemoglobin) was identified on 21% of the 154 lithic artifacts analyzed from Swallow site. Deer was the predominant species, but bison, sheep, turkey, and human blood were also identified. Overall, the data present a coherent picture. There is possibly an increased frequency of blood residue in more recent time, a clearly increased frequency on rough-surfaced material (quartzite) than on smooth-surfaced (cryptocrystalline) materials, and a roughly equal distribution of blood residue on different tool types.

Two situations, both related to the number of bone fragments of different species found at the site, need further consideration. First, blood residue analysis shows unexpectedly that bison were a significant resource for the people of the Hogback valley. Bison blood residue is second in frequency at the site only to deer, followed by sheep, presumably mountain sheep. This is in contrast to the bone assemblage, where deer and deer size bones accounted for over 90% of the identifiably bone specimens from Swallow site (see Chapter 15), while bison bone is less than 0.5%, and mountain sheep is not present at all. It is possible that unidentifiable mountain sheep bone is intermixed with deer in the deer size category; mountain sheep have somewhat more robust bone than deer, but the size is similar enough to make distinctions difficult in highly fragmented bone assemblages. Bison bone, however, is substantially different in size, making its absence from the bone assemblage clear. Bison were presumably butchered where they were killed, as opposed to deer, which were brought back to camp for butchering. Bison meat, hides, and the tools used to process them were presumably brought back to camp, but the bones were left behind. Alternately, bison and mountain sheep may have been hunted at a different time of year than that spent at Swallow. There is clear evidence of communal mountain sheep hunts at high elevation game drives in the Rocky Mountains to the west. The sheep blood on the tools may suggest participation by Swallow residents at those summer drives before wintering in the Hogback valley. Whatever the case, the blood residue broadens our understanding of subsistence strategies.

Second, no rabbit blood residue was identified, although rabbit bone is secondary only to deer in frequency throughout the site. It is possible that there is enough genetic variation in hemoglobin from the laboratory strain of rabbit used to produce the test reagent for the assay and the wild rabbit strains killed at Swallow site that blood residue from tools used to process rabbits at the site was not recognized as rabbit by the assay. Ethnographic accounts are abundant of rabbits being hunted with other methods, for example driven into nets and killed with sticks. They may also have been minimally butchered, being small enough to cook whole without dismemberment, minimizing the use of stone tools in butchering. Given that butchering marks, clearly made by stone tools, were found on rabbit bone, however, it is also likely that the lack of rabbit blood is the result of sampling error or a need to refine the laboratory test.

Finally, human blood is probably to be expected and is not necessarily evidence of interpersonal violence. It can be easily accounted for by accidental cuts during use or manufacture of artifacts.

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18

Macrobotanical Remains

Peter J. Gleichman

During the excavation of the Swallow site (5JF321), botanical material visible to excavators was collected as macrofloral material. A few seeds, nuts, and seed pods were encountered and collected.

Bulk soil samples were also collected during the excavation of the Swallow site to recover botanical and other small scale remains. Flotation of the bulk soil matrix will separate organic from inorganic materials and the resulting botanical material can provide direct evidence of the economic botany of the site occupants. Plants used for sustenance and fuel are generally recovered and produce data pertaining to diet and subsistence, feature function, and overall site function. Archaeobotanical remains also produce a view of the past ambient vegetal environment and can assist in climatic reconstruction. Archaeobotanical material can aid in understanding past human-plant interaction, such as the type and amount of human affect and manipulation of the local ecosystem in the formation and maintenance of habitats for anthropogenic plant communities. Non-botanical small scale remains such as microliths and bone are also often recovered from flotation of bulk soil samples and can also provide information regarding feature function, stone tool materials, and subsistence pursuits of the occupants. Non-cultural material recovered from the soil samples such as modern (uncarbonized) plant elements, insect chitin, rodent pellets, and bone indicate bioturbation, disturbance, and contamination of deposits with modern material.

As discussed below, floated material had been sent to Brian Elliott, a botanist, for sorting and identification. Some information exists about prior flotation efforts and methods, but precise information is lacking. The botanical material was accurately identified by Brian Elliot, but the condition of the elements—carbonized or uncarbonized, was not recorded. Current concepts about archaeobotanical remains are that uncarbonized plant material is, with few exceptions, modern contamination and not cultural. It was decided that the float samples should be reexamined and

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condition of the plant elements documented. Fortunately, Mr. Elliott had retained the samples and sent them to the author for additional study.

Previous Work and Procedures

Around 1990 a list of "Macrofloral Samples" was compiled, perhaps by Winifred (Winnie) L. Ryan. The list gives Provenience, Feature Number, and Description for 15 samples. Catalog numbers are not given. The "Description" gives information such as "seed pod," "charred acorns," "seeds," "burned acorn." These were plant elements visible to excavators and collected as such. Four of the macrofloral samples were sent to PaleoResearch Laboratories and were identified by Kathryn Puseman. The identifications were published in the Swallow Second Interim Report (Rathbun 1992:6) and are included here (Table 18.1). The four macrofloral samples were returned to Winifred Ryan who sent them to the Swallow lab on February 15, 1994. The identified material is all uncarbonized.

Table 18.1. Macrofloral samples identified by PaleoResearch Laboratories.

Catalog No.	Sample	Provenience	Description
12533	F6- Level 5 -Art. 1	Feature 117, 64N/33W	*Cleome serrulata* (Beeweed) - 5 uncharred whole seeds, + an estimated 1860 uncharred seed fragments
15377	C3- Level 18 -Art. 8	157N/200W - 194d	*Celtis* (Hackberry) – 1 uncharred whole seed
15320	C3- Level 17 -Art. 29	Feature 116, 142N/5W - 190d	*Pinus edulis* (Pinyon Pine) - 1 uncharred whole nut
15235	C3- Level 17 -Art. 35	Feature 116, 189N/122W -190d	*Quercus* (Oak) – 5 uncharred whole acorns, and 12 uncharred acorn fragments

Macrofloral material was also recovered from immediately below the rockfall. A lens of sand containing a concentration of carbonized *Celtis reticulata* (hackberry) seeds was present at the top of Stratum D1, labelled Feature 208. The seeds were identified by Meg Van Ness. The seeds yielded an Early Archaic date of 6930±50 BC (Date 40, see Chapter 5).

During a visit to the University of Denver Museum of Anthropology (DUMA) in November 2022 two additional boxes of macrofloral material were located. The University of Denver (DU) was unwilling to release the samples to the author for analysis. A cursory examination indicates the majority of the macrofloral samples are uncarbonized plant elements. Two of the samples contain carbonized concentrations of *Helianthus* (sunflower) seeds; Sample #7618 from E3/L6, and Sample #14280 from C3/L4. These are both in Early Ceramic period levels.

The bulk soil samples were subjected to flotation to facilitate the recovery of small scale remains. Flotation is based on differing specific density of material, which can be separated by a liquid medium. Water separation was used, with water as the medium. Material with greater specific density than water, such as stone and most bone, will sink through it (the "heavy fraction"); and material with a lesser specific density, such as charcoal and plant elements, will float or be suspended in the medium (the "light fraction").

Detailed information about methods is lacking. A 2-page report "5JF321 Swallow Site Flotation Samples – Processed and Reported by Marie Mayer" (Mayer 1991:40-41) gives methods used for at least some of the flotation. A memo from Marie Mayer to Fred Rathbun dated April 20, 1991, is a "Listing of Flotation Sample Bags, RE: Swallow Site 5JF321, Being Processed and Sorted by Marie Mayer." The list is 16 samples, 8 from Feature 12 (burial) and 8 from 4 other features (F. 95, 102, 104, 105).

Mayer's report states that a number of samples have been floated and are being sorted per PAAC Flotation Methods class attended in May 1989. The soil samples were double-screened at the site and placed in plastic bags. One-liter samples were floated by pouring the soil into a bucket of water and the water agitated. Floating materials were skimmed into a sieve double-lined with 1 mm mesh, and the materials were air-dried and bagged. Sorting had been started using a 12x microscope. (Note that the use of 1 mm mesh to capture floated material is limiting in that many seeds are smaller than 1 mm.)

The 16 samples Mayer floated were located in the boxes of Swallow materials that had been in Bill Hammond's possession. Mayer had sorted one sample from Feature 102 and partially sorted one sample from Feature 12. No further work had been done on these samples. For unknown reasons they were not sent to Brian Elliott for sorting or identification. The heavy fraction of the samples floated by Mayer was apparently not retained.

Also present in the box of Mayer samples were seven bags with vials of items which have presumably been extracted from floated samples. The bags are labeled with site number and catalog numbers, with no other information. Catalog numbers are 19891, 20214, 20230, 20438, 21070, 24903, 31386. There is no information about who floated the samples or what the methods of flotation and sorting were.

It is unknown if the process Mayer followed was used for other floated samples, or who did the flotation or when it was done. The volume of soil floated for each sample is unknown. Floated material was sent to botanist Brian Elliott. He sorted or extracted plant material from 26 samples, placing the plant elements in paper bindles and vials. Elliott prepared a preliminary list of sample contents for 11 samples in 2004, and a table of botanical identification by sample on March 10, 2005. Elliott is an accomplished botanist, but had not worked with archaeological material, and was unaware that archaeobotanists generally consider only carbonized or charred material as cultural, and uncarbonized plant elements as modern contaminants.

Thirty-nine samples were received from Elliott. Seventeen samples also had vials labelled "heavy" and presumably were from the heavy fraction. These vials generally contained uncharred seeds or pebbles. It is unknown who sorted the heavy fractions, but apparently aside from what was extracted and placed in the heavy fraction vials the heavy fraction material was tossed.

The light fraction matrices received from Elliott were almost all very small volumes. The light fractions were sifted through a series of graduated sieves and divided into 2 mm, 1 mm, and 0.425 mm particle sizes. The particle sizes were then sorted under magnification using an 8-45x stereoscopic microscope. Notes were taken for each sample, listing the presence, condition (carbonized or not) and number of individuals by taxa of plant elements, and the presence of insect exoskeletons, rodent fecal pellets, bone, gastropods, and microliths.

Pieces of wood charcoal large enough to identify were rare. Pieces greater than 2 mm in size were identified to the finest taxonomic level possible through examination of the cellular structure of freshly broken transverse sections at 45x magnification. Identification of the plant elements retrieved from the flotation samples was accomplished by comparison with modern specimens, some experimentally charred.

Sample Contents

The condition of the plant elements is important to considerations of deposition during occupation versus post-occupational introduction of plant elements into archaeological contexts. Carbonization, or charring, is a definite means of preservation of prehistoric plant material, and plant elements that are visibly charred may be considered prehistoric (Minnis 1981). Uncharred plant material from open sites is generally not prehistoric; however, it is unknown how processing techniques such as parching or smoking may enhance the preservation potential of seeds without altering their appearance. Rock shelters may provide protection from moisture, and uncharred perishable material may be preserved; however, the Swallow shelter is not a dry shelter. The term “seed” in Tables 18.2, 18.3, and 18.4 and throughout this report is generic, encompassing all forms of propagules.

Rodents and insects both harvest and store seeds (Brown and Davidson 1977), which can result in post-occupational deposition of seeds, and contamination of archaeological deposits. Rodents also bring other plant elements into their nesting area. The presence of insect parts and rodent fecal pellets in flotation samples are noted on Tables 18.2, 18.3, and 18.4 as an indication of the contamination potential. Almost all samples had insects. Rodent fecal pellets were uncommon, but rodent bone was commonly recovered, and rodent burrows commonly encountered during excavation. Together with the distribution of artifacts and fire-cracked rock, it’s clear that the deposits at Swallow were subject to significant bioturbation.

All samples had small amounts of wood charcoal. Aside from charcoal bits, carbonized plant elements were rare, with only 12 samples containing carbonized elements. A Flotation Data Record was filled out for the 12 samples that have carbonized elements. Given that this study is being

Table 18.2. Macrofloral samples.

	Provenience				
	Feature 44 FS 19132	Feature 95 FS 32858	Feature 95 FS 32859	Feature 108 FS 13667	Feature 108 FS 13668
Liters Floated/Light Fraction Volume	?/0ml	?/8.5ml	?/1.25ml	?/8ml	?/2ml
Contents					
Seeds					
Astragalus type		1			
Celtis		2F/4*		12F	
Chenopodium.	1+2F/1*				
Rosa type		1F			
Sporobolus			2*		
Unknown				1*	
Unknown				5F*	
Other					
Allium skin	1				
Chrysothamnus bud	1				
Juniperus scale leaves					
Poaceae stem	1*				
Pinus edulis cone scale					1*
Pinus edulis needles		P/3*			
Pinus edulis bark				P*	5*
Wood Charcoal					
Gymnosperm	P*	P*	P*	P*	P*
Juniperus					
Pinus edulis					
Dicot					
Non–Floral					
Bone	13/3*	1		11/1*	3/1*
Gastropods		7	P	7	
Insects		P	P	P	P
Microliths	2				

* = Charred; 3/5* = Uncharred and charred elements in same sample; (3/5* = 3 uncharred, 5 charred); F = Fragment; +F = Fragments present in additional to individuals; P = Present

done voluntarily and the number of unknowns about the methods, no effort was made to further refine the identifications of the uncharred seeds. They are assumed to be modern contaminants, not cultural, and are not included for further discussion.

Twenty-seven samples without carbonized plant elements other than wood charcoal are listed in Table 18.5. Seeds, other plant elements, wood charcoal, and non-floral materials for the 12 samples with carbonized elements are delineated by condition and number in Tables 18.2, 18.3, and 18.4.

Table 18.3. Macrofloral samples.

	Provenience				
	Feature 121 FS 19112	Feature 123 FS 19280	Feature 123 FS 19327	Feature 155 FS 21994	Feature 157 FS 21995
Liters Floated/Light Fraction Volume	?/155ml	?/33ml	?/5ml	?/15ml	?/49ml
Contents					
Seeds					
Celtis		2 F/3*	3F*		
Chenopodium.	30+2F*			10+2F*	1*
Helianthus	6*				1+6F*
Juniperus	1*				
Poaceae	1*			1*	
Portulaca	1*				
Scirpus		1			
Sporobolus	2*				
Stipa spikelet				1	
Unknown	2*				2*
Unknown					1*
Other					
Cactaceae spine		1F*			
Juniperus scale leaves					
Pinus edulis cone scale		1*			
Pinus edulis needle bracts	P				
Pinus edulis bark	45+*	4*	4*	6*	27+*
Wood Charcoal					
Gymnosperm	P* (20)	P*	P*	P*	P*
Juniperus					
Pinus edulis	3*				
Dicot	1*				
Non –Floral					
Bone	6/5*	1*			1*
Gastropods	2	P -F			1
Insects	P	P	P	P	P
Microliths	1				

* = Charred; 3/5* = Uncharred and charred elements in same sample; (3/5* = 3 uncharred, 5 charred); F = Fragment; +F = Fragments present in additional to individuals; P = Present

Paleoethnobotany

Interpreting the cultural use and importance of the archaeological macrobotanical material from the Swallow site involves understanding plant-human relationships, or ethnobotany. Ethnobotanical studies from the ethnographic present are used as guides to past economic botany—how plants were used by people. However, prehistorically deposited seeds and other plant elements preserved through charring are not necessarily indicative of cultural use of the plants. There are numerous pathways by which plant elements may become charred and incorporated into cultural deposits.

Human utilization of plant resources can be conceived of as a continuum of varying levels of plant-human interaction. One end of the continuum is represented by wild plants, in which there is no human intervention in the plant's growth cycle or habitat. The opposite end of the continuum contains cultivated plants. The process of cultivation involves human activities directed at altering plants and their habitat. Cultivation activities range from encouragement of specific plants through selective weeding, watering, or transplanting, to agriculture (the planting and caring for domesticated crops in prepared fields). Domesticates are the extreme end of the human-plant continuum, consisting of populations whose genetic composition and phenotypic expression have been altered through an evolutionary process of human intervention (selection). Between wild and cultivated plants, the continuum contains anthropogenic communities, plant communities that are initiated and maintained unconsciously by human activities. Plants in these communities are adapted to disturbed habitats, habitats created by human disturbance. They are often pioneers or adventives in secondary succession, exhibiting weedy characteristics, termed ruderals.

Table 18.4. Macrofloral samples.

	Provenience	
	Feature 193 FS 32312	Feature 193 FS 32331
Liters Floated/Light Fraction Volume	?/23ml	?/15ml
Contents		
Seeds		
Amaranthus		2
Astragalus type.		3
Helianthus	1+4F*	1
Juniperus		1F
Polygonum		1
Rosa		1
Sporobolus		2
Unknown		2*
Unknown		
Other		
Pinus edulis bark	17+*	10*
Wood Charcoal		
Gymnosperm	2*	
Juniperus	4*	2*
Pinus edulis	3*	3*
Dicot		
Non–Floral		
Bone	3	
Insects	P	P
Rodent fecal pellets	P	P

* = Charred; 3/5* = Uncharred and charred elements in same sample; (3/5* = 3 uncharred, 5 charred); F = Fragment; +F = Fragments present in additional to individuals; P = Present

Table 18.5. Samples without carbonized plant elements other than wood charcoal.

Catalog Number	Provenience	Feature	Modern Plant Elements	Bone
7389	E3S – Level 5	52	Present	
12223	D2S – Level 13/14	17	Present	1
12529	F6S – Level 4	117	Present	
12534	F6S – Level 5	117	Present	6
13258	F3S – Level 9	106	Present	
13666	F3S - Level 12	108*		
13941	F3S – Level 15	106	Present	2
16027	C1S – Level 15	102	Present	
17556	D1S – Level 4	118	Present	
17573	D1S – Level 14	none	Present	3
19220	C1N – Level 4	123*	Present	
19338	C1N – Level 6/7	123*	Present	6
21315	C1S – Level 32	161	Present	1
21389	D1N – Level 14	160	Present	
21487	C1N – Level 18	160	Present	
25385	F5S – Level 4	166		
26058	F5S – Level 10	181	Present	
28705	E2S – Level 14	36B	Present	
28826	E2S – Level 17	36	Present	
29141	E4S – Level 20	147		
29213	E4S – Level 21	147	Present	2
31428	A2S – Level 9	192	Present	
31429	A2S – Level 9	192	Present	
31809	B3N – Level 13	195	Present	3
32025	A1S – Level 7/8	202		1
32289	B2N/C2N – Level 4	154	Present	
32395	C3N – Level 5	199	Present	2

* = Features that also had samples that contained carbonized plant elements.

Ethnobotanical information has previously been compiled and summarized for edible plants (Harrington 1967, Yanovsky 1936). Moerman has recently produced thorough compilations of all ethnobotanical data (1998, 2009). The following information on plant use is abstracted from these sources.

Nine taxa of plants with carbonized elements were recovered from the Swallow site.

Wild Plants

Six taxa of wild plants were recovered. Seeds from *Celtis* (Hackberry) *Juniperus* (Juniper), and at least two types of Poaceae (grass) were present. *Pinus* (Pine) was recovered as needles and cone scales. Juniper and pine wood charcoal was also recovered. One Cactaceae (cactus) spine was recovered.

Hackberry fruit berries were eaten, both fresh and dried and stored. The fruits with seeds were also pounded or ground into powder or cakes and dried for winter use.

Sporobolus (dropseed) and seeds from two undifferentiated types of Grass Family (Poaceae) were recovered, as was a grass stem. All native members of the family have edible seeds which were parched and ground into meal. Awns or hairs were burned off. Young leaves of some grasses were cooked as greens. Grass was also used for fiber crafts, and as bedding, floor covering, and insulation.

Juniper had many uses. Berries were used as food and medicine. Berries were eaten fresh and dried and stored, ground into meal, used to flavor meat stews, roasted and steeped to make a beverage. Juniper scale leaves, high in vitamins, were used to make a medicinal tea for coughs and colds. Juniper wood was used for fuel and construction, and for bows and arrows. Berries, needles, and bark were used to produce dye, yellow to orange to brown. Bark was used for bedding, floor covering, tinder, and to line storage pits for dried fruits. Pitch was used as an adhesive.

Pinyon pine is another important resource with many uses. The nuts are highly nutritious. The nuts themselves were not recovered, but cone scales were. Whole cones were sometimes heated to open the scales and release the nuts. Nuts were eaten raw or roasted. Roasted nuts were stored in the shell or ground into meal. Pinyon needles, also high in vitamins, were steeped to make medicinal tea, and heated and the fumes inhaled. Pinyon buds, inner bark, and resin were also used medicinally. Inner bark was mashed into cakes or ground into meal and eaten. Bark scales were repeatedly recovered, which may have been from use as fuel or perhaps from use of the bark for food. Pinyon wood was a valuable fuel due to high pitch content and was also used for construction.

The single cactus spine fragment may have been incidental or may have been from preparation of cactus fruits. Spines were removed by burning the fruits as preparation for consumption or storage.

Ruderals

Three taxa of ruderals were present. Seeds of *Chenopodium* (Goosefoot), *Portulaca* (Purslane), and *Helianthus* (Sunflower) were recovered. All are weedy annuals, adapted to disturbed anthropogenic habitats. There is extensive ethnographic data on the consumption of seeds from these plants. Seeds were usually ground into meal, added to stews and soups, or formed into cakes or made into batter. Sunflower seeds were also eaten as seeds. These three taxa of seeds have been repeatedly and commonly recovered archaeologically, throughout the Archaic stage and from the Early Ceramic period. They were an important food resource. Goosefoot seeds are the most commonly reported weedy annual from archaeological contexts. Goosefoot and Purslane leaves were also eaten as greens.

Domesticates were not expected and not recovered.

Context

Carbonized plant elements aside from charcoal were recovered from eight features.

- Feature 44/Sample 19132: This is postulated as a lean-to structure, with the sample from a line of sand possibly demarcating the lean-to shelter edge. The feature is from Level 1, the Early Ceramic period.

- Feature 95/Samples 32858 and 32859: Feature 95 is described as a "hearth," a "burned rock pile on a burned surface" from Levels 17-21. Sample 32858 is from Level 20, mixed Middle and Late Archaic. Feature 95 dated to 2800±80. RCYBP (Date 34), a Late Archaic date.

- Feature 108/Samples 13667 and 13668: This is described as "Separated clay masses" from Levels 11 & 12, mixed Middle and Late Archaic. The samples are from Level 12.

- Feature 121/Sample 19112: This is described as a "pit with charcoal at the bottom," as a "hole - poorly defined burned rock, charcoal," and as a "possible fire-pit" from Level 3, the Early Ceramic period. This sample had the most matrix of all samples and the most carbonized material. It appears to be a hearth..

- Feature 123/Samples 19280 (Level 5) and 19327 (Level 6): Described as a hearth, and a rock-lined basin, in Levels 4-6, the Early Ceramic period.

- Feature 155/Sample 21994: Described as an ash pit, with the sample from Level 4, the Early Ceramic period.

- Feature 157/Sample 21995: Described as an ash pit with the sample from Level 4, the Early Ceramic period.

- Feature 193/Samples 32312 and 32331: Described as a "hearth, a shallow semi-circular basin with dense rock and charcoal fill," "possibly several merged or overlapping hearths." Samples are from Level 4. Feature 193 dated to 1150±60 RCYBP (Date 4), the Early Ceramic period.

Conclusions

Botanical materials visible and recovered during excavation were rare, and with three exceptions were modern contamination. The exceptions are the concentration of charred *Celtis* (hackberry) seeds, Feature 208 at the top of Stratum D1, Early Archaic deposits below the rockfall; and two concentrations of charred *Helianthus* (sunflower) from Level 4 and Level 6, Early Ceramic deposits.

Carbonized plant material recovered from flotation of soil samples was also meager. The paucity of carbonized plant material recovered from flotation samples at Swallow is striking and somewhat puzzling. Only a few carbonized seeds and other elements from a small number of taxa were recovered. Given the length and intensity of occupation of the shelter, one would expect a larger array of plants and greater frequency of occurrences.

The sparseness of cultural macrobotanical material may in part be due to the methodology of flotation. The methods used to float the bulk soil are not documented, with the exception of the samples floated by Marie Mayer. If the soil samples were floated using the methods described by Mayer of using a 1 mm mesh, then almost all seeds smaller than 1 mm would not be recovered. The majority of plant seeds are smaller than 1 mm.

It also appears that many of the features did not contain primary deposits, or that the feature contents were a mixture of materials that had blown or sifted into the feature. The very small volume of light fraction is indicative of feature fill that does not contain much organic material. However, the amount of soil floated from each feature is unknown. The one exception to this is Sample 19112 from Feature 121. That light fraction of 155 ml yielded the most carbonized material. The sample gives every appearance of being primary deposits from a firepit.

The wood charcoal remains recovered indicate that most firewood was from gymnosperms, including juniper and pine. Some dicotyledonous shrub wood was burned. Most of the charcoal is too small for identification to species or genera, and the amount that can be identified is of insufficient quantity to show preferences or change through time.

Three taxa of ruderals were recovered. Seeds from *Chenopodium* (goosefoot), *Portulaca* (purslane), and *Helianthus* (sunflower) were present in limited occurrences and quantities. These taxa are indicative of anthropogenic disturbance, human disturbance creating habitats to which the plants are adapted. One would expect such habitats in and around the rock shelter.

Wild plants were used, including juniper berries, *Sporobolus* (dropseed) and other grass seeds. *Celtis reticulata* (hackberry) was used in the Early Archaic, Late Archaic, and Early Ceramic. Uncarbonized hackberry seeds were also repeatedly recovered. Hackberry does grow on the slopes of the Lyons hogback, although it is not listed as occurring in the Ken Caryl vicinity (Lyons 1997). Juniper berry (seed) was used, and pine nuts were almost certainly also used. Pine nuts were not recovered, but scales from pine cones were.

Six of the eight features that yielded carbonized plant elements are from the Early Ceramic period. There is insufficient data to examine diachronic plant use or gain a realistic view of the role of plants in the subsistence of the site occupants.

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Human Skeletal Remains

Michael Finnegan and Sarah J. Meitl

Editors' Note: Skeletal analysis was conducted at Kansas State University by Dr. Michael Finnegan (now emeritus) and Sarah Meitl (now at the Alaska State Office of History and Archaeology). In consultation with the Ute Mountain Ute Tribal Historic Preservation Officer, the complete Chapter 19, Human Skeletal Remains, is available to qualified researchers at the Office of Archaeology and Historic Preservation, History Colorado, as OAHP Burial Case #384. The abstract from Chapter 19 is also provided here.

The burials and a few isolated human bones from Swallow and the other Ken Caryl sites have been repatriated to the Ute Mountain Ute Tribe.

Abstract

Two human burials were found at Swallow site. Both were tightly flexed, primary burials. The skeletal remains were analyzed to the extent allowed by the condition of the bony material. One (Feature 12) was that of an adult female 50-60 years of age, the other (Feature 17) an adult male, 50+ years of age. Both burials were found in Stratum C, suggesting an Archaic age, however the top of the burial pit was not defined in either case, making their ages uncertain. Charcoal found near each burial was radiocarbon dated, providing a tenuous date of 3440±90 RCYBP for Feature 12, and 1880±90 RCYBP for Feature 17. While neither skeleton is complete, the extant bone displays a variety of pathology and trauma which indicates the strengths of the individuals and their survival skills. These remains are compared with other Late Archaic remains from near proximity as well as elsewhere in the Plains. Analysis of these remains extends our knowledge of the hazards and resultant traumas suffered by Late Archaic peoples of the Plains.

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Synthesis and Conclusions

Jeannette L. Mobley-Tanaka
and Peter J. Gleichman

Drawing conclusions from Swallow is both an exciting and a frustrating process. Among the deepest, richest, and most completely excavated sites in the Hogback valley, Swallow has the potential to address long-standing questions in Colorado archaeology and clarify our understanding of ancient indigenous lifeways along the Front Range. On the other hand, extensive bioturbation, both by animal and human activity, has resulted in relatively weak chronological control, despite numerous radiocarbon dates obtained in several ways. Furthermore, the volunteer nature of the analysis conducted over more than a 20-year time span by numerous different people has left gaps and inconsistencies in the research that limit our interpretations in some ways. We hope the summary of information and interpretations here will provide useful insights to Colorado archaeology and the place of the Hogback valley in indigenous history, but also serve to inspire future researchers to pursue as yet underutilized aspects of the assemblage.

Swallow Site Summary

With cultural deposits extending to a depth of 4.3 m and a 7,000-year time span of occupation from 8320 BP to 1040 BP, dated both by radiocarbon dates and diagnostic artifacts, Swallow is an important archaeological site. It is the largest and most extensively excavated of the rock shelters explored by the Denver Chapter of the Colorado Archaeological Society (DC-CAS) in the 1980s and 1990s on the Ken-Caryl Ranch. Excavations took place from 1983 to 1998. A 2-x-2-m grid was laid out consisting of 57 units extending 7 m west from the shelter wall on the north, and 16 m west from the wall on the south, and a total of 20 m north-south. Forty-two units were ultimately opened. Of those, half of the units were excavated to a depth of approximately 160 cm, into the upper Early Archaic levels. As accessing the Lower Early Archaic levels required jackhammering and removing large slabs of rock, only the 14 units in the center portion of the site were excavated

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below the rockfall, and of those, 8 were excavated to bedrock. Grid units left unexcavated were primarily on the southwest corner of the site. Excavators noted that the site does extend to the south of the excavated units for an unknown distance. Exploratory trenches to the west and north, however, confirmed that the majority of the site was encompassed by the excavation grid on all sides except the south. Approximately 37% of the excavated volume of the site was in Early Ceramic levels, 30% in Middle/Late Archaic levels, and the remaining 33% in Early Archaic levels (13% above the rockfall and 20% below).

There is one notable gap in the habitation sequence, during the Early Archaic after the collapse of a portion of the monolith. This collapse created a rockfall layer that partially sealed the earliest occupation of the site, which dates to the beginning of the Early Archaic. A later Early Archaic level can be defined above the rockfall, and a very clear Early Ceramic layer is evident in the upper 70 cm of the site. Between these more clearly defined components, the layers representing Late and Middle Archaic occupations are heavily intermixed, as evidenced both by the distribution of diagnostic projectile points and radiocarbon dates, and Late and Middle Archaic components cannot be clearly delineated.

By far the densest occupation levels and most clearly represented component at the site is the Early Ceramic, which accounts for approximately half of the features and artifacts recovered during excavations. The evidence suggests that, through all periods of occupation, the shelter served as a winter habitation site, probably a base camp for hunter-gatherers who practiced a collecting strategy of resource acquisition in the winter months as part of a repetitive, predictable land use pattern that incorporated the Hogback valley, the mountains, and the Palmer Divide for millennia.

Paleoindian

A Folsom preform base fragment, identified as such by Jodry and Stanford (1995), and a single radiocarbon date are the only suggestions of a Paleoindian presence at the site. The earliest date from the site, 8320 ± 60 BP came from charcoal below the Folsom preform but substantially postdates Folsom, representing the end of the Paleoindian Stage. This indicates that the presence of the Folsom point is the result of curation by later, Early Archaic people. Two Early Archaic dates (7170 ± 60 BP, 6930 ± 50 BP) occurred in the layers immediately beneath the rockfall, which also contained Early Archaic projectile points. This suggests that the earliest use of the site occurred sometime near the Paleoindian/Early Archaic transition, but with no constructed features exposed below the rockfall and only a sparse scattering of artifacts, defining any activity that predates the Archaic is not possible. We therefore remain open to the possibility of Paleoindian activity in the Hogback valley, but do not consider Swallow to have a Paleoindian component.

Early Archaic

Early Archaic (5500-3000 BC/7500-5000 BP) occupation at the site can be divided into two distinct occupations by a collapse of a portion of the shelter wall, dubbed "the rockfall" by excavators.

This rockfall sealed the earliest occupation at the site; we refer to these sealed layers as the Lower Early Archaic, while the layers immediately above it are referred to as the Upper Early Archaic.

Lower Early Archaic

The earliest layers are defined as Early Archaic based on diagnostic artifacts and the dates given above. Use of the site before the rockfall event appears to have been light, with no constructed hearths uncovered, despite the Lower Early Archaic excavation units being in the central part of the site, where the greatest density of features occurs in higher levels. A general lack of fire cracked rock below the rock fall further suggests that constructed hearths are largely lacking in this earliest Archaic occupation. The only feature found consists of a sandy, ashy lens containing charred hackberry seeds. A sparse assemblage of artifacts was recovered, including five projectile points. Four large corner notched points, Swallow Type 2a, were present, as was the base of a stemmed-indented base point, Swallow Type 3d. The Type 2a points are consistent with types documented elsewhere in the Hogback valley (LoDaisKa J, MM23), but the Type 3d point bears similarities to Pinto Shouldered points found west of the Continental Divide. All were made of local materials.

Other Early Archaic artifacts below the rockfall included 13 scrapers, 10 bifaces, 28 bone tools, and 11 grinding stones. In addition, a moderate amount of animal bone was recovered, including deer, rabbit, bison, elk, and a variety of small and medium size mammals and birds. As with all levels of the site, the animal bone was dominated by deer, highly fragmented and burned, suggesting processing for bone grease and marrow as well as meat. The most notable distinction in the faunal assemblage in this earliest occupation was the level of burning. Substantially more of the bone was burned, both of large and small animals. Forty-four percent of the Lower Early Archaic deer bone was burned, compared to 33-38% in later levels. For rabbit bone, the trend was even more pronounced, with 51% of the Lower Early Archaic bone burned, compared to 20-22% in later levels. Along with the apparent lack of constructed hearths, this indicates different cooking strategies in the earliest Early Archaic occupation with meat roasted with direct heat, potentially over open fires built without formal hearths, rather than cooked with indirect heat, as might be achieved with stone boiling or in hearths filled with hot stone. Carbonized hackberry seeds suggest the use of local plant foods, but with no formal hearths, macrobotanical material was limited.

The range of tools implies a variety of activities one might expect at a habitation site, but their paucity might suggest shorter duration or less frequent stays than those of later times. The major distinctions between this earliest level of occupation and later ones are the lack of hearths and minimal amounts of fire-cracked rock. Troyer (2014) has documented the lack of rock-filled hearths prior to the Archaic in northern Colorado. The lack of them in these earliest levels at Swallow, along with the evidence for different meat cooking strategies and the early dates may suggest that the lowest levels at Swallow represent a transitional time before the innovation of rock-filled hearths was fully established.

A second notable distinction between the Lower Early Archaic and later use of the site is the distribution of lithic flakes and artifacts concentrated in the central part of the site, just outside the shelter dripline. This is a slightly different orientation of the space than seen in later occupations and suggests that the more formalized pattern of use seen later had not yet been established by these earliest occupants.

Upper Early Archaic

With the collapse of a large section of the monolith, the topography of the shelter floor became a jumble of large rocks that may have initially made the space unattractive for occupation. A 600-year gap in radiocarbon dates and a 12-30 cm thick red-orange layer of relatively sterile sediment demonstrate a hiatus of occupation for a significant span of time. Nine Early Archaic radiocarbon dates from above the rockfall span from 6345 ± 25 to 5335 ± 15 BP.

Local environmental reconstructions derived from pollen columns, one near the rock shelter wall within the core of the site, and one outside the shelter dripline near the southwest corner of the site where evidence of human activity is more sparse (see Groth, Chapter 6) suggest that the Upper Early Archaic occupation (after the rockfall and hiatus) occurred during a time of fluctuating moisture regimes, with moisture levels on the whole somewhat less than modern averages, and with at least three significant intervals of dry-to-drought conditions during the use of the site. In the Early Archaic levels (Levels 19-23), two extreme droughts appear to occur with a wetter interval between them. This appears to correlate with the Altithermal droughts and supports the two-drought model for the Altithermal in the foothills and mountains (Benedict 1979; Nelson et al. 2008). Despite fluctuating relative moisture, pollen samples indicate that both flowing water and shallow or boggy riparian habitats remained part of the local environment, in addition to open sage and grasslands and nearby open woodland of juniper, scrub oak, and pine.

With the reoccupation of the shelter after the rockfall and accompanying hiatus, a distinct spatial patterning developed, with concentrations of features and cultural materials in the south-central section and another on the northern section of the excavated area. Features in these areas were positioned along the dripline of the shelter, perhaps to prevent the pooling of smoke under the rock. This pattern of two concentrated activity areas begins in the Early Archaic and persists throughout the Archaic levels, speaking to the consistency in the use of space. This use may have been somewhat shaped by the presence of the rockfall, which created sheltered areas on the north end and flatter, more open areas to the south, but it may also reflect an established camp that was reused according to where features were already visible or where people remembered doing certain activities on previous visits. Such consistency of site use over long periods of time has been observed at other ancient indigenous camps on the Great Plains (Bamforth et al. 2005). Oetelaar and Oetelaar (2007) discuss the ethnographic traditions that maintained camp locations and the environment around them through subsistence rounds that were also annual ritual rounds, connected to practices and deeds of ancestors preserved through oral histories and local landmarks. Repeated visits to locations came with an obligation to generations both before and after, and included controlled burns, culling undesirable plants, and renewal rituals that enhanced desired species.

These ritualized maintenance activities ensured camp localities remained viable for repeated use year after year, ultimately building deep archaeological deposits. It is easy to imagine similar site maintenance activities contributing to consistency of site layout at Swallow and of food resources in the Hogback valley.

At Swallow during the Upper Early Archaic, the channels and sheltered spaces among the fallen boulders on the north end of the site would have been most pronounced, and appear to have been used as shelters, while the more open south-central area was more conducive to food processing or other activities that required more open space. It was probably the kinds of traditions discussed by Oetelaar and Oetelaar (2007) that kept these established patterns of the two ends of the site in place, even as sediments filled in around the rocks and the channels no longer provided the same shelter they once had.

In addition to long-term activity areas, faunal remains, features, and artifact types all suggest very similar use of Swallow through the Archaic, despite the fluctuations in environment. Seven hearths, of two distinct styles, were found in the Upper Early Archaic levels; rock-filled hearths that were most likely used in food preparation, and slab lined hearths, a style of hearth diagnostic of the Archaic in Colorado (Johnson et al. 1997b:137) designed to create maximum heat with minimum fuel (Stiger 2001). Rock-filled hearths are of moderate size in the earliest levels but increase in size through the end of the Early and the beginning of the Middle Archaic. Troyer (2014) hypothesizes that rock-filled hearths were primarily used in the preparation of plant foods, though there is little macrobotanical evidence to support this idea. The reduction in burned bone at Swallow simultaneous with the appearance of rock-filled hearths and scattered fire-cracked rock suggests that rock-filled hearths and stone boiling may have been used to cook meat; however, whether exclusively or in conjunction with plant foods is not known. Only one Early Archaic hearth, Feature 95, dated to the Early/Middle Archaic transition produced macrobotanical food remains, in the form of two charred hackberry seeds.

Rock-filled hearths at Swallow occur in the south-central portion of the site. Slab-lined hearths are generally smaller and occur in the northern portion of the site, sometimes in channels between boulders. These hearths were most likely warming features, located in narrow channels in the rockfall that could have been easily enclosed with a roof of brush or hide to create cozy spaces for sleeping or for riding out cold or stormy weather.

This Upper Early Archaic layer has the first of three dense layers of scattered fire-cracked rock that were found at the site. These layers could be the result of several different processes—the dismantling or refurbishing of rock-filled hearths, the destruction of hearths by natural processes during intervals when the site was not in use, or the discarded materials from periods of intensive stone boiling. While this is the smallest of these layers, it does attest to the beginning of a pattern of steady use of the site that persists into the Early Ceramic era.

Diagnostic projectile points associated with the Early Archaic levels above the rockfall include four Swallow Type 3d shouldered points (Pinto Shouldered points), two Swallow Type 4d side notched points (LoDaisKa H/MM3), and one Swallow Type 2a corner notched point (LoDaisKa J/MM23). Two of these three types were also found beneath the rockfall. In addition, manos and metates were relatively abundant, attesting to the increased importance of plant foods characteristic of the Archaic. Bifaces, scrapers, choppers, gravers, bone awls and scrapers, and bone beads were all found in the Upper Early Archaic layers in greater abundance than in the earlier deposits. Artifact and lithic scatters center around the same areas as the greatest concentration of hearths, in a pattern analogous to the drop and toss zones identified for hunter-gatherer campsites by Binford (1978), with the greater amount of activity taking place around the south-central hearths, suggesting that the rock-filled hearths in this area were not only used for preparing food, but were also important generalized activity areas.

Bone, at all levels in the site, was dominated by deer and heavily fragmented, but small quantities of other large, medium, and small mammals are present, including elk and bison, rabbit, prairie dog, squirrel, and porcupine, in addition to turkey.

Middle and Late Archaic

After the Early Archaic, occupation and activity at the site intensified, but the timing of that increased activity is uncertain, as the Middle Archaic (3000-1000 BC/5000-3000 BP) and Late Archaic (1000 BC-AD 150 / 3000-1800 BP) levels were so thoroughly mixed as to make it impossible to sequence activities through this time span. Nine Middle Archaic dates span the period 4760 ± 60 to 3150 ± 100 BP. Five Late Archaic dates extend from 2800 ± 80 to 1880 ± 90 BP. Features, which do not move with bioturbation as readily as artifacts, and many of which were hearths containing charcoal that could be radiocarbon dated, offer a hint that occupation may have fluctuated through the Middle and Late Archaic. Hearths dated to the Early/Middle Archaic interface are on average larger and show greater variation overall than at any other time at the site. There are also more features at the Early/Middle Archaic transition than any other point in the Archaic. Associated levels in the environmental pollen column show a significant increase in the pollen of cheno-ams in the Early/Middle Archaic transition levels, running contrary to grass and sage pollen ratios that suggest an overall increased moisture regime at this time (see Groth, Chapter 6:Interval 2). This increase in cheno-am pollen may indicate increased human impact in the environment; cheno-ams are weedy annual plants that thrive in disturbed soils around human habitations. Taken together, these lines of evidence suggest an increase in activity at the site at the end of the Early Archaic or onset of the Middle Archaic.

The number of features as well as size of hearths shrink dramatically in the Middle Archaic, and cheno-am pollen reduces to one of the lowest levels throughout the site occupation, despite more xeric conditions that can favor cheno-ams, suggesting a subsequent decline in site use for a period of time. In the upper levels of the Late/Middle Archaic sequence, hearth size and number of features increase once again. It appears, then, that the Middle to Late Archaic was a time span when group size and/or frequency of use at the site varied, with an initial increase around the Early-to-Middle Archaic transition, lighter use for a period of time in the middle of the sequence, and increased use again toward the end of the Archaic, though the exact timing and duration of these intervals is uncertain. They do, however, seem to correlate with shifting moisture regimes as reconstructed from the pollen records. Ratios of wet and dry indicator species indicate two spikes in moisture, when effective moisture surpassed modern averages, and these two spikes occur in Levels 15-16 which roughly correlates with the Early-to-Middle Archaic transition hearths (identified in L15-18), and Levels 8-10, which correlate with the latest Archaic hearth group (identified in L9-11). Thus, it appears that site use increased during local wet periods and decreased during periods of dry to drought conditions.

Despite these demographic fluctuations at the onset and throughout the Middle and Late Archaic, features, use areas, and artifact assemblages remain remarkably unchanged. It would appear that subsistence practices were relatively resilient; response to poor climatic conditions was achieved through reduced utilization of the area rather than a change in resource use. Rock-filled and slab-lined hearths continue in use and occur in the same north and south-central areas in an unchanging activity pattern. A denser layer of fire-cracked rock runs through the Late/Middle Archaic deposits, the densest concentrations in Levels 11-14. This is the dry span between moisture spikes that we have suggested saw decreased use of the site. It is not inconceivable, then, that the spread of fire-cracked rock in these levels represents the destruction or scattering of rock from features during an interval of disuse, but it might also indicate more intensive stone boiling of bones to render every bit of nutrition from them in leaner times.

Heavy admixture of deposits resulted in the presence of 22 different projectile point styles, diagnostic of all time periods. The majority (12 types) are characteristic of Late and Middle Archaic, while 7 were of Late Prehistoric origin and 3 represented the Early Archaic. The most common type, accounting for 25% of the projectile points found in these layers, was the Duncan Point, a type within the McKean complex, dating to the Middle Archaic. A complete list of Middle and Late Archaic points from the Middle/Late Archaic levels is found in Table 20.1.

A large number of bifaces and scrapers was recovered from the Middle/Late Archaic layers, as well as a variety of other lithic and bone tools. Bone beads, fragments of bone decorated with punctate designs, and grinding palettes stained with red ochre suggest personal adornment. Ground stone was especially abundant in these layers of the site, with 116 metates and 75 manos, many of which were found in caches, suggesting ground stone was curated from year to year, or possibly for mass processing events, like harvest events or bone crushing for grease extraction events. Ground stone is the only category of tool from the site that occurs in greater abundance in the Archaic levels than in the Early Ceramic levels.

Finally, bone, as before, was dominated by deer and was heavily fragmented, implying bone grease extraction; however, the Late/Middle Archaic layers have dramatically more bone (almost 12 times more) than earlier layers, and a wider variety of animals represented. While 14 taxa were

Table 20.1. Middle and Late Archaic projectile points from Middle/Late Archaic levels.

Swallow Type	Similarity/Named Type	Number
3d	Pinto Shouldered	1
3a	Duncan	27
3e	Mallory	2
2b	LoDaisKa K, MM 20	8
4c	LoDaisKa H MM 5	7
4b	MM 18, MM 21	3
4a	LoDaisKa H, MM 32	3
11d	LoDaisKa C, MM 10	1
5	Unknown	1
2c	LoDaisKa F, MM 22	5
9	Besant	3
10	Small Sudden-like (LA/EC)	1

found in all Early Archaic levels, 28 occur in the Middle/Late Archaic levels. The larger number of animals is undoubtedly due in part to the increased sample size but may also represent a wider range of hunting strategies and an expansion of species considered food resources. The presence of duck and turtle, for example, suggests a utilization of wetland resources not seen earlier, while the addition of antelope and marmot may indicate a wider hunting sphere, extending both east onto the plains and west into the higher elevations of the mountains. Before suggesting that the large number of species present implies broad spectrum foraging by Swallow inhabitants, it should be noted that deer and unidentified deer-sized mammal bone make up 91-93% of the bone assemblage throughout the occupation, peaking at 93% in the Late/Middle Archaic levels. Cottontail rabbit is the second most common species, accounting for 5% of the assemblage. The remaining 26 species combined make up only 2% of the bone found in these levels (excluding bone considered to be intrusive species). Thus, while there is evidence for an expanded use of resources, there is stronger evidence for a continued heavy reliance on deer, and the addition of other foods may be more opportunistic than representative of a meaningful shift in subsistence.

Early Ceramic

A number of traits distinguish the Formative Stage across North America, including use of the bow and arrow, adoption of or increased reliance on pottery, and the adoption of horticulture. In eastern Colorado, the term “Formative” has been dropped from use due to the absence of an agricultural adaptation. The era is termed the Ceramic Period and the Early Ceramic is characterized by small, corner-notched points indicative of arrows, and cord-marked pottery, but only scant evidence of domesticated plants. Swallow site is no exception to this; despite ample evidence of Early Ceramic occupation, no evidence of cultigens was found, and there is very little reason to believe they were grown in the Hogback valley.

The environmental record for the Early Ceramic occupation at Swallow is somewhat uncertain, as degradation of the upper part of the soil column (from surface to 80 cm) led Groth (see Chapter 6) to reject that section as contaminated. The Late Archaic levels seem to end with a period of drought, consistent with the Terminal Archaic Drought proposed by Gilmore (2008a), followed by a dramatic spike in moisture regimes that might correlate with the beginning of the Early Ceramic occupation. Whether this spike is the onset of a moist interval or a brief anomaly in a dry period is not clear because of the truncation of the pollen record immediately after.

Whether it was because of favorable weather patterns or for other reasons, the Early Ceramic (AD 150-1150 / 1800-800 BP) occupation represents the most intensive use of the site locality throughout the occupational sequence. Fourteen radiocarbon dates span 1650 ± 40 to 1040 ± 80 BP. Layers associated with the Early Ceramic (L1-7 or 8) are stained gray, indicative of increased activity, and the Early Ceramic layers, about 37% of the excavated volume at the site, contain approximately half of the assemblages of features and all artifact classes except ground stone. Nineteen discontinuous segments of stained and compacted surfaces occur throughout the Early Ceramic occupation, indicating increased foot traffic, either due to larger populations, longer periods of occupation, or both. This increased activity at the site is consistent with regional demographic reconstructions for eastern Colorado that indicate a dramatic increase in population through the Early Ceramic (Gilmore 2008a, 2008b).

Both the types and the spatial distribution of features changed in the Early Ceramic period. The slab-lined hearth disappeared, and two new styles of cooking/heating features appeared: the unlined pit and the ash pit. Unlined pits are simply that, pits without rock in them, but the pit walls were burned and the fill contained high amounts of charcoal and ash, indicating they were used as hearths. Ash pits are shallow features filled with burned material fully reduced to ash. These new pits suggest new cooking strategies were being employed in the Early Ceramic, either because new foods were entering the diet or because pottery allowed old foods to be prepared in new ways. As a pot can sit in or over a fire in a different way than a boiling bag would, and differently than meat or vegetables being slowly roasted in a nest of hot rocks, it is logical that cooking in pottery vessels necessitated different hearth constructions and potentially different ways of handling heating sources (slow beds of coals in ash pits rather than open flames from burning logs in a slab-lined hearth, for example). In addition to these two new hearth styles, rock-filled pits continued in use throughout the Early Ceramic.

While hearths continued to be constructed roughly along the dripline of the shelter overhang, they no longer displayed the north/south-central site patterning of the Archaic, but formed a more continuous line along the length of the shelter. This may simply be because there are so many more Early Ceramic hearths, 30 in total, and the palimpsest of hearths over time masks any distinctions of activity areas that may have been present during use, or it may be that the older arrangement of space no longer served the needs of site residents once the channels between rockfall boulders filled in to the extent that they did not create spaces that could be used as shelters. One feature does suggest something of the old pattern of shelter on the northern end of the site, and that is

Feature 44, a 6.5 m long linear deformity interpreted as a lean-to shelter. The feature consisted of a shallow (5-10 cm) channel running parallel to the rock face, filled with orange-red sand, and with a deformed base due to irregular compaction of the ground. A stained living surface was identified between the channel and the rock, in what would have been the interior of the lean-to, along with an ash pit. The sandy red sediment filling the channel appeared to be decayed sandstone from the monolith and was interpreted as run-off deposits from the overhang that would have flowed across a lean-to and settled at its base. Feature 44 was situated on the north end of the site, where the now-buried rockfall blocks had previously been used as shelters.

While the feature is somewhat enigmatic, the interpretation of a lean-to is not unprecedented. Brunswig (1996) includes rock shelter lean-tos as one of the four subclasses of habitation structures seen in Early Ceramic sites in Colorado. Perhaps the most analogous feature was one found at Three O'clock Shelter (5WL1997) in Weld County, where a linear arrangement of boulders just outside the dripline of the shelter wall was interpreted as the base of a lean-to (Gilmore 1999:240). This feature had a similar placement in the shelter to the Swallow lean-to, though it was smaller and included rock at the base, which the Swallow feature does not include. The lack of rock along the base of the Swallow lean-to is perhaps the most problematic aspect of the interpretation. Early Ceramic structures recorded thus far at other Colorado sites, whether in open camps or rock shelters, incorporate either an excavated basin indicative of a pit structure, or piled or stacked rock walls or alignments to secure superstructures, neither of which is present at Swallow. Excavations at the nearby Magic Mountain site in the 1990s revealed two structures (Kalasz and Shields 1997), but both included sandstone slabs on the floors and linear arrangements of rock that would have served as a base for a superstructure of perishable materials. At Swallow, a dense layer of fire-cracked rock, the latest and densest of three such layers at the site, occurred in Levels 3-7, and it is possible that any stone used at the base of the shelter (which occurred in Level 4) could have been scattered into this layer by bioturbation, human reoccupation of the site, or simply missed by the excavators because of the overall density of stone; however, the lack of a stone alignment leaves the interpretation of the lean-to tentative.

As is characteristic for Early Ceramic in eastern Colorado, the dominant projectile points are small, mostly corner-notched points, heralding the use of bow and arrow technology. Due to the extreme bioturbation of intense human use, rodent burrows, and modern disturbance, nearly all point styles found at the site were present in the upper levels, but the projectile points recovered from the Early Ceramic levels are dominated by small, corner-notched Hogback points as well as a variety of Magic Mountain and LoDaisKa styles (Table 20.2).

In addition, over 300 bifaces, 143 scrapers, and various other lithic tools were found in these levels, indicating the same range of activities seen in earlier times. Manos and metates are slightly underrepresented, and more frequently made of local sandstones, compared to earlier ground stone, especially manos, which are more frequently made from igneous or metamorphic rock. This may suggest that reliance on grinding plant foods decreased as the introduction of cooking in vessels reduced the need for extensive processing of hard or dried foodstuffs. Pollen washes on

Table 20.2. Early Ceramic projectile point types recovered from Early Ceramic levels.

Swallow Type	Named/Similar Type	Number
10	Small Sudden-like (LA/EC)	2
13a	Hogback	89
13b	LoDaisKa aa, MM 31, Hogback, Ruby, Scallorn	20
13c	LoDaisKa cc, MM 36, Rose Spring	10
11c	LoDaisKa C, MM 10	1
12	MM 74, MM 75	12
11a	MM 33 (Middle Ceramic)	3
11b	MM 32 (Middle Ceramic)	2

metates recovered from all levels of the site showed elevated pollen counts for grasses and cheno-ams, suggesting that the plant resources most frequently ground on them did not change notably through time, but pots would have allowed for the soaking and slow boiling of coarsely ground or unground grains.

Similarly, faunal assemblages at the site show no significant difference between the Early Ceramic levels and those immediately before them. Highly fragmented deer bone continues to make up nearly 90 percent of the assemblage, followed in frequency by cottontail rabbit. Thirty-two taxa deemed human-use species are represented, including all those seen in the Late/Middle Archaic levels except bear, and adding muskrat, turkey, turkey vulture, goose, and gull, in minute quantities.

While the presence of new styles of features and pottery suggests new cooking strategies, the condition of bone, highly fractured and frequently burned, does not reflect this. If bone was being processed for bone grease in pots rather than boiling bags, it would probably not change the degree of fracturing. The presence of a dense layer of fire-cracked rock in the upper levels suggests that stone boiling may have continued throughout the Early Ceramic period and that the arrival of pottery did not render that cooking technique obsolete. Burning on bone and the continued use of rock-filled hearths both indicate that roasting meat continued in much the same way from the Upper Early Archaic through the Early Ceramic. Burning on bone decreases slightly between the Late/Middle Archaic (33% of bone burned) and the Early Ceramic (31%) but the difference is slight, so if the presence of pots changed cooking habits, it probably did so more for plant foods than animal foods. For example, moist heat cooking (boiling) is the most effective technique for converting the polysaccharides in grass seed to monosaccharides, making the seed digestible to humans (Stiger 1998). It would seem that pottery presented one additional tool into an effective lifeway, expanding the variety and ease of preparation methods rather than dramatically altering food regimens.

Pottery recovered from Swallow consisted of 289 relatively small sherds, all cord-marked and suggestive of conical vessels with pointed bases and little curvature at the shoulder or rim, consistent with Woodland traditions of the Early Ceramic. Some sherds in higher levels exhibited obliteration of cord marks, a trait that Ellwood (1987, 2002) equates with late Early Ceramic or Early-to-Middle Ceramic transitional vessels, but no Upper Republican style ceramics (diagnostic of later time periods) were found at the site. Pottery appears to be of local or near-local manufacture, based on analyses of clay and inclusions, and much of it may have been made without the addition of temper, relying instead on existing inclusions for the aplastic component. This is not typical of Woodland pottery in eastern Colorado, which commonly has crushed rock temper (Ellwood 1995).

The ancient indigenous sequence of occupation at Swallow ends toward the end of the Early Ceramic period, as evident in both the radiocarbon dates and the artifact assemblages. The latest radiocarbon date at the site is 1040 ± 80 BP, well within the Early Ceramic period. Three projectile point styles identified by McComb (see Chapter 9) were described as diagnostic of Middle Ceramic, two small side-notched points (Swallow Types 11a and 11b), similar to MM 32 and MM 33, and small, unnotched points with convex bases (Swallow Type 12). Only Swallow Type 12, the small unnotched points, occurred in significant numbers, with 11 found in Early Ceramic levels, 7 in the Late/Middle Archaic levels, and 1 with no vertical provenience.

While small unnotched points have been attributed to the Middle Ceramic, the points at Swallow had convex bases, while the unnotched points of Middle Ceramic origin identified elsewhere in Colorado more typically have straight or slightly incurving bases (Eighmy 1984). This difference, combined with stratigraphic evidence, led Hammond and Rhodes (2013) to propose that the unnotched, convex-base point is an unrecognized Early Ceramic type where it occurs in the Hogback valley, while similar points at Magic Mountain were considered to be unfinished and classified as preforms (Johnston 2022). Clearly, more work is needed before unnotched points can be interpreted as a temporal marker. Diagnostic pottery styles suggest occupation into the end of the Early Ceramic and the transition toward Middle Ceramic but no later. The diagnostic artifacts then, along with the radiocarbon record, suggest that the transition to the Middle Ceramic saw the departure of indigenous people from Swallow site on a permanent basis. This is consistent with settlement patterns observed at other Hogback valley sites (Johnson et al. 1997a; Koons and Mitchell 2022).

The only use of the shelter after the Early Ceramic occurred in historic times and was Euro-American in nature (see Appendix F for a discussion of historic materials). Euro-American presence in the valley began around 1860. Cattle ranching began around 1876 and continued until around 1980 (Johnson and Mobley-Tanaka 1997:2); this activity had a major impact on the site. Large quantities of cattle dung and evidence of hoof churning at the surface indicate that cattle used the rock overhang as shelter against weather and sun, probably of their own accord as there is no evidence of corrals or fences on the site. Also during the historic era, circular bulls-eye targets were painted on the western face of the monolith and used for target practice, resulting in a number of bullets and bullet cartridges in the upper layers of the site. Bullets and cartridges styles were dated ranging from the 1880s through modern times (Rathbun 1991:Appendix F), suggesting ranch hands and later recreational visitors to the area made use of the targets for almost 100 years. Bottle glass on or near the surface is also associated with these activities, perhaps because bottles were included as targets, or because shooting parties were raucous good times in the shelter. A steel animal trap was also found in historic levels, suggesting that historic hunting or vermin extermination could also account for some of the bullets.

Swallow Site in the Local Context

Swallow is one of six rock shelters tested by DC-CAS as a part of their Ken-Caryl Ranch work (along with Bradford House II, Bradford House III, Southgate, Falcon's Nest, and Crescent). Of the six, Swallow was the most extensively excavated, and as of the publication of this report, the most thoroughly analyzed. Differences in the analysis and reporting make detailed comparisons difficult, but a few observations can be made. Information about the other excavations in this section is taken primarily from the Ken-Caryl report produced by Johnson and colleagues (1997a).

All six shelters were multi-component, with occupations spanning the Middle Archaic through the Early Ceramic. Two shelters, Bradford House II and Bradford House III, as well as two minimally tested sites (5JF209 and 5JF210), had a slightly later Late Prehistoric component, but Swallow does not.

Only Swallow has a well-defined Early Archaic component, although the lowest levels at the nearby Crescent site were not explored. Swallow, therefore, deepens and expands our understanding of occupation of the valley, shedding light on the earliest use, and somewhat later, the establishment of a routine use in the valley. Once established, a remarkably consistent pattern of rock shelter use persisted for thousands of years through the Middle and Late Archaic. Early Archaic sites are not common on the plains of Colorado, perhaps because of limited use in the Altithermal, perhaps because depositional conditions have buried them too deep for discovery (Oetelaar 2004; Koons and Mitchell 2022), or probably a combination of both factors. The Early Archaic levels at Swallow are a clear example of deposition masking early deposits, occurring more than 1.5 m below the surface, and only uncovered because of the clear evidence of later occupations overlying them. On the other hand, the lack of Early Archaic materials at the other Ken-Caryl sites that were excavated may indicate that the paucity of Early Archaic sites in the vicinity reflects reduced or limited human activity, even in areas like the Ken-Caryl Ranch that saw intensive use later in time.

While evidence of Early Archaic use of the Ken Caryl area is restricted to Swallow and limited in amounts of artifacts and features, six types of Early Archaic projectile points were recovered. Large Early Archaic corner and side-notched points are present, as are Mount Albion Corner-notched, Northern Side-notched, Sudden Side-notched, and Pinto Shouldered. Pinto Shouldered, Sudden Side-notched and Northern Side-notched are primarily found west of the Continental Divide and into the Great Basin. They occur from the Early to the Middle Archaic. The presence of a Pinto Shouldered point below the rockfall is a clear Early Archaic occurrence. The variety of point styles may be indicative of a variety of Early Archaic cultural entities utilizing Swallow. The presence of Early Archaic components at Swallow demonstrates that the western edge of the Colorado Piedmont was not entirely abandoned or unused during the Altithermal, though occupation in the

Hogback valley, at the very base of the foothills, does little to inform on how extensively the Plains were utilized in times of drought.

Swallow is also one of only two sites (Crescent being the other) to have any Paleoindian material, in the form of a single, isolated Folsom preform. The Paleoindian evidence at Crescent likewise comes from a single artifact with no associated features, dates, or occupational evidence. In both cases, the points were likely curated by later groups, and the use of the shelters in the Hogback valley was not incorporated into Paleoindian lifeways.

One notable difference between Swallow and the other shelters excavated by DC-CAS is the overwhelming amount of deer bone in the faunal assemblages, largely to the exclusion of other large ungulates like bison, elk, bighorn sheep, and pronghorn (although unidentified pronghorn could be present in the unidentified deer-size bone). While deer and indeterminate deer-size bone makes up the largest fraction of bone on all the Ken-Caryl sites, the percentage for most Ken-Caryl rock shelters as reported by Johnson and others (1997a) hovers around 40-50%, with bison and elk making up more of the remaining assemblage than rabbit. At Swallow, by contrast, deer and deer-size bone makes up over 90% of the assemblage, rabbit is the second most common species, and bison and elk are nearly absent, accounting for only 0.1% and 0.3% of the assemblage respectively.

Before too much is made of this difference, it would be useful to re-examine the faunal materials from the early Ken-Caryl analyses. Bone lab methods evolved through time in the project, and some difference may be in the manner of analysis and recording. However, the core group of bone analysts remained largely the same throughout the Ken Caryl project, and they frequently expressed surprise at the lack of bison bone at Swallow, their general impression affirming that it was different from other sites they had analyzed. While the bone assemblages from the other sites are smaller and the excavations less extensive, it is unlikely to be entirely sampling error. Small sample error typically results in less diversity in faunal assemblages, not more. Furthermore, faunal assemblages from other Hogback valley habitation sites, including LoDaisKa (Irwin and Irwin 1959) and Magic Mountain (Kalasz and Shields 1997:179; Falk 2022:154), also contain more bison and mountain sheep than found at Swallow, so it seems likely that, while re-examination of the materials might shift the numbers somewhat, deer bone dominates the Swallow assemblage more than it does at neighboring sites in the very near vicinity.

In addition to the rock shelters, DC-CAS also recorded open sites on the Ken-Caryl Ranch property, six of which were tested (Twin Cottonwoods, Popsicle, Twin Junipers, Anniversary, Pinnacle, and Big Red), some with subsurface augur and shovel tests, others with a few 3-x-3-ft grid squares (Johnson et al. 1997b). Open sites were generally shallow, with Late Prehistoric and/or Early Ceramic surface materials. Only one of the sites, Twin Cottonwoods, had features and diverse artifact assemblages suggestive of a habitation site. The remaining five sites are considered to be limited activity sites, with chipped and ground stone, animal bone, and in some cases, pottery occurring in small amounts. Charcoal and artifacts were identified in subsurface tests, but no diagnostic artifacts were recovered from lower levels, so whether or not open sites are a later phenomenon or one that extends deeper in time is not clear. Their location along the Dakota ridge, where accumulation of sediment would not be expected and deflation is likely, makes depth of deposits an unreliable indicator of age.

Subsequent surveys conducted by DC-CAS in summer 2000 identified nine additional open sites along the Dakota and Lyons ridges and added additional information to the previously recorded Twin Cottonwoods site (Moore 2002). Based on artifact diversity in surface finds, Moore (2002:15) identified four of the nine sites recorded as camps while the remaining five were classified as limited activity sites.

Open sites have received less attention but are equally important for our understanding of ancient indigenous use of the area. Other studies beyond the Ken-Caryl project demonstrate that these small, open sites are abundant in the area. Along the Dakota Hogback, open sites that have been tested include Massey Draw (Anderson et al. 1994), Cherry Gulch (Nelson 1981), Van Bibber Creek (Nelson 1969); Dutch Creek (Gilmore 1989; Jepson and Hand 1994), and Window Rock (Tate 1979). These sites have generally been interpreted as sporadically used camps with assemblages that represent limited activities, similarly to those in the Ken Caryl studies. All have Early Ceramic components and Late Archaic components, but only Massey Draw, Cherry Gulch, and Dutch Creek have earlier components. They are therefore suggestive of short-term camps and limited activity areas associated either with a logistical collecting strategy or a dispersed foraging strategy. Activities like game processing, plant collecting and processing, lithic procurement, and game lookouts have been proposed (Johnson et al. 1997a; Moore 2002).

Magic Mountain may be an exception to this, as a deeply stratified open camp with evidence of structures (Kalasz and Shields 1997), although in a more recent examination of modified stone from the site, Johnston (2022:141) argues the assemblage indicates a site that is "primarily task focused rather than seasonally residential." Magic Mountain is also different from those listed above for its location on the western side of the valley, as opposed to the eastern side or on the ridge or east face of the Hogback outside the valley itself, locations that are more exposed than the rock shelters that lie closer to the valley floor. Magic Mountain may imply yet a third strategy for activity in the valley.

Open sites, then, indicate a use of the Hogbacks distinct from that of the rock shelter habitations, that includes resource procurement of specific resources and at specific times of year when the rock shelters may not have been in use. They are too close to the rock shelters to be sites of logistical collecting from those winter base camps, as collectors from the rock shelters would have simply taken resources back to their camps. Some could be nearby work areas associated with the rock shelters, but a number of the open sites that have been tested have hearths or other features that suggest habitation beyond that of a work area. Massey Draw is perhaps the best example of this. Excavations revealed two distinct areas, one for bone processing and the other a habitation area where groups camped while carrying out hunts and the resulting processing of meat (Anderson et al. 1994:230). Multiple components contained fetal bone, indicating repeated spring kills. Spring processing at Massey Draw could conceivably be associated with the end of a winter occupation in the valley rock shelters but could also indicate use of the area for spring foraging as a different part of a foraging or collecting cycle.

Temporal Patterns at Swallow

As is evident from the summaries above, there is remarkable consistency through time in a number of aspects of the Swallow occupation. Activity areas persist throughout the Archaic, and faunal assemblages remain remarkably unchanged through all time periods. Proportions of various raw materials shift slightly in lithic and ground stone assemblages, but materials themselves remain throughout the sequence. In the following sections, we detail and discuss some of these trends and what they may indicate about the lifeways of Swallow residents.

Environmental and Subsistence Trends

While pollen records indicate fluctuations in relative moisture, pollen indicative of riparian, grassland, and upland plant communities remain present throughout the sequence. Groth (see Chapter 6) notes that "the climate did not change enough to cause any major taxa to completely disappear or completely dominate." This contrasts to the pollen record from Massey Draw, just 1.5 mi away on the eastern side of the Hogback, where only a limited number of xeric plants dominate the counts, most notably sage, high-spine Asteraceae (composites including sunflower, rabbitbrush, and aster), while arboreal species are uncommon. The Hogback valley, even in times of drought, provided access to water and a range of plant resources, as well as the animals that fed on them.

This constancy is reflected at Swallow in the very limited change through time in the faunal and botanical assemblages. As already discussed, the faunal assemblages show an increasing number of species through time, but that wide range of species never made up more than 5% of the assemblage. Deer and deer-sized mammal bone varies only from 91 to 93% of the assemblage. Cottontail rabbit remains constant at 5.0-6.3% of the total assemblage, and jackrabbit (which sometimes replaces cottontail in drying environments) stays close to the mean of 0.2% through time.

The lack of bison, or bison-sized bone, never making up more than 0.16% of the assemblage, seems especially aberrant because of the proximity of Massey Draw, a processing site with mostly bison bone. To explain this seeming aberration, the faunal team (see Chapter 14) suggests that bison meat may have been a larger part of the diet of Swallow site residents than is indicated by the bones, but the meat was processed at sites like Massey Draw, away from the habitation site, and as a result, only meat and not bone was brought to the habitation.

This suggestion is somewhat supported by the blood residue analysis of a variety of lithic tools at Swallow, which identified bison blood on 8 tools, 25% of the tools that tested positive for residue. Given bone breakage at the site, indicating that bone was itself a food resource processed for grease and/or marrow, it is surprising that if site residents were participating in bison kills nearby, they considered bone to be waste and did not bring it back for further processing. This may be because bone grease was only consumed when other resources were scarce, and a bison kill produced enough food that bone grease could be ignored. Given the proximity of Massey Draw, and the presence of bison blood residue in the projectile point assemblage, we should not be too hasty to rule out the possibility of bison as a more significant part of the diet than represented in the bone, but we should not be too quick to assume its use either. Massey Draw appears to have been used in the spring, whereas the evidence (presented below) indicates that Swallow was a winter habitation, making their temporal association suspect. Bison may not have been present near Swallow in the winter. Changes in the available migratory game may in part account for the presence of open versus rock shelter sites, as summer and winter hunting patterns brought people to the valley for different resources.

Bamforth (1988:78) argues that the shortgrass plains of Colorado may have had relatively low numbers of bison in ancient times compared to regions farther north, accounting in part for the heavy reliance on deer seen in many Archaic sites in eastern Colorado. One line of evidence supporting this idea comes from Middle Archaic McKean Complex points. Davis and Keyser (1999) propose that the four projectile point styles of the McKean Complex are part of a multi-weapon system, with McKean Lanceolate and Mallory points used on thrusting spears to dispatch bison in trap-style hunting (drives, corrals, etc.) while Hanna and Duncan points served on atlatl darts for non-drivable animals like deer. Building on this observation, Larmore (2002), in a study of multiple McKean assemblages from the Front Range, including Swallow, found that Mallory and McKean Lanceolate points are relatively rare in Colorado where sites are dominated by deer bone, but more common in Wyoming and in Colorado sites where bison bone makes up more of faunal assemblages. In the Swallow assemblage, McComb (see Chapter 9) identified 48 Hanna and Duncan points combined, but only 5 McKean Lanceolate and Mallory points.

This may indicate that, in the Middle Archaic at least, bison were not a major source of game for Swallow residents. While bison may be underrepresented in the faunal assemblage, the focus on deer, and to a much lesser extent cottontail rabbit, given the wide range of game available, suggests that the Swallow site occupants were not at pains to utilize every resource available to them, but had a relatively comfortable existence focusing on just a few species. One interesting side note to this is the prevalence of prairie dog. While they represent only a tiny fraction of the bone count overall, the MNI is relatively high, approaching that of rabbit. It would seem that prairie dogs were harvested with some regularity. This may speak to a secondary hunting strategy employed during extended stays at Swallow. Prairie dogs, as colony dwellers, are a predictable resource on the landscape year-round (prairie dogs do not hibernate. They may enter a state of torpor in the coldest months or when snow cover prevents foraging, but they are active at least some of the time throughout the winter). While they are easy to find, they can be difficult to hunt, as wounded or frightened animals retreat into burrows that interconnect and have multiple entrance and exit points. They can, however, be obtained relatively easily with passive hunting strategies such as snares or traps and may have been a supplemental food resource when more mobile game was sparse or hunting trips were difficult due to weather or the demands of other time-consuming activities.

Botanical evidence from the site is also limited, though this may reflect laboratory processing error more than a focused use on few species. The charred remains of seeds from hackberry, sunflower, goosefoot, juniper, portulaca (purslane family), and several types of grass including sand dropseed were found in hearths, as were a single cactus spine and cone fragments and bark scales from pinyon pine, though no pinyon nuts or shells were found.

Pollen washes on ground stone provided strong evidence for the grinding of grass seeds and cheno-ams (goosefoot, lambsquarter, and pigweed). Other economic pollen was found on the ground stone at frequencies too low to confirm that it was ground on the stones, but include Cucurbita (squash family, most likely buffalo gourd), dogbane (used for medicine and fiber), shrubby hazel, prairie clover, prickly pear cactus, chokecherry, and cattail. Starches from grasses and Apiaceae (umbel family) roots were also recovered and probably indicate grinding. Groth (see Chapter 6) notes several instances of unusually high *prunus* and rosaceae pollen in the environmental pollen column, suggestive of wild plum and chokecherry, but cautions that nesting birds on the rocks and shrubs at the location are a likely source of fruit transport; its presence cannot be tied directly to human use.

This list of botanicals provides direct evidence for the use of only a few foods (grasses, Apiaceae roots, and a few seeds from annuals), but it confirms that a wide variety of resources was available in close proximity to the site, in contrast to locations just a few miles away outside of the Hogback valley. This relative abundance no doubt made the location ideal for broad spectrum gathering. Winter habitation (discussed below) may have limited access to some of the available plants to Swallow residents. It is notable that pollen washes on metates could only confirm the grinding of grasses and cheno-ams on the majority of samples. The single potsherd tested also yielded grass phytoliths, supporting a primary role of grass seed as a focal resource. Grass pollen is consistently abundant in the environmental pollen record examined by Groth (see Chapter 6), in contrast to the Massey Draw pollen record where it was present in much lower levels. It may be that the valley had predictable, lush stands of grass, the seeds of which could be easily harvested because of their abundance in the fall when inhabitants arrived to establish winter camps. Historical and ethnographic accounts offer numerous examples of Plains groups that used controlled burns in the area around preferred camp locations to encourage the growth of grass for horses (Oetelaar and Oetelaar 2007) and that the use of fire to encourage desired species can be traced into the record long before the arrival of the horse. It is conceivable (though not demonstrable) that such a practice in the Hogback valley could have ensured an annual harvest of grass, no matter what else was available. In this light it is intriguing that augur testing at the Twin Juniper site, an open site along a wash a few hundred meters from Swallow, revealed a "heavy charcoal laden soil horizon, probably resulting from earlier brush fire," at a depth of 80 cm (Quinn 1997:119).

Recovery of carbonized *Chenopodium* and *Portulaca* seeds from features, although limited in quantity and occurrence, does indicate that ruderals, plants adapted to anthropogenic or humanly disturbed habitats, were being utilized. This is bolstered by the cheno-am pollen on ground stone, and the cheno-am pollen in the pollen columns. Ruderals were commonly used and are often recovered from features at sites in the Hogback zone, and while their use undoubtedly varied through time, their presence and use at Swallow is almost certainly underrepresented due to the flotation methodology used, which limited the recovery of small seeds (see Chapter 18). For whatever reason, the evidence suggests that a fairly narrow reliance on deer and seeds of grasses and annual ruderals as principal food sources sustained the Swallow population, but the unfortunate loss of macrobotanical material limits our understanding. Some unprocessed macrobotanical samples remain at History Colorado – Office of Archaeology and Historic Preservation, and future analysis may refine this view.

Lithic Procurement Trends

Beyond food, indigenous populations relied on a variety of other resources, most notably stone, for tools. Unfortunately, not all of the stone used to manufacture tools can be sourced to a specific point of origin, and the large number of people involved in different portions of the lithic analysis complicates efforts to make broad comparisons from the flaked stone. With over 800 projectile points and point fragments, over 700 bifaces, numerous other tools, and abundant lithic debitage, the collection from the site is rich with potential and ripe for analysis to address a range of focused questions about lithic use, material acquisition, or local and regional movement of people. Here we will make what observations and draw what conclusions we can, but stress that the potential of this assemblage is as yet largely untapped.

As with plant and animal resources, there is consistency through time in the use of lithic material, with some slight shifts in frequencies of different local resources. The Hogback valley has an abundant variety in rock. Formed by fragmentation of sedimentary layers when the Rocky Mountain uplift pushed through them, no fewer than seven geologic formations and two named alluviums are exposed in the valley (Rathbun 1997:21-22). Streams flowing out of the adjacent foothills further enrich lithic source availability, as cobbles from higher in the mountains are transported downstream. Moore (2002) identified an agate quarry located on the Dakota Hogback within a few kilometers of Swallow. As a result, a variety of quartzites, cherts, chalcedonies, agate, quartz, and petrified woods are available within a few miles range of the site, and many of these resources were used for chipped stone tools. Likewise, tabular sandstone and harder igneous and metamorphic rock such as gneiss and granite were available for use as ground stone.

Despite the abundance of immediately available materials, a large portion of the lithic material at the site comes from the Dawson Arkose in the form of petrified wood and accompanying agate, jasper, chalcedony, opal, and quartz crystal that formed as the wood mineralized (Mustoe and Viney 2017). The Dawson Arkose borders the Denver basin on the south and southeast and intersects with the Hogback valley in the vicinity of Roxborough State Park. Documented quarries for Dawson petrified wood, as mapped by Black (2000:135), occur to the south, across the Platte

River in Douglas County in the Roxborough area (about 15 km south of Swallow) and about 30 km to the east on the north edge of the city of Parker (though it should be noted that Black focused on sources at elevations of 6,000 ft or higher and notes quarries exist at lower elevations. Given that the locations mentioned above are on the northern edge of the Dawson Arkose, they are probably among the nearest sources). Gilmore and Larmore (2003:25) note that outcrops and nodules of petrified wood have "ubiquitous primary and secondary sources throughout the Palmer Divide," suggesting that it might be encountered casually by hunting or gathering parties, but the relatively high frequencies of it at Swallow suggest more than a casual access on brief collecting forays.

Dawson petrified wood is the most common material in the projectile point assemblage, accounting for 19% of points, followed by chert (18%), quartzite (18%), and chalcedony (16%), and it is highly probable that many of those cherts and chalcedonies come from Dawson deposits as well, pushing the Dawson total higher. Hammond and Gooding (see Chapter 11) identified 34% of the cores as Dawson materials, many of them chalcedony and chert as well as petrified wood. While Dawson petrified wood isn't exactly a long-distance resource, available within a half day's walk of Swallow if one knew where one was going and didn't have to search, it is not available in the immediate vicinity, and accessing sources required crossing the Platte River, which in fall and winter can be an easy wade, but in spring and early summer could be more challenging. It is noteworthy, then, that it occurs in such high frequencies, and that it accounts for more than twice as many projectile points as Green Mountain petrified wood, the source of which is slightly closer to the northeast and arguably easier to access, with fewer river or creek crossings. While there are both cores and flakes of Dawson petrified wood at Swallow, it is underrepresented in the flake count (making up only 10% of flakes compared to approximately 20% of flaked tools), and the majority of Dawson cores (70%) are exhausted. While Green Mountain petrified wood makes up only 8% of projectile points, compared to 19% for Dawson, they make up nearly equal portions of the flake count (10% Dawson vs. 8% Green Mountain). Taken together, these lines of evidence favor a scenario in which tools utilizing Dawson material were not made primarily at Swallow, a point we will discuss more in a subsequent section.

Temporal trends in both tools and debitage indicate an increased use of cryptocrystalline materials (chert, jasper, chalcedony, agate) through time and a steady decrease in quartzite and quartz, though all materials remain in use throughout the site occupation. As all these materials are locally available, these trends don't imply changes in access to materials, but rather a preference for cryptocrystallines for other reasons, perhaps relating to flaking or performance qualities, or even appearance.

While chalcedony, chert, and jasper show a steady increase in use through time, the usage of petrified wood for both diagnostic and non-diagnostic tools peaks in the Middle and Late Archaic period, rising from 23% in the Early Archaic to 33% in the Middle/Late Archaic levels and returning to 21% in the Early Ceramic. This trend is not evident in the lithic debitage; flakes of Dawson petrified wood remain at remarkably steady proportions through time, varying from 9.1% to 10.6%. This shift may indicate that, while the resources of the Dawson Arkose were known and utilized by the occupants of Swallow throughout time, Middle and Late Archaic populations were accessing them in a substantially more frequent or significant way, an observation that bears on models of mobility that will be discussed in more detail below.

Materials from even farther away—truly long-distance resources—are present at Swallow in very limited amounts, and occur in both Archaic and Early Ceramic levels, although amounts are too low to evaluate trends. Debitage has not been thoroughly examined with expert eyes or expert techniques to accurately identify exotic materials, so only tentative conclusions can be drawn here. Using both visual evaluations and florescence, McComb (see Chapter 9) identified 16 projectile points of probable Kremmling chert and 4 of probable Windy Ridge Quartzite, both sources from Middle Park. Two cores and a handful of flakes were also identified as Kremmling chert, using only visual characteristics. Trout Creek jasper from South Park was suspected among the flakes and one core, though positive identifications of jasper sources is problematic. Six obsidian flakes were recovered, and one projectile point (made in a local style) and three flakes were identified as Alibates chert, originating in Texas. Finally, McComb noted at least four projectile points made of local materials, but in styles more typical of western Colorado, suggesting the movement of people and ideas across an extensive area, but to a limited degree.

Seasonality and Mobility

Hammond, in his 2020 memoir and preliminary report on Swallow site, identified seasonality as a key research objective of the Swallow project, and one that, with the information available at the time of that writing, could only be addressed in very limited terms. Hammond's interest in seasonality arose out of questions about how Swallow site specifically, and the Hogback valley more generally, fit into regional population models, including Benedict's up-down (Benedict and Olson 1978; Benedict 1992) and grand-circuit (Benedict 1992) models that posited movement of populations from the eastern foot of the Rockies into the mountains and back in seasonal patterns, and a suggestion from Johnson et al. (1997b:147) that posited a similar cyclical movement into South Park, where Trout Creek jasper is abundant. Benedict's models in particular propose the Hogback valley as the location of winter residences for people who utilized the mountains in the summer. This view of the Hogback valley was formulated based on observations made at mountain sites and has not been as rigorously examined against Hogback site assemblages, so a thorough treatment here is warranted. We will address Swallow's position *vis-a-vis* several regional models in a subsequent section. Here, we assemble the available data from the site itself that can be brought to bear specifically on the topics of seasonality and mobility.

Seasonality

Seasonality, by definition, is tied to mobility, because the presence of a human group at one location in only one season requires them to be elsewhere in other seasons. Seasonality is a smaller question than mobility, but it is by no means an easier or more straight forward one to answer. A variety of approaches to seasonality have been devised by archaeologists, but none are without problems and most provide only circumstantial evidence. Monks (1981) summarizes a number of direct and indirect archaeological approaches to the question of seasonality, including presence/absence of plant and animal species, physiological changes in animals (e.g., growth and aging patterns), marine resource isotopes, sediment deposition characteristics, burial patterns, types and positioning of features, and activity-specific artifacts. Studies focusing on technological organization have added additional ways to look at site use relative to mobility and seasonality through the examination of manufacturing and curation processes (Raab et al. 1979; Larmore 2002; MacDonald 2009; Strum et al. 2016). Not every approach can be applied to an assessment of the Swallow site (for example, soil and sediment studies were not conducted during excavation, and we are sorely lacking in shell mounds for marine isotope analysis), but those that can be used will be addressed here. It is worth reiterating that the site was utilized by humans for a span of 7,000 years, and the assumption that it was always utilized in the same way through that enormous span of time is not necessarily valid. Some evidence is relevant to only some components, most notably pottery, and should not be assumed to represent the entire span of time. As noted above, however, there are many strong consistencies that run through one level of occupation to the next, so some broad statements are justified.

Presence/Absence of Taxa

Because edible parts of plants are available at different times of year, the season in which they are harvested indicates season. The difficulty lies in that plants can be, and are, dried, stored, and transported, leaving uncertainty that the location or timing of consumption aligns with the location and timing of harvest. With a large enough sample of plant remains, a preponderance of species associated with a single season provides reasonably good evidence but, at Swallow, charred plant remains are sparse and biased toward larger materials due to processing methodology.

The available macrobotanical data show a trend toward fall-harvested resources (Table 20.3). Charred seeds from seven subsistence plants were identified in flotation samples taken from hearths. Four of those, (hackberry, juniper, dropseed, and sunflower) are harvested primarily in the fall, with harvest for hackberry and juniper extending into the winter. The other three plants, goosefoot, purslane, and undifferentiated grass, have potential harvests through much of the summer and into the fall, with a range too broad to be useful in determining season. None of the plants on the list are

Table 20.3. Charred macrobotanical remains and their season of harvest.

Plant	Harvest Season	Occurrence
Hackberry	fall to winter	Early Archaic, Middle/Late Archaic, Early Ceramic
Juniper	fall to winter	Early Ceramic
Sand dropseed	early to late fall	Middle/Late Archaic, Early Ceramic
Sunflower	late summer to fall	Early Ceramic
Goosefoot	summer to fall	Early Ceramic
Purslane	spring to fall	Early Ceramic
Undifferentiated Grass	spring to fall	Early Ceramic

available exclusively in the spring or early summer, suggesting that a spring occupation is unlikely. The macrobotanical record then, sparse as it is, suggests a late summer/fall occupation, possibly extending into winter.

Another source of botanical information was provided by the pollen and phytolith analysis of ground stone and a single potsherd. This analysis showed a consistent pattern of processing grass seeds. Unfortunately, grass provides limited evidence for season, because there are both cool and warm season grasses that mature and might be harvested at a range of times from spring through fall. The phytoliths from the potsherd provide some insight to what season grass processing might have occurred, as the phytoliths were evenly divided between cool season grasses that mature in spring and again in late fall, and hot season grasses that mature in late summer to fall, suggesting that fall might be the most likely season for harvesting and processing both taxa at Swallow. While phytoliths were recovered from only one potsherd, they offer circumstantial evidence that the prevalence of grass on grinding stones from all levels of the site might expand this tentative suggestion of a fall occupation to the Archaic occupation as well. In an analysis of small seed resource use in eastern North America, including grasses and cheno-ams, Gremillion (2004) found that the time and energy required to harvest highly nutritious small seed crops is low, but processing effort is high. Therefore, plants like grasses are most effectively incorporated into hunter/gatherer diets when they can be harvested and stored for processing later, in winter months when other resources are scarce and time for labor intensive processing is available. She argues that storable small seed crops offer a predictable resource, particularly in areas where human modification of the environment through disturbance of soils or controlled burning can be used to manage them. Thus, they are a valuable resource to offset unpredictable harvests of other foods that may vary year to year, and they provide storable foods to offset winter food stress.

Seasonally available animal species can also be evaluated using the presence/absence approach. The presence of migratory species or species that hibernate at certain times of the year can be indicators of seasonal occupation. Deer and rabbit are both available year-round; however, a few species in the record are seasonal. Beck (1970:4) has argued that turtle is a summer resource, due to hibernation under the mud in the winter. Turtle remains were found in small numbers in the Early Ceramic and Middle Archaic levels; however 3 of the 11 pieces found were worked, indicating that turtle carapace was curated for use as tools or decorations. It therefore has the same storage problem as seeds.

A single goose bone was also recovered from the Early Ceramic levels. Today, Canada geese are available year-round, but more abundant in winter due to migration. Historical records are sparse, but early 20th century studies indicate year-round breeding populations along the Front Range were rare prior to efforts to introduce them in the 1950s (Gammonley 2019). Agricultural crops, artificial lakes, parks, and golf courses in the modern era have resulted in exploding populations, with migratory populations increasing sevenfold and resident populations increasing more than ninefold between 1970 and the early 2000s (Gammonley 2019). The presence of geese in the summer in antiquity is therefore uncertain and fall or winter acquisition may be suggested.

A number of small migratory birds were identified in the assemblage, including grosbeak, towhee, killdeer, nighthawk, rock wren, lark bunting, cedar waxwing, swallow, and longspur. These were all identified as intrusive by the bone lab, although a more thorough investigation of this bone is warranted, as some bird bone listed as intrusive was also burned or modified, indicating use. If these species were intrusive, they might provide a reversal of the usual approach to presence/absence evidence. Intrusive birds might occur because they are nesting or feeding on the monolith and surrounding vegetation, or could have been introduced by predators bringing their kill into the shade of the rock, activities that would be disrupted by the presence of humans at the site. So, the presence of these animals might tell us when humans *weren't* present. Of the nine bird species listed as intrusive, seven (all but cedar waxwing and longspur) occupy Colorado as part of their summer range (Stokes and Stokes 2013). This, then, might imply that summer was not the season of human site use and by extension imply a fall or winter occupation. All but 3% of intrusive bones were found in the Early Ceramic and Middle/Late Archaic levels (Levels 1-16), so it is possible that many of the intrusives in the higher levels indicate post-habitation use. On the other hand, all but 3% of use bone was also found in Early Ceramic and Middle/Late Archaic levels, so the distribution is consistent with bone related to the occupation of the site.

Physiological Development

Despite the preponderance of deer bone at the site, the extreme fragmentation of the bone makes determination of MNI and the identification of specific growth traits of individual animals difficult. Two hundred thirty molars and premolars of deer were in a condition that could be used to derive age estimates of 32 animals: 11 in the Early Ceramic, 19 in Middle/Late Archaic, and 2 in Early Archaic levels. Of these, two (one in Early Ceramic and one in Middle/Late Archaic) were identified as juveniles with an age range of 2.5-4.0 months. Mule deer typically give birth in June or July, indicating a late summer or fall kill.

A single skull fragment of an adult animal was found with evidence of an attached, mature antler. Antlers are shed in spring and grow back slowly over the summer, so its presence also suggests a fall or winter kill.

Characteristics of Faunal Assemblage

A final aspect of the faunal assemblage that can be addressed is the highly fractured nature of the bone, which is indicative of the crushing and boiling of bone for the extraction of bone grease. Bone grease extraction has been argued by various researchers as evidence of winter occupation, as a result of late season food stress (Gilmore 2008a; Metcalf and Black 1991) or as a means of getting needed dietary fat when animals are very lean (Speth and Spielmann 1983). Leechman (1951:355) found no link to season in ethnographic accounts of bone grease extraction, but Vehik (1977:169) found that ethnographies of the Ojibwa and Crow identified it as a winter activity. The extent of breakage at Swallow might therefore be interpreted as indicating a winter occupation, though research on seasonality is not conclusive. The vast majority of Archaic and Early Ceramic sites in eastern Colorado are characterized by highly fragmented bone assemblages (Gilmore 1999), calling the assumption of grease processing as an exclusively winter activity into question. Of course, it is possible that a mobility system of winter aggregation and summer dispersal makes winter camps much more visible to archaeologists, or more likely to be preserved long enough to be discovered. It may also be evidence of wintering on the plains for groups that utilized the mountains in spring and summer, though bone breakage indicative of grease extraction is common in mountain sites as well. Bamforth (2011:27) notes that bone grease was an essential ingredient of pemmican, and as such was used to preserve and store meat for transport and later use, which may have occurred at any time of year and would not, then, be an indicator of seasonality.

Site Features

A number of types of site features are suggested to imply seasonality (Monks 1981). Investments in construction are typically only made at sites that will be occupied for a long enough time to make construction worthwhile or where adequate shelter is needed against the elements (McGhee 1972). Therefore, the presence of structures is associated with winter sites. Other features that show long term residence, indicative of a logistical collecting subsistence pattern, are storage pits, refuse accumulation, burials, some types of hearths, and the differentiation of activity areas within the site. These traits are in general more indicative of collector habitation sites and not necessarily season. They are often also cited as indications of winter residence, where weather prohibits movement or food acquisition and therefore structures, storage and heating hearths are required (Monks 1981).

Swallow has limited evidence of constructed structures, only the single feature hypothesized to be a lean-to in the Early Ceramic levels. Of course, the use of a rock shelter, as opposed to an open camp, can be considered a *de facto* structure. In addition, in the Archaic levels, the placement of hearths in narrow channels between large boulders created shelters within the natural environment. Hide or brush covers over the tops and across the front of these channels would have constituted constructed shelters for sleeping and escaping the elements but left no evidence in the archaeological record. A relatively denser accumulation of bone and fire-cracked rock in the southwest portion of the site may be evidence of a midden, indicating that episodes of site occupation were of significant duration to result in an accumulation of debris that had to be moved aside to keep the living space livable.

At Swallow, some evidence of storage areas exists, though only one constructed storage feature was found. As with shelters, the natural features of rock shelters create *de facto* storage for winter groups (Greubel et al. 2017), and this can be seen at Swallow. Only one feature was identified as a constructed storage bin, consisting of the placement of slabs to enclose a space between a boulder and the shelter wall. Multiple groundstone caches provide evidence of deliberate storage, including one that had been placed into a natural crevice in the rockfall blocks, utilizing the natural topography of the site for storage without modification. In addition, foodstuffs could have been kept in bags or baskets under the shelter wall, a pattern that has been documented in rock shelters in both the eastern and western US (Gremillion 2004:228). It is also possible that one attraction of the Hogback valley could have been that animal and plant resources were available through the winter, requiring less reliance on stored foods. In a climatological study of the area, Tate (1997:19) argues the Hogback valley provided a warm microclimate in winter, on average a few degrees warmer than surrounding areas. This may have attracted not only humans, but game to the region. With relatively warm, snow free days occurring throughout the winter, the foot of the Colorado Front Range rarely experiences extended snowed-in periods of time where reliance on stored food would be vital for survival. The inconsistency of snow cover, with snow often melting off and the ground bare for periods throughout the winter could have made resources like grass seed or prairie dogs available for harvesting in the winter to a limited degree if larger game could not be found.

The internal differentiation of activity areas implies longer-term occupation at a site, as it indicates a need for organization that is not necessary in a short-term stay. This organization is evident at Swallow, where the south-central part of the shelter contains features and debris indicative of food processing while the north end contains features that suggest sheltered/sleeping areas (see Chapter 7). The presence of midden deposits to the southwest of the food processing area reinforces the interpretation that space was designated and maintained for use over a period of time.

Burials

Burials have been associated with longer term camps that serve as a central place for hunter-gatherers. They have also been argued to suggest lean season habitations, when higher mortality of the very old and very young may occur (Gruber 1971).

Primary burials within habitation sites are the most common type of interment of the dead associated with the Archaic in Colorado (Gilmore et al. 1999; Gilmore 2008b). Two primary burials occurred at Swallow, both of older individuals (age 50 plus), and both with evidence of compromised health due to age (severely eroded teeth, debilitating injuries, and age-related pathologies) (Chapter 19).

Expanding beyond Swallow, a total of six individuals in five burials were uncovered at the Ken-Caryl Ranch sites overall. Three individuals were past the age of 50, two were women in the 30-45 age range, and one was an infant, aged 4-6 months. The infant and one of the younger women were buried together, suggesting postpartum mortality. Overall, this mortality profile is consistent with the possibility of lean season deaths of vulnerable individuals, but six individuals hardly represent the many hundreds of people that utilized the space over millennia, and as vulnerable people might succumb to a variety of hardships (or simply die of old age), the argument for their deaths being evidence for seasonality is tentative at best.

Taken together, the feature data, including the sheer number of features (and artifacts) as well as the arrangement of sheltered space, storage, midden, and the interment of the dead all indicate that Swallow was a significant place in the annual cycle of hunter gatherers throughout the Archaic and into the Early Ceramic period, and that episodes of occupation fit the expectations of a logistical collecting habitation site. The sheltered spaces suggest those extended stays could have been cold season occupations.

Artifacts

The artifact data speak more to mobility than to seasonality. The quantities of Dawson petrified wood (and related stone), as well as the clay source for at least some of the pottery, indicate activity to the south on the Palmer Divide. Given the difficulty of transporting pottery, it seems likely that the movement, at least some of the time, involved northward migration, from the manufacture of pottery at Jarre Creek near the town of Sedalia, to the use and storage of that pottery at Swallow site, in order to minimize the distance the pots were carried and maximize the chance that they survived the journey to where they were needed.

Strum and colleagues (2016) argue that pottery is most successfully made in the summer, when clay can be dug easily and cold temperatures don't freeze drying pots (not to mention the wet hands of potters), but that pottery as a tool is most efficient for hunter-gatherers in the winter, when it allows for slow cooking of dried foodstuffs. It is also much more efficient than stone boiling in winter, when heated rocks lose heat rapidly when transitioned from fire to bag. Winter is also a time when hunter-gatherers in many temperate environments camp for extended periods, thus making hard-to-move pottery more appealing.

If pots are made in summer for winter use, it requires them to be stored, which in turn requires more durable construction so that they can be curated, and so they can survive through the cold months until clay can again be successfully mined and replacements made. Similar to lithic technology arguments, Strum and colleagues (2016) argue that pots might be evaluated as low investment, quickly made expedient wares for use at short-term summer camps where they are soon after discarded, while pots for winter use are more carefully made so they can be curated. High investment, durable ware would be indicative of long-term winter camps, where it would also be curated to last through the cold months when replacement is difficult.

It is challenging to assess the Swallow pottery for expedient vs. durable criteria. On one hand, the potters utilized clay from locations at some distance from the site, which would have required either a stop on their seasonal round, or a multi-day logistical collecting trip, allowing time for mining clay, construction, drying, and firing. Transporting fragile pottery for approximately 15 km, crossing several creeks and rivers along the way, would also take some effort. The selection of a better clay source at some distance rather than a poor clay much closer to home would therefore constitute a high-investment choice. On the other hand, crushed rock temper was not prepared or added to the clay, as is common in Woodland (Early Ceramic) pottery in Colorado (Elwood 1995). Utilizing the natural inclusions in the clay as temper was a time-saving step, foregoing cleaning and processing the clay as well as the effort of selecting and preparing rock for temper. Thus, the self-tempered nature of the vessels might suggest a more expedient construction, associated with short-term use and discard.

Finally, the presence of drilled repair holes on sherds indicates that some care was taken to extend the use life of vessels that cracked, more indicative of preserving pottery for longer term use, as might be expected in winter. Taken together, two out of three technological criteria (clay choice and curation) would favor a long-term winter use of pottery, but the temper data is problematic, and the analysis far from conclusive.

The phytolith evidence for cooking late season grasses discussed above adds a bit more confidence to the assertion that Swallow pottery was used in the winter. Slow cooking of grain could have reduced the time spent grinding it. If we accept this argument, the presence of pottery at Swallow suggests either a late summer foray to Jarre Creek, or a seasonal movement in which the Jarre Creek locality may have been the penultimate, late summer stop in a seasonal round which allowed for the manufacture of pottery and lithic tools of Dawson petrified wood before moving to the longer-term winter camp in the South Ranch sites of the Ken-Caryl Ranch, the largest of which was Swallow. This reconstruction is supported by the pottery and the high frequency of Dawson lithic tools but lower frequencies of Dawson petrified wood debitage, suggesting time was spent making stone tools away from the site.

A final technological argument for mobility and seasonality was made by Larmore (2002) who used projectile points from Swallow among others in an analysis of the McKean Complex. He conducted a technological analysis of a number of site assemblages to place them on a continuum from forager to collector subsistence strategies. Based on four key technological traits, he argues that the Ken-Caryl Ranch sites have the mixed characteristics one might expect of localities that serve as base camps in a logistical collecting strategy practiced during winter months by groups that then switch to a more residentially mobile foraging strategy in summer. Taken together, the pottery and the evaluation of McKean points suggest winter base camp occupation in two time periods, the Early Ceramic and the Middle Archaic. Similar research on lithic technology could be done to extend this approach into the Early or Late Archaic, which could strengthen the conclusions so far drawn, and we would encourage future work in this area.

To summarize, no single line of evidence for seasonality at Swallow is particularly strong, and all are accompanied by caveats, because data are highly limited, or because more work is needed, or because seasonality is, on the whole, difficult to pin down (or all three). In the aggregate, though, (Table 20.4), they point toward a cold season habitation by logistical collectors, perhaps starting in the late summer/early fall when grass stands and other late season plants were ripe and quantities could be harvested, and lasting through the cold months of the year, when the rock channels and the shelter wall offered protection from the elements and the abundance of deer and small game as well as stored late season plant harvests could sustain the population through the winter. Another attraction to the valley as a winter habitation area might have been the ability for groups that scattered through the summer to aggregate in the winter by occupying the multiple rock shelters created by the sandstone monoliths throughout the valley, and particularly clustered in the vicinity of the South Ranch. To explore this, we turn next to a discussion of how Swallow fits into models of mobility in the region.

Table 20.4. Summary of evidence for seasonality.

Evidence	Season	Data caveat
Macrobotanical	fall to winter	Limited data, transport and storage issues
Ground stone pollen	inconclusive	Broad seasons of availability
Pottery phytoliths	fall	Based on a single sherd, EC period only
Geese	fall to winter	Based on 1 bone, MLA period only
Turtle	summer	Based on 11 bones, evidence of curation
Migratory intrusives	winter	Some intrusives may postdate occupation
Physiological traits, deer	late summer- winter	Based on two young animals, 1 adult skull
Bone grease processing	winter	More research needed on winter assoc.
Features	winter	Evidence addresses mobility more than season
Pottery use	fall to winter	Only relevant to EC component, varied results
McKean points	winter	Only relevant to Middle Archaic component

Mobility

Four mobility models have been proposed that incorporate the Hogback valley and will be evaluated here. First is Benedict's grand circuit model (1992), in which groups moved north in spring along the eastern edge of the mountains to the Laramie Basin, then over the mountains into North and Middle Park in early summer, into the high country along the Continental Divide for large communal hunts in late summer and returned to the Hogback valley and vicinity in fall to reside in winter base camps. A second, more direct up-down transhumance model implies movement directly from winter camps at the plains-mountain margin into high elevations for the summer, then back to the plains in the fall. This pattern was identified in particular for the Early Archaic Mount Albion Complex (Benedict and Olson 1978). Both models were based on material types in lithic tool and ground stone assemblages from high-altitude sites, and on the extent of high-altitude game drives that would have required large groups to conduct hunts. Benedict's two models have received attention from Front Range/Hogback zone archaeologists because they incorporate the Hogback zone as an integral part of the adaptations involving high altitudes of the Front Range and provide logical explanation for the distribution of tool stone from mountain sources in Hogback zone sites, and the presence of tool stone from plains sources in mountain sites.

Benedict actually proposed a third model of seasonal mobility, involving mountain-oriented groups who wintered in the pinyon-juniper forests west of the Continental Divide. The groups moved eastward to the alpine tundra in summer, and returned westward in the fall, which Benedict saw as analogous to the movement and use of the mountains by the Utes (2000:84). However, the Utes were not restricted to the mountains and are known to have traveled to the base of the Front Range and Hogback zone on occasion if not regularly, then returned to the mountains, a sort of "down-up" model. As this model would not be a source of extensive use of the Hogback valley, it is not as relevant to our discussion and not directly evaluated here, but the Ute or Mountain Tradition analogy has some relevance for considering broader regional movements, discussed below.

The third model we evaluate is another up-down model of movement for Hogback valley groups but moving in a different direction. Johnson and colleagues (1997b:147) and Larmore and Gilmore (2006) suggest that the residents who wintered in the vicinity of the Ken-Caryl Ranch would have been more likely to move up the relatively easy route of the South Platte River and Kenosha Pass, southward into South Park, rather than the northern direction proposed by Benedict. Johnson suggested this premise on the observation of jaspers in the Ken-Caryl sites that were identified as Trout Creek jasper; however, more recently Larmore and Gilmore (2006) report other lithic sources in South Park that bear strong resemblance to both Trout Creek and Dawson jaspers, and Black and Theis (2015:346) describe so many central Colorado chert and jasper sources that they propose a "jasper toolstone source zone" for a large area, including the Trout Creek source and many others stretching over a wide region.

Taken together, these studies demonstrate that macroscopic identification of Trout Creek jasper is highly suspect. To avoid problematic lithic identifications, Larmore and Gilmore (2006) built their model on population estimates postulated from radiocarbon dates for the two areas. The high similarity between population in the two areas, they argue, is because the two populations are in essence the same, moving between the two environments at different times of year.

Finally, a fourth, short-range mobility model for the Hogback valley has been proposed by Moore and Busch (2003). They postulate that the Hogback valley was used year-round, with occupation during all seasons and not limited to winter. They assert the Hogback valley and surrounding area contain enough natural resources, including flora, fauna, clay, and lithic resources that occupants would only have to move short distances for short periods of time to acquire needed materials. The valley would only be vacant for a few weeks or less as people moved onto the Palmer Divide or east onto the plains for resource procurement. Other researchers working on the plains and the plains-mountain margin have begun to build a picture of a more complex pattern of movement that incorporates more of the plains area and the Palmer Divide into seasonal rounds, without building specific models (Gleichman 2012; Kalasz et al. 2003).

Table 20.5 summarizes these four models in terms of what each would predict for Hogback assemblages. Two lines of evidence are of key importance in evaluating the models—seasonality and patterns of resource procurement and use.

Seasonality

As the above section discusses evidence for seasonality at Swallow, we will address this aspect of the models first. The evidence at Swallow suggests it was a winter base camp from which logistical collecting took place to sustain the group for an extended period. Late fall and winter plant sources that may have grown in abundance in or around the valley include grasses, hackberry, juniper, and pinyon. Good stones for flaked tools and grinding stones were available locally, game could be found in the foothills and the plains in addition to the valley, and plenty of natural shelters made Swallow and the surrounding rock shelters a clear choice for a winter base camp. This evidence,

Table 20.5. Summary of expected evidence in the Hogback valley for mobility models.

Model	Seasonality	Direction of Movement	Position of Hogback	Non-Local Resource Procurement
Grand Circuit[a]	Winter	North, then west	Southern and eastern limit	Middle Park and local
Up-Down[b]	Winter	East to west	Eastern edge	Continental Divide (quartz)
South Park[c]	Winter	Southwest along Platte	Northeastern edge	South Park jasper, including Trout Creek
Short-Range[d]	Year-round	Denver basin	Not applicable	local and near local

[a] Benedict 1992
[b] Benedict and Olsen 1978
[c] Johnson et al. 1997b; Larmore and Gilmore 2006
[d] Moore and Busch 2003

then, supports the three transhumance models, but a broader view is needed to evaluate the Short-Range Mobility model. Year-round use of the area would not necessarily mean use of any given site year-round, and the presence of open camp sites as well as limited activity sites through the valley may indicate use at other seasons.

Open camp sites have been minimally tested in the Ken-Caryl area. Johnson and others (1997b) reasoned that the rock shelters like Swallow, with a western exposure, would have been too hot in summer, and therefore open camp sites are summer habitations. So far, the majority of sites recorded in the Ken-Caryl area have been classified as limited activity sites, and open camps appear to be small and relatively shallow, suggesting a lighter occupation/use of the valley compared to the rock shelter use, though a bias in research focus may be contributing to that impression. Open camps may also represent a later use of the valley; open sites identified in the DC-CAS surveys and tests only exhibited Early Ceramic components (Johnson et al. 1997a; Moore 2002). Only four open sites (Dutch Creek, Cherry Gulch, Massey Draw, and Magic Mountain) have so far yielded Early or Middle Archaic components.

The dense Early Ceramic levels at rock shelters throughout the valley along with the presence of Early Ceramic open camps indicate a heavier use of the valley in the Late Prehistoric, consistent with overall demographic trends for eastern Colorado (Gilmore 2008a). Open camps may indicate that the heavier use included a longer duration of stay, extending beyond the colder months, consistent with the Short-Range Mobility model, but it is questionable whether this argument extends back in time much earlier than the Early Ceramic. The record from Massey Draw for use in the Early and Middle Archaic is instructive here, as researchers identified long periods of disuse between occupations, indicating that, while the site is a multi-component site used for a long time, its use was far more sporadic than that seen in the rock shelter deposits at sites like Swallow.

Massey Draw also provides one of the strongest seasonality arguments for sites in the area, with fetal or newborn calves of both bison and elk recovered from multiple bone levels (Anderson et al. 1994:228), indicating spring use. Other evidence for seasonality of open sites can be gleaned from macrobotanical materials from Early Ceramic components at Magic Mountain (Puseman

2022), which are notably different from those at Swallow in a few taxa. *Prunus* sp. seeds (most likely chokecherry) are present in about half of the samples, along with plum and riverbank grape occurring less frequently. All of these are mid- to late-summer fruits in the Denver basin, and all are lacking in the Swallow macrobotanical samples. By contrast, hackberry, a late fall to winter fruit, is among the most common seeds recovered at Swallow and completely lacking from the Magic Mountain samples. While the two sites are some distance apart in the valley, there is little reason to think resource availability would be different in the catchment area of each, so these differences suggest seasonal use differences.

In summary, there is clear evidence of activity in and around the Hogback valley in seasons other than winter, as proposed by the Short-Range Mobility model, but not enough to demonstrate the same level of use at all seasons as the model proposes. Rather, the pattern appears to be an aggregation at rock shelters in the valley in winter, and a dispersal in summer that may have left a small number of people in or near enough to the valley to use it sporadically in other seasons. Furthermore, this pattern can only be confirmed for the Early Ceramic and possible Late Archaic, but to date, evidence of year-round use deeper into the Archaic is lacking.

Resource Acquisition

Given that each model argues for movement in a different direction, raw material acquisition is the most obvious way of differentiating them. In the Grand Circuit model, the Hogback valley would be on the southernmost end of the circuit, so long-distance resources should come from the north and west. The most notable resources along this route are the lithic resources of Middle Park, Kremmling chert and Windy Ridge quartzite, and the food resource of bighorn sheep, harvested in communal game drives in the summer along the Continental Divide.

The Up-Down Transhumance model likewise involved the hunting of game, notably bighorn sheep, in the high country, but without the access to the Middle Park lithic sources. Rather, in this model Benedict and Olson (1978) noted that a number of high-altitude sites contained a variety of materials that probably came up from the eastern base of the Rockies (most notably Lyons sandstone), and that quartz was utilized in high amounts for flaked tools. This use of quartz was explained as a locally available, low-quality material that was used at high-altitude sites once better-quality tool material imported from the eastern foot of the Rockies was used up. Therefore, we might expect to see these quartz tools transported to the valley in the fall, then replaced with local materials through the winter.

Transhumance to South Park would be attractive for access to Trout Creek jasper and similar jaspers that occur in that region, thus Trout Creek jasper would be expected as a non-local material in the Hogback valley sites in this model. When Johnson and others (1997b) first proposed this model for the Ken-Caryl sites in 1997, they had identified quantities of Trout Creek jasper on the Ken-Caryl sites, but as we now believe visual identifications are insufficient to differentiate some Dawson Arkose and South Park/Central Colorado jaspers, lithic procurement cannot be used to support this model without further research. Game available in South Park includes deer, bison, and antelope, similar to game available on the plains.

Finally, the Short-Range Mobility model predicts that long distance materials would be rare, in favor of local material. Moore and Busch (2003) proposed the Hogback valley was occupied for all but a few weeks of the year, with trips outside the valley of short range and short duration. In this case, given the abundance of cherts and quartzites in close proximity to the site, we might expect these local resources to dominate the assemblage, though this would be consistent with all models. If trips away from the site were of short duration, we would expect tools from short-range sources, such as Dawson petrified wood and Green Mountain petrified wood, to be manufactured on site.

Some evidence can be rallied to support each of these models, but none is a perfect fit. Local quartzites and cryptocrystalline materials (chert, chalcedony, and agates) make up the majority (70-80%) of the Swallow assemblages throughout the occupation, as might be expected in all the models. Beyond that, however, imports to the site provide a more complicated picture.

Dawson petrified wood is the most common material from outside the immediate area. The evidence presented above suggests that tools made of Dawson petrified wood were primarily made elsewhere, unlike tools of Green Mountain petrified wood and the various local chalcedonies and cherts, materials found in abundance in the debitage assemblage as well as the tool assemblage. This is not the pattern we would expect if material was acquired through quick forays to the south or casually picked up while hunting, but rather implies that a substantial amount of time was spent on the Palmer Divide. Tools and some raw materials were then brought to Swallow for the portion of the year the group resided there, where curated cores and tools were used up, and the tool supply was replenished with locally available quartzites and Green Mountain petrified wood. (It should be noted that similar quartzite deposits occur along the east face of the Front Range for some distance, so the presence of quartzites in the Swallow assemblage does not necessarily represent resource acquisition at that location, but only the possibility of local acquisition. Green Mountain petrified wood, on the other hand, has a narrower range of source locations, nearer to Swallow site.)

Lucius' analysis of clay sources for the pottery at Swallow adds further to this interpretation. Based on refiring color, Lucius (see Chapter 12) identified seven distinct clays in the Swallow assemblage. All contained substantial quantities of quartz sand and mica, suggesting the clays originated from deposits relatively near each other with similar decompositional environments. He located likely source locations for three of the seven clays in the Jarre Creek drainage just west of the town of Sedalia, where the Dawson Arkose meets the Hogback. It is worthy of note that in 2010, a massive outcrop of petrified wood was identified on the Cherokee Ranch (Mustoe and Viney 2017), about 8 km from the Jarre Creek clay source. Lucius argues that pots rather than clay were likely transported, which would suggest a minimum stay of days or weeks for potters at the clay localities to allow for clay mining and mixing, vessel construction, drying, and firing. Mobley-Tanaka's (Chapter 13) seriation of cord marks on pottery from Lucius's identified sources demonstrates that use of the Jarre Creek clay source was by no means an isolated event but spanned the Early Ceramic occupation at Swallow. The Jarre Creek area was therefore a regular part of the seasonal movement of the population, at least in Early Ceramic times, perhaps scheduled at the appropriate time to construct pots that could then be taken to locations where they could be used for processing certain seasonal food resources. Pots are bulky and fragile, and not ideal to carry move after move all year, so it would make sense to make them when they were most useful and minimize transport.

This substantial use of Palmer Divide resources is problematic for all three transhumance models. The Grand Circuit model postulates a general flow of people northward, movement that would put the Hogback valley at the southern end of the seasonal round, making residents far more familiar with resources northward through Boulder and Larimer counties than south onto the Palmer Divide. The Up-Down and South Park models might be modified to accommodate a season spent on the Palmer Divide, but the focus on summering in the high country implicit in those models would have to be narrowed.

The similarity of resources available in South Park and on the Palmer Divide is also worth considering in evaluating these models. Lithic materials are very similar, as are game resources, reducing the advantage of the long trek to a mountain valley. Escaping the summer heat of the Denver basin likewise can be achieved on the Palmer Divide without the various risks of high elevation. According to the National Weather Service, average July high temperature at Palmer Lake (near the crest of the Palmer Divide) is 79.6 degrees, compared to 89.9 degrees in Denver and 76 degrees at the Antero Reservoir weather station in South Park (NOAA 2024).

Broader distribution patterns for Dawson petrified wood indicate that it was widely used by groups in the Denver basin, but its use fell off rapidly to the north in Boulder, Larimer, and Weld Counties. Johnston (2022:Figure 4.9). compared the prevalence of petrified wood from a number of sites along the eastern foot of the Rockies and found it accounted for more than half of the assemblage at Magic Mountain on the northern end of the Hogback valley, but less than a quarter at Rock Creek in Boulder County and was lacking entirely from the assemblage at Cass in Weld County. Preliminary data from Fossil Creek in Larimer County indicates petrified wood is only 5% of the assemblage (Millonig 2015). Kalasz and others (2003) document substantial amounts of Dawson petrified wood in sites on the south and east side of the Denver Basin, including Ridgegate, East Plum Creek, and Box-Elder-Tate Hamlet at the Denver International Airport (DIA). At another DIA site, Monaghan Camp, Tucker (1990) identified Dawson petrified wood to be as much as 80% of the assemblage. Similarly, Lucius (see Chapter 12) identified clays from the Jarre Creek source at sites along the east and northeast edge of the Basin, at 5DA1957 in the Newlin Gulch drainage near Parker, and at 5WL215 near Kersey in Weld County.

The distribution of these Dawson Arkose resources does support the concept proposed by Moore and Busch (2003) of a definable area of resource use in the Denver basin (what they term a habitation area), though far more systematic mapping of materials than that done by Moore and Busch or presented here is needed to define it. While this distribution fits the habitation area idea of the Short-Range Model, it does not support the premise that such short-range mobility within the habitation area was anchored year-round in the Hogback valley.

Longer distance imports account for less than one percent of all tools. Of those that can be identified, Middle Park materials (Kremmling chert and Windy Ridge quartzite) are the most frequently occurring, with 16 projectile points, 2 cores, and a few flakes of Kremmling chert, suggesting these tools came to the site primarily as finished artifacts. Four projectile points made of Windy Ridge quartzite further bolster the evidence for Middle Park resource acquisition. Together, Middle Park materials make up almost 3% of the projectile point assemblage and are associated with all time periods.

Very little Kremmling chert has been recorded at other Hogback valley sites, but there seems to be some variation. Johnson and others (1997b:146) argued that Kremmling chert was not observed at other Ken-Caryl Ranch sites, but as only visual examinations were done, she concedes that more work may reveal its presence. In subsequent surveys of the Ken-Caryl Ranch, Moore (2002) identified 11 flakes of Kremmling chert at an open camp site in the south valley, not far from Swallow. No Middle Park stone was identified at Massey Draw (Anderson et al. 1994), while Johnston (2022) identified no tools and only 7 flakes of Kremmling chert/probable Kremmling chert and one of probable Windy Ridge quartzite at Magic Mountain.

The low frequencies of these materials do not necessarily conflict with the grand circuit model, as the material would be largely depleted during the summer game drives and the ensuing trek down the mountains in the fall before settling at winter residences, but the support is weak in comparison to other sites along the eastern edge of the mountains. Kremmling chert and Windy Ridge quartzite occur at irregular frequencies along the plains-mountain margin, but in higher frequencies in Boulder and Larimer Counties than in the Jefferson County Hogback sites. Gleichman (2012) identified 18 Boulder County sites where Kremmling chert has been found, including the Chautauqua Cache, consisting of 19 bifacial preforms made entirely of Kremmling chert (Gleichman and Becker 2015). At Rock Creek, 2.0% of Archaic debitage and 9.2% of Ceramic period debitage, as well as 16 projectile points, were sourced to mountain sources, most notably Kremmling chert. Kremmling chert and other mountain lithics are also present at the Fossil Creek site in Fort Collins, Larimer County (Millonig 2015).

Taken together, the distribution patterns of Dawson resources and Middle Park resources seem to imply that the southern boundary of the Grand Circuit transhumance pattern lies somewhere between Boulder and Golden, with Hogback inhabitants south of Golden not regular participants in the Grand Circuit. A systematic mapping of Dawson and Middle Park resources at sites from Roxborough Park to the Wyoming border might be useful in distinguishing groups that focused their annual cycle to the north or south. For the Ken-Caryl Ranch residents, traveling north to the Laramie Basin to cross to Middle Park would have meant a long spring trek through areas largely depleted by the winter camps of neighbors, making a more direct path into the mountains or onto the Palmer Divide a better bet for accessing fresh food sources after a long winter of hunting and gathering along the foothills and plains. If winter camps occurred along the plains-foothills boundary from Roxborough Park to Fort Collins and beyond, as the archaeological record suggests, it is easy to imagine this would pose a problem, and would have required numerous access points to the mountains, some making it to Middle Park for Kremmling chert, others moving directly west along the many rivers and creeks that flow from the mountains, others moving southwest into South Park for jasper, and still others directly south onto the Palmer Divide or elsewhere in the Denver basin for some or all of the summer months, in a complicated pattern that allowed for broad exchange and acquisition of materials. As noted by Johnson and others (1997b) and Larmore and Gilmore (2006), the South Platte drainage and Kenosha Pass into South Park provide a direct and relatively easy path into the mountains, negating the need for a long traverse to the Laramie Basin. The open sites in close proximity to Swallow would suggest that some groups stayed on the plains and utilized the Hogback valley intermittently in seasons when the rock shelters were not in use. It is easy to imagine that these forays along the Hogback were conducted by foragers or collectors summering on the Palmer Divide or eastward on the plains.

Finally, the utilization of quartz as a lithic material at Swallow offers some support to Benedict's Up-Down transhumance model. Quartz makes up 5.9% of the flakes, and 9% of tools, which is surprisingly high in a valley with so many better-quality materials available. Quartz occurs in the highest quantities in the Early Archaic, where it accounts for nearly 13% of tools, as opposed to around 8% in later time periods. Benedict and Olson (1978) theorize that the large number of quartz tools found at Mount Albion sites at high elevation are indicative of time spent in the mountains, and the necessity to replenish tools when far from the good lithic sources on the plains. If so, we might expect an initial influx of quartz tools on winter sites when groups first arrived with their mountain tool kits of quartz, which were then discarded for better tools at a leisurely pace through the winter months when collecting local material can take place. The higher frequencies of quartz in the Early Archaic reflect this connection to high-elevation Mount Albion sites; however, the connection is weakened by the fact that only one Mount Albion style projectile point was found at Swallow. Moore and Busch (2003) compared Hogback assemblages to those of two sites on the eastern side of the Denver basin and found quartz entirely lacking in assemblages farther east, but consistently occurring in Hogback valley sites. This, then, would seem to imply a connection between the high-altitude sites and the Hogback sites more than it would imply a connection between the Hogback and the sites on the eastern side of Denver basin.

A few other lines of evidence suggest connections to the mountains. The blood residue analysis of stone tools from Swallow indicated the presence of mountain sheep blood on multiple tools, though mountain sheep was not found in the faunal assemblage. Its presence suggests hunting at higher elevations, possibly through participation in the summer game drives discussed by Benedict (Benedict and Olson 1978). Yellow-bellied marmot is another higher elevation animal that was identified in the faunal assemblage.

Several projectile point types that originate west of the Continental Divide have been found at the site. The large variety of projectile point types at Swallow, with 13 main types and a total of 27 subtypes is itself demonstrative of wide areal associations. As markers of identity, point types can be indicative of cultural and geographic connections. Point typologies are constrained by our weak grasp of the huge variety of forms; their geographic origin, spread, and areal occurrence; and by an imprecise knowledge of the temporal span of their manufacture and use. The regional basis of type definitions results in different type names for similar points from different areas. Nevertheless, some geographic connections can be proposed for the Swallow types, including types associated with areas to the west and southwest. These include Pinto Shouldered, Northern Side Notched, Sudden Side Notched, and Armijo style points. Rose Spring points (also known as Rosegate) are primarily associated with the Great Basin, Fremont area, and Intermountain West, but similar styles occur with other type names in Texas and farther east. The presence of these point types suggests that some inhabitants of the winter camp at Swallow had connections to the mountains or areas west of the mountains through trade or travel. The mobility associated with those connections could have varied among groups inhabiting the Hogback valley and varied through time. This evidence could fit any of the mountain transhumance models. It is not consistent with the Short-Range Mobility model that would keep people mingling in the limited geographic region or the Denver basin. The Ute analogy proposed by Benedict for Western slope movement into the high country comes to mind, given the ethnographically known forays onto the plains of Ute groups who inhabited the Western slope. Occasional visits by Mountain Tradition folks to the Hogback valley probably occurred and could result in indirect acquisition of mountain tool stone, deposition of western point types, manufacture of western point types using local materials, and transmission of point styles or hafting technology.

In summary, the seasonality and materials evidence from Swallow lends some support to all models but is not a particularly strong fit with any. Connections to the mountains can be made, but not to the extent that the various transhumance models seem to imply (though the South Park model is inadequately tested here). The apparent heavy use of the Palmer Divide does not support the mountain transhumance models, but likewise does not support the Short-Range Mobility model that postulated year-round usage in the Hogback valley with limited usage of adjacent Denver basin areas.

One potential flaw in all the models is the assumption that all residents of the Hogback winter camps followed the same pattern of movement and arrived from the same direction. One major advantage to wintering in the Hogback valley is the large number of rock shelters relatively close to one another, allowing for many groups to come together in a pattern of winter aggregation. Summer dispersal and winter aggregation is a hunter-gatherer practice perhaps best known from ethnographies of Northern Paiute (Stewart 1939; Steward and Wheeler-Voegelin 1974; Fowler and Liljeblad 1986; Bengston 2003) and Western Shoshone (Steward 1937, 1997; Bengston 2003) in the Great Basin, but observed in other parts of the world as well. Among Great Basin tribes, winter camps brought together bands that spent their summers dispersed across a broad territory, not all traveling to or from the same direction or the same resources. Winter aggregations were times of ceremony, gift giving, affirmation of alliances, and mate selection, made advantageous to all because of the diverse resources brought by different groups in their separate travels. Such interactions, while not necessarily focused on economic exchange or resource acquisition, moved a variety of materials among people who did not themselves have access to all resources. From his survey of the ethnographic record, McDonald (2009:76) argues that long distance travel among hunter-gatherers may be associated with socializing, exploring and mating more than with resource acquisition, but can account for a notable quantity of non-local material into a site.

If we consider that a major advantage of winter aggregation is to bring together individuals from far-reaching bands, to share knowledge and resources from diverse locations and provide marriage partners from different gene pools, it casts an interesting light on some aspects of the Ken-Caryl rock shelter assemblages. The presence of hematite, ochre, and other pigments, pigment grinding palates, bone beads and other decorated bone ornaments, and evidence of bone bead manufacture at Swallow, LoDaisKa, and other Ken-Caryl rock shelters hint at ritual or social activities as a regular component of life at these winter habitations.

The presence of groups from far reaching territories might also account for some of the differences seen among the assemblages. Swallow has a faunal assemblage consisting almost entirely of deer while neighboring sites have more bison, elk, and antelope. Is this an indication of groups with different seasonal rounds, with bands that spend more time on the plains and therefore more focused on bison hunting while other bands focused on deer in the foothills? A cylindrical gneiss pestle and groundstone axe at Willowbrook shelter (Tate 1979) and similar cylindrical grinding stones along with several projectile point styles recovered from Bradford House II suggested a Southwest connection (Johnson et al. 1997a:157). Moore and Busch (2003:Table 3) report that only 4% of tools from Bradford House III are made from Dawson petrified wood, an anomaly compared to other Hogback sites with percentages around 20-25%. Gilmore (1989) reported Flattop chert from northeastern Colorado at Dutch Creek, a resource not recorded at other Ken-Caryl sites. Plainware pottery with a smooth surface finish has been found at LoDaisKa, Van Bibber Creek, and Magic Mountain, intermixed in small amounts with cord-marked pottery. Early researchers suggested a Shoshonean connection (Irwin and Irwin 1959; Nelson 1969), though Kalasz and Shields (1997) argue it is a variant of local Woodland pottery. Whichever is the case, it is one of many anecdotal hints that the winter occupants of the Hogback valley may not have been a homogenous group.

Could the small amounts of Kremmling chert and projectile points made of local materials but in non-local styles indicate intermarriage or exchange alliances among people who followed different annual cycles? What would better clay and temper sourcing tell us about the directions from which vessels arrived in the valley? Perhaps the cultigens from LoDaisKa (Galinat 1959; Irwin and Irwin 1959) and the Southwest connections suggested by the Irwins for Archaic materials at Magic Mountain (Irwin-Williams and Irwin 1966) or by Nelson (1981) for Cherry Gulch could be fruitfully re-examined as part of a larger exploration of broad social connections in the Hogback valley. DC- CAS lithic analysts initially identified substantially more Trout Creek jasper in other Ken-Caryl assemblages than in the assemblage from Swallow. While this sourcing has subsequently been called into question, it remains as anecdotal evidence that the assemblages are visually different. If frequencies of various non-local materials truly are different among the tightly clustered Ken-Caryl sites, it illuminates an interesting picture of winter aggregation of far-reaching bands, but much more clarity on distinguishing sources and rigorous control of material identification is needed before such a conclusion is warranted. These are conjectures that, at the moment, extend beyond our analytical grasp, but present directions for future research that could open up our understanding of the Hogback valley and of prehistoric mobility in interesting ways.

Conclusion and Directions for Further Research

Swallow site gives a picture of a remarkably long occupation and resource use on the mountain-plains margin, spanning nearly 7,000 years. The lowest levels, representing the beginning of the Early Archaic suggest a somewhat minimal use of the site that differs from later occupations. By the middle of the Early Archaic, however, established site use patterns develop that continue through the Middle and Late Archaic, creating a picture of long cultural memory and repetitive use in a subsistence pattern that was remarkably stable over millennia. While spatial patterning of use areas changes in the Early Ceramic period, resource use continued relatively unchanged. This pattern involved winter occupation of the rock shelter, and utilization of a few primary food resources, most notably deer, rabbit, grasses, and ruderals, even through times of environmental fluctuation. While the regional technological and demographic changes of the Early Ceramic are apparent at the site, the overall subsistence pattern remains largely unchanged.

The research potential of the Swallow assemblages are underutilized. Lithic sourcing could be very fruitful, ground stone and chipped stone tools other than projectile points have been minimally analyzed, and lithic debitage has not been evaluated for reduction strategies. The geologists from DC-CAS have raised the topic of use of non-crystalline silica, i.e., common opal, at Swallow as tool stone. The question of identification and use of opal and its implications should be investigated. Geometric morphometric studies of some of the projectile point types could result in greater understanding of geographic connections, e.g., Burnett’s study of geometric morphometrics of Rosegate (also known as Rose Spring) points from the Great Basin, Colorado Front Range, and mountains of Wyoming showed the style has geographic idiosyncrasies, with unique shapes for each region (2011).

Some soil and macrobotanical samples remain unprocessed and could expand the floral evidence. Numerous carbon samples exist and dating of specific features could refine understanding of the temporal developments. The Hogback valley has among the highest densities of sites in eastern Colorado (Gilmore et al. 1999), and Swallow is one of the most extensively excavated sites in the valley. Its potential for helping refine our understanding of ancient indigenous populations in the eastern half of Colorado is significant. We therefore extend here a few thoughts on further research that might be pursued.

The similarity of resource use at Swallow through time, despite changing technology and environment, is intriguing and begs further exploration into human-environmental interactions that allowed for such stable lifeways. A variety of research into ancient Indigenous American lifeways has begun to acknowledge the active role of indigenous groups in encouraging and managing valuable resources (Gremillion 2004; Oetelaar and Oetelaar 2007; Kimmerer 2013). More research into how stable lifeways like that at Swallow were maintained could be useful not only to our understanding of the past, but to our hope to sustain native species and wild resources into the future.

As one of the few sites in the area with a well-excavated Early Archaic component, Swallow also has the potential to inform on questions about the use of the area in the Altithermal. Subtle differences between the earliest Early Archaic layer at the site and a subsequent occupation suggest a tentative early use of the valley that did not settle into a formalized part of a seasonal round until much later. The early radiocarbon dates in this lowest layer suggest this may represent a transitional lifeway between late Paleoindian and Early Archaic.

Swallow fits with models of mobility in the region so far as it is a winter habitation. Benedict's (1992) up-down model of transhumance in the Early Archaic may be supported by the quantities of quartz tools in the Early Archaic levels; however, resource acquisition patterns in all time periods more strongly speak to a southern round that incorporated the Palmer Divide for part of the year. Movement up the Platte into South Park could fit into such a south-facing migratory round, but evidence to support its inclusion is beyond our analytical grasp until we develop better ways to differentiate lithic resources in the Palmer Divide and the central Colorado mountains.

Models of mobility employed to date in Colorado have focused too exclusively on the mountains for summer foraging. The evidence from Swallow suggests that these models should be re-evaluated to include more use of the Palmer Divide, which does provide some of the advantages of mountain locations and clearly played a significant role in the seasonal rounds. More work needs to be done to establish what that role was, either as an area for logistical collecting in fall and winter, or an area of productive seasonal foraging and material acquisition for a larger part of the year. In addition, we question the assumption that a single pattern of mobility was used by all those who gathered in the Hogback valley. Differences among Hogback valley sites, while as yet based on limited data, suggest that it could be fruitful to explore the possibility of winter aggregation from bands that dispersed in different environments and directions in the summer. Such a pattern might have incorporated light, year-round use of the valley, with some bands passing through on short summer forays from time to time, accounting for the small open sites and limited activity sites, while the more major occupation took place in the winter in the numerous rock shelters.

Swallow, along with the sites around it, offers opportunities for further research to expand our understanding of mobility patterns along the plains-mountain margin, and the nature of band aggregations within those mobility patterns. So many winter habitations in close proximity must have created social interactions that have thus far gone unexplored. Discussions of exchange are largely lacking from interpretations of non-local materials along the Front Range, the focus being primarily on mobility patterns. A more nuanced discussion of how materials move in hunter-gatherer societies could be an enlightening thought exercise for reconstructing ancient lifeways.

Connecting a South-Platte-to-South-Park transhumance pattern to the occupants of Swallow and neighboring rock shelters remains frustratingly out of reach, given our current inability to accurately differentiate central Colorado jasper sources from Dawson sources. More research to identify other lines of evidence that would support or refute the South Park mobility model, originally proposed by Larmore and Gilmore (2006) based on radiocarbon data, would also be productive. It is our hope that the rich assemblage from Swallow will be utilized in the future to continue to address these questions and many more in future years.

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Appendix A: Features

Jeannette L. Mobley-Tanaka

Features at Swallow were recorded on standardized feature forms that included a description, measurements, a map or drawing of the feature, and a soil smear to preserve soil coloration where relevant. The original forms are all preserved at OAHP. Copies of these forms were also placed along with photographs of each feature into feature notebooks to make interpretation and analysis easier. These notebooks are also housed with site files at OAHP.

Data from the forms, along with interpretations/observations made from them and the accompanying photographs were entered into a spreadsheet in 2005 in order to facilitate analysis and report writing. At that time, decisions were made to remove or combine features as appropriate, and to classify features into categories.

Initially, the spreadsheet included all recorded features, but as work progressed, a number of these were eliminated from the analysis as irrelevant (for example, a number of "postholes" could be eliminated as rodent burrows, and the change in color between strata was initially identified as a feature and only later recognized as a horizon.) A few other features were eliminated from the analysis due to a lack of adequate information when forms, maps, and photographs were missing.

The Appendix A spreadsheet contains only the features discussed in the final report, with all features that were removed from that discussion also removed from the spreadsheet for clarity.

The columns included on the spreadsheet are as follows:

Fea #: this is the feature number assigned in the field and corresponds to the feature numbers on the original feature forms.

Description: this includes an abbreviated description that may be taken from the field forms and/or includes observations made from the photos or maps during analysis. Information in quotation marks in this column indicates it is taken verbatim from the feature form.

Feature type: this is the classification of the feature used in the report, though for the purpose of reporting, surfaces and lenses were combined in the report discussion.

Level: the level at which the feature was found. In some cases it is a single level, in others multiple levels were given on the form and these are listed with a space between them (eg, 1 2 3 is levels 1-3)

Stage Desig: EA=Early Archaic, MA=Middle Archaic, LA= Late Archaic, L/MA= Late/Middle Archaic, EC=Early Ceramic. See Chapter 7 for more detail on how these designations were determined.

Reported Depth: the highest and lowest depths given for a feature. Depths were not recorded on feature forms for all features.

Unit: Excavation Unit.

Dimen. 1, Dimen. 2, Dimen. 3 (depth) : these columns record length, width, and depth, primarily of hearths. Features were not profiled during excavation, so in some cases depth measurements were recorded by excavators and in other cases they were reconstructed from level forms and/or information in notes.

Notes: a few additional comments as needed.

Double-click the icon to access feature data spreadsheet:

Appendix B: Projectile Point Data

Katherine C. McComb

Photographs of all points within a type are given in this section along with relevant data for each projectile point. The following metrics are given:

- Catalog Number – Swallow Site field specimen number.
- Square – Excavation unit in which projectile point was found.
- Level – Arbitrary excavation level in which projectile point was found. There is a level approximately every 10 cm on a per square basis.
- Material Type – Type of flaked stone material (Rathbun assessment and 2008 assessment).
- Length – Length in centimeters.
- Width – Width in centimeters.
- Thickness – Thickness in centimeters.
- Weight – Weight in grams.
- Max Haft Width – Maximum width below the shoulder portion of the projectile point.
- Min Haft Width – Minimum width below the shoulder portion of the projectile point.
- Comment – Additional information about the projectile point.

All numeric metrics are given in centimeters, except weight, which is in grams. A numeric measurement may be delineated by ( ) symbols. This indicates that the full measurement could not be taken because some portion of the projectile point along the measurement was missing. The following abbreviations are used in the data tables:

Ag	Agate	PW-D	Dawson Petrified Wood
C[1-8]	Column 1, Column2, etc.	PW-GM	Green Mountain Petrified Wood
Cy	Chalcedony	Qe	Quartzite
Ct	Chert	Qz	Quartz
Js	Jasper	Qz-Crystal	Crystalline Quartz
Meta	Meta-quartzite	Qz-Vein	Vein Quartz
MQ	Morrison Quartzite	R[1-8]	Row 1, Row 2, etc.
NMT	No Material Type given	Sfc	Found on surface of site
NVP	No Vertical Provenience	*	Indicate possible Kremmling chert
Op	Opal	+	Indicates possible Windy Ridge quartzite
PW	Petrified Wood	“	Indicates possible Alibates chert

Note that a number of the projectile points have no vertical provenience (NVP). These points were from the side walls of excavation units that had caved or fallen off over the winters. They are marked as “cavings” or “cav” on the catalog cards.

Figure B1: Types 1, 2a and 2b

Reference for Figure B1: Types 1, 2a and 2b

		C1	C2	C3	C4	C5	C6
Type 2a	R1	5818	8465	8472	12606	9806/12886	13811
	R2	14918	15284	17142	17830	21193	22242
	R3	24615	24779	28635	31158	31174	31951
Type 2b	R4	5747	7139	7940	11949	12208	15552
	R5	16688	16756	18097	22718	27456	27981
	R6	28594	28685	33519	37910	Type 1 →	21271

Table B1 Type 1, Folsom Preform

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
21271	C1S	L30	NMT	Ct	(2.7)	2.1	.5	(3.7)	2.5	N/A	Grinding on edge of base

Table B2: Type 2a, Large Corner-Notched Projectile Points

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
5818	B3S	L10	Js	Js	(2.80)	(1.84)	0.62	(2.9)	1.36	1.05	No grinding
8465	E3S	L12	PW-D	PW	(1.91)	1.96	0.45	(1.7)	1.33	1.05	Grinding on basal edge and on innermost portion of notch
8472	E3S	L12	Ct	Ct	4.02	2.72	0.63	(5.9)	(1.35)	1.21	Ground on base and edge of fractured notch
9806	C2S	L5	Ag	Cy	(1.92)	(1.69)	(0.41)	(0.8)	--	--	Matches 12866
12606	E6S	L5	Ag	Cy	3.13	2.20	0.40	(2.6)	(1.12)	1.05	No grinding
12886	F2S	L8	Ag	Cy	2.74	(2.02)	0.46	(2.7)	(1.09)	1.09	Minimal grinding on the notches. Matches 9806
13811	F3S	L14	Qe	Qe	2.71	(2.04)	0.50	(2.9)	1.60	1.25	Ground on one notch
14918	C3S	L12	Cy	Cy	(2.01)	(2.01)	0.54	(3.4)	1.50	1.2	No grinding
15284	C3S	L17	Qe	Qe+	3.18	(1.93)	0.45	(2.5)	1.40	1.27	Ground on notches and base
17142	C4S	L6	Qe	Qe	(2.65)	2.15	0.39	(1.8)	1.60	1.15	No grinding
17830	C4S	L9	Ag	Ct	(2.50)	2.05	0.48	(3.3)	1.62	1.35	No grinding
21193	D1S	L29	Qe	MQ	3.13	2.14	0.46	2.6	1.42	1.20	No grinding
22242	C2N	L6	Qe	Qe	(3.56)	(2.60)	0.50	(3.6)	(1.11)	1.11	No grinding
24615	D5S	NVP	Ag	Cy	3.46	(2.51)	0.53	(4.2)	(1.8)	1.30	Ground on base
24779	C2S	L30	Qe	Qe	3.20	1.83	0.42	(2.5)	1.21	.97	No grinding
28635	E1S	L8	Qe	Qe	3.68	2.08	0.50	4.1	1.40	1.10	No grinding
31158	A3S	NVP	NMT	Qe	(2.04)	1.86	(0.66)	(2.0)	1.40	1.10	No grinding
31174	B2S	L29	Qe	Qe	(2.64)	(2.08)	0.52	(2.7)	1.34	1.20	No grinding
31951	B1S	L30	Qe	Qe	3.04	2.00	0.47	2.7	1.20	0.95	No grinding

Table: Type 2b, Large Corner-Notched, Wide base

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
5747	B3S	L9	Qe	Qe	(1.99)	(1.24)	(0.41)	(0.7)			No grinding
7139	E3S	L4	Qe	MQ	(2.46)	1.74	0.50	(2.5)	(1.62)	1.42	No grinding
7940	E3S	L7	Js	Js	(2.46)	2.22	0.57	(3.0)	(1.61)	1.35	No grinding
11949	E1S	L2	PW-GM	PW	(2.53)	(1.60)	(0.37)	(1.0)	(1.60)	missing	No grinding
12208	D2S	L14	PW-D	PW	(1.57)	2.12	0.53	(1.8)	1.55	1.25	Ground on the base and the notches
15552	C3S	L21	PW-GM	PW	(1.81)	2.27	0.50	(2.5)	(1.85)	1.35	Ground on the base and the notches
16688	C2S	L15	PW-D	MQ	(1.27)	(2.08)	(0.49)	(1.3)	(1.53)	1.32	Ground on the notches
16756	C2S	L16	PW-D	PW	(1.77)	(2.07)	0.45	(1.8)	2.08	1.50	Minimal grinding on the base
18097	C4S	L12	Ag	Cy	(2.23)	2.35	(0.55)	(2.7)	(1.51)	1.20	Ground on the notches
22718	F3S	L17	PW-D	PW	3.18	2.10	0.46	2.5	(1.70)	1.30	Ground on the base and the notches
27456	B3S	L14	Qe	MQ	3.59	2.75	0.54	4.6	2.20	1.40	No grinding
27981	D3S	L14	PW-D	PW	(2.50)	(2.20)	(.40)	(1.7)	(2.20)	(1.20)	No grinding
28594	E1S	L7	PW-D	PW	3.53	(1.99)	0.44	3.3	2.00	1.46	Ground on the base and the notches
28685	E1S	L9	Qe	MQ	(3.03)	(2.33)	0.50	(3.5)	2.33	1.50	Ground on the notches
33519	D2S	NVP	PW-GM	PW	(2.18)	2.10	0.50	(2.6)	1.83	1.10	Ground on the base and the notches
37910	A2S	NVP	Qe	MQ	2.22	2.40	0.44	2.1	(2.2)	1.58	Ground on the base and the notches

Table: Type 2c, Medium Corner-Notched, Wide Base

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
1823	D3S	L5	PW-D	PW	(3.54)	1.96	0.55	(3.6)	1.31	1.10	No grinding
3510	E2S	L13	Qe	MQ	(2.05)	(1.92)	0.49	(2.3)	1.53	1.21	No grinding
11555	E4S	L11	Js	Js	(2.30)	2.14	0.42	(1.7)	(1.55)	1.30	No grinding
12592	E6S	L5	Ct	Ct*	(2.57)	(1.81)	(0.55)	(2.4)	1.78	1.4	Slightly ground on the base
14025	D5S	NVP	PW-D	PW	(2.88)	2.15	0.51	(2.9)	1.70	1.20	No grinding
15510	C1N	NVP	Ag	Ct	(2.62)	2.11	0.42	(2.0)	(1.8)	1.31	Ground on the edge of the base
19656	C1N	L9	Qe	Qe	2.28	1.50	0.46	(1.9)	1.73	1.18	Blunted on the edges near the tip
20996	C1N	L12	PW-GM	PW	(1.08)	(1.95)	(0.50)	(1.1)	1.82	1.32	Ground on one notch
27113	B2S	L10	Qe	Qe	(2.18)	1.91	0.55	(2.8)	1.80	1.49	Ground on one notch
34181	B4S	NVP	PW-GM	Cy	2.79	1.79	0.55	2.2	(1.49)	1.30	Very slight grinding on base and notches

Figure B2: Type 2c

Reference for Figure B2: Type 2c

Type 2c		C1	C2	C3	C4	C5	C6
	R1	1823	3510	11555	12592	14025	15510
	R2		19656	20996	27113	34181	

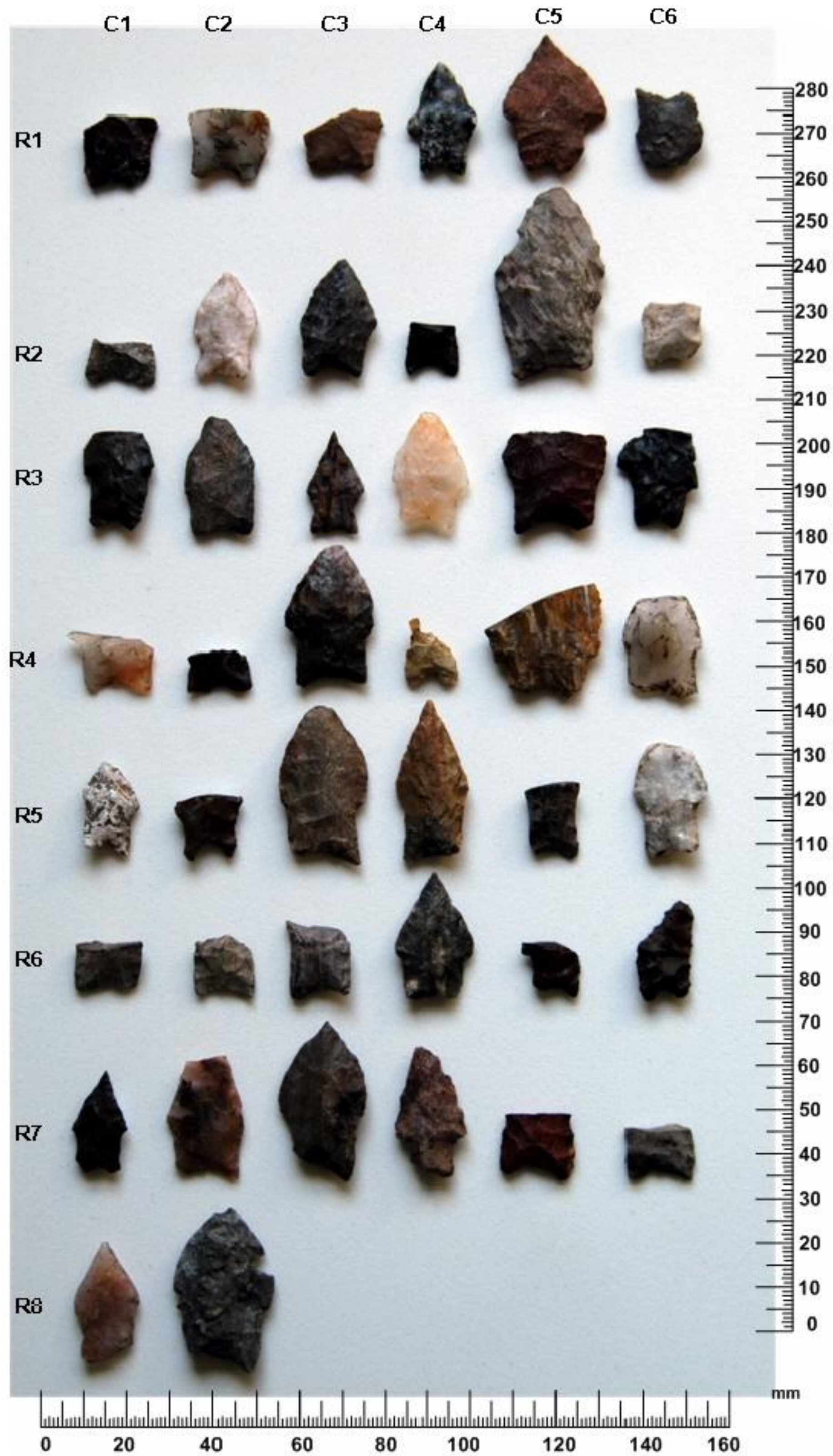

Figure B3: Type 3a

Reference for Figure B3: Type 3a

Type 3a		C1	C2	C3	C4	C5	C6
	R1	623	1712	3114	3133	3141	3460
	R2	4493	4684	4834	5140	6129	6545
	R3	6831	6883	12467	12591	14703	14991
	R4	15101	16130	16170	16559	16769	17907
	R5	19868	20577	20604	20656	21002	22225
	R6	23312	23862	25192	25209	26550	27336
	R7	27892	29307	31117	31268	31484	31492
	R8	33562	37541				

Table 1: Type 3a, Duncan

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
623	D4S	L12	Js	Js	(1.68)	(1.73)	(0.40)	(1.4)	1.60	1.47	Grinding on edge of stem
1712	D3S	L6	Ag	Op	(1.53)	(1.78)	(0.55)	(1.8)	1.65	1.46	No grinding
3114	E2S	L7	Qe	MQ	(1.40)	(1.72)	(0.38)	(1.0)	1.60	1.42	No grinding
3133	E2S	L7	Ag	Ct	2.64	(1.63)	0.44	(1.7)	1.10	1.10	Grinding on small portions of edges of stem
3141	E2S	L7	Qe	MQ	3.27	2.33	0.43	3.1	1.50	0.95	Very minimal, if any
3460	E2S	L12	PW-GM	PW	(1.88)	(1.48)	0.46	(1.6)	missing	1.33	No grinding
4493	D1S	L10	Ct	Ct	(1.00)	(1.59)	(0.38)	(0.6)	missing	1.55	No grinding
4684	D1N	L3	Op	Ct*	(2.37)	1.42	0.29	(1.2)	1.25	1.05	No grinding
4834	D1N	L5	PW-GM	PW	2.72	1.72	0.55	2.4	1.40	1.34	No grinding
5140	D2S	L8	PW-GM	Ct	(1.19)	(1.18)	(0.39)	(0.6)	1.20	1.01	No grinding
6129	B2N/2	L14	PW-D	PW	(4.29)	2.46	(0.75)	(7.0)	1.81	1.76	Minimal grinding on stem
6545	B1S	L13	Qe	Qe	(1.38)	(1.30)	(0.49)	(1.1)	(1.30)	1.20	No grinding
6831	E3S	L1	PW-D	PW	(2.21)	(1.56)	0.42	(1.8)	1.30	1.18	No grinding
6883	E3S	L2	PW-GM	PW	(2.63)	(1.54)	0.42	(1.9)	1.45	1.35	No grinding
12467	F6S	L4	PW-GM	PW	2.17	1.24	0.36	0.60	1.05	.90	No grinding
12591	E6S	L5	Ag	Cy	(2.51)	1.66	0.42	(1.8)	1.30	1.20	Small amount of grinding at top of stem near shoulder
14703	C3S	L9	Js	Js	(2.29)	2.27	0.54	(3.2)	1.81	1.70	No grinding
14991	C3S	L13	Op	Js	(2.14)	1.64	0.44	(1.7)	1.13	1.00	No grinding
15101	C3S	L15	Ag	Cy	(1.29)	(1.92)	(.46)	(0.9)	1.52	1.32	No grinding
16130	C1S	L17	Op	Js	(0.87)	(1.31)	0.30	(0.6)	1.39	1.21	No grinding
16170	C1N	L11	PW-D	PW	(3.05)	(1.94)	0.54	(3.0)	1.51	1.50	Minimal amount of grinding on basal end of stem
16559	C2S	L13	PW-D	PW	(1.07)	(1.16)	0.45	(0.6)	1.20	1.00	No grinding
16769	C2S	L16	PW-D	PW	(2.22)	(2.65)	(0.47)	(2.9)	1.70	1.55	No grinding
17907	C4S	L10	Cy	Cy	(2.00)	1.54	0.40	(2.0)	(1.45)	1.45	No grinding
19868	C1N	L10	Op	Ct	(2.04)	(1.14)	0.46	(1.0)	1.00	1.00	No grinding

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
20577	B1N	L8	Ag	Ct	(1.34)	(1.44)	0.46	(0.9)	1.10	1.09	No grinding
20604	B1N	L9	Qe	MQ	(3.26)	1.91	0.43	(3.1)	1.45	1.45	No grinding
20656	B1N	L10	Qe	Qe	3.36	1.62	0.53	(2.5)	1.35	1.30	Grinding on haft element
21002	C1N	L12	PW-GM	PW	(0.99)	(1.58)	(0.46)	(1.0)	1.60	1.42	No grinding
22225	C2N	L6	PW-D	PW	(2.30)	1.58	0.36	(1.7)	1.13	1.13	No grinding
23312	E4S	L18	PW-GM	PW	(1.05)	(1.47)	0.45	(0.7)	1.40	missing	Minimal amount of grinding on edges of stem
23862	D2S	L6	PW-GM	PW	(1.09)	(1.24)	(0.36)	(0.7)	1.22	missing	No grinding
25192	C2N	L10	PW-GM	PW	(1.67)	(1.4)	(0.48)	(1.1)	1.30	1.30	No grinding
25209	C2N	L11	PW-D	PW	2.66	1.70	0.42	(1.8)	1.33	1.30	No grinding
26550	B2N	L8	PW-D	PW	(0.91)	(1.24)	(0.34)	(0.5)	0.98	0.96	No grinding
27336	B3S	L3	PW-D	PW	(2.24)	(1.18)	0.35	(1.0)	1.15	1.10	No grinding
27892	D3S	L11	Op	Js	(2.10)	1.19	0.38	(0.8)	1.05	0.95	No grinding
29307	D1S	L12	PW-D	PW	(2.48)	1.61	0.41	(1.7)	1.35	1.30	No grinding
31117	B4S	L15	PW-GM	PW	3.29	1.90	0.62	(3.1)	missing	1.40	No grinding
31268	B3S	L18	Qe	Qe	(2.75)	1.49	0.54	(2.2)	0.96	missing	Grinding below the shoulders
31484	A2S	L10	Qe	Qe	(1.40)	(1.72)	(0.38)	(1.0)	1.60	1.44	No grinding
31492	A2S	L10	PW-GM	PW	(1.15)	(1.43)	(0.34)	(0.6)	1.42	1.42	Grinding on basal end of stem
33562	E4S	NVP	Ag	Cy	(2.48)	1.39	0.35	(1.3)	(1.09)	1.05	No grinding
37541	A3S	L11	Op	Ct	(3.33)	(2.09)	(0.65)	(3.7)	1.57	missing	No grinding

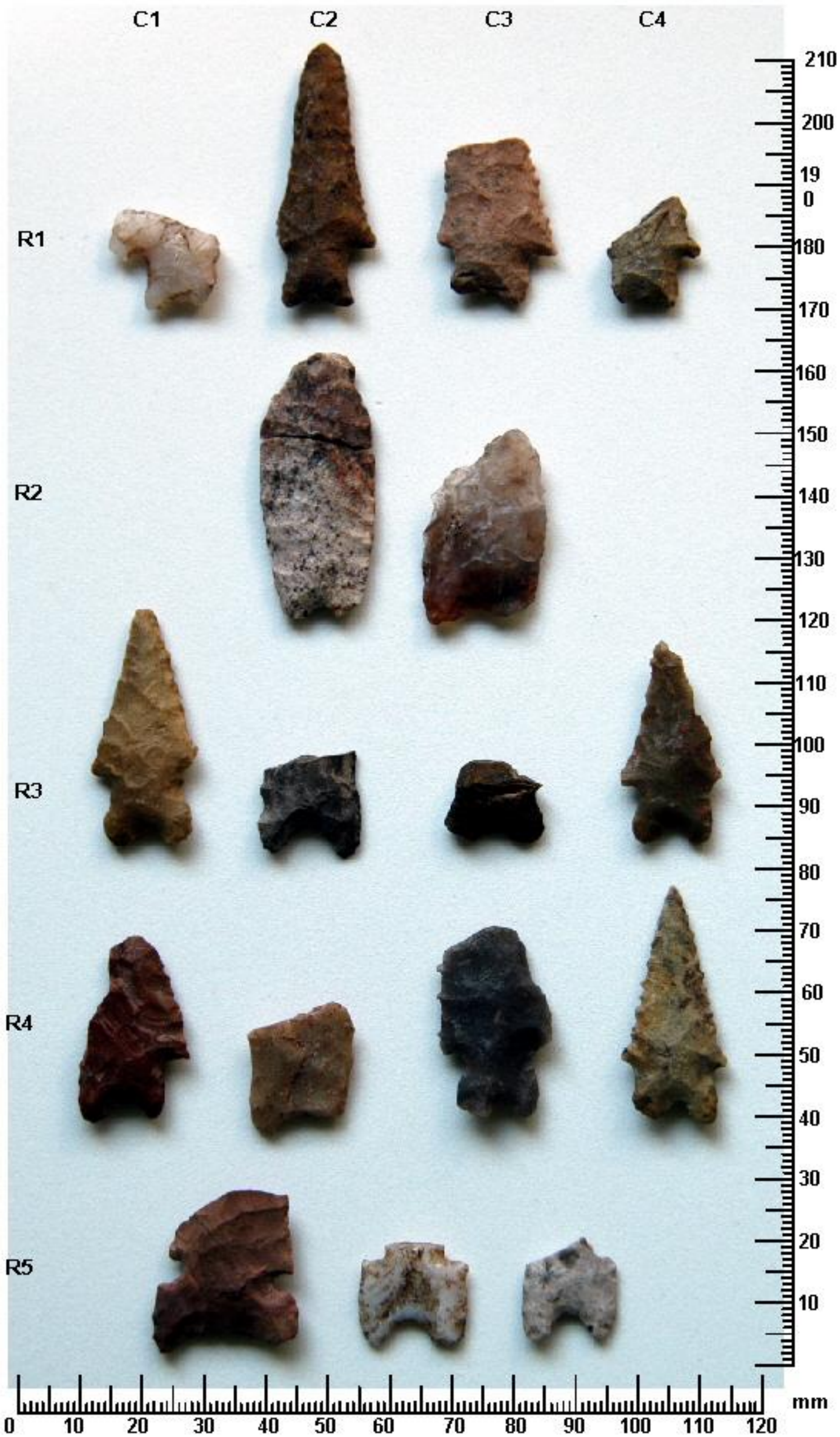

Figure 1: Types 3b, 3c, 3d, and 3e

Reference for Figure 1: Types 3b, 3c, 3d, and 3e

		C1	C2	C3	C4
Type 3b	**R1**	1504	30641	31119	34112
Type 3c	**R2**		29486/32855	35490	
Type 3d	**R3**	4700	7682	16867	21448
	R4	22888	24790	28162	36362
Type 3e	**R5**	8361	23270	27393	

Table 2: Type 3b, Hanna

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
1504	D3S	L3	Op	Ct	(1.66)	(1.60)	0.49	(1.5)	(1.20)	1.08	Grinding on upper portion of stem near shoulders, and ground on the basal edge
30641	B2S	L23	Qe	MQ	(4.49)	(1.59)	0.50	(3.4)	1.10	0.95	Grinding on one blade edge and on edges of stem
31119	B4S	Cav	Qe	Qe	(2.70)	(1.86)	0.52	(3.0)	1.25	1.21	Grinding on notches and minimal grinding on basal notch
34112	G7S	Sfc	Qe	Qe	(1.83)	(1.50)	0.50	(1.4)	1.10	1.05	Grinding on edges of stem

Table 3: Type 3c, McKean Lanceolate

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
29486	D2S	L17	Qe	Qe	(2.99)	1.85	0.48	(3.4)	??	1.25	Refits 35490
32855	D3S W	L5	Ag	Cy	(3.00)	1.79	0.64	4.0	1.83	1.70	No grinding
35490	C3S W	NVP	Qe	Qe	(1.52)	(1.81)	(0.50)	(1.4)	--	--	Refits 29486

Table 4: Type 3d, Stemmed Indented Base

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
4700	D1N	L3	Qe	MQ	(3.84)	1.67	0.45	(2.8)	1.42	1.15	Grinding on stem and base
7682	E3S	L6	Op	Ct	(1.68)	(1.54)	0.52	(1.4)	1.60	1.52	No grinding
16867	C2S	L18	PW-D	PW	(1.33)	(1.51)	0.53	(1.2)	1.54	1.25	Minimal grinding on upper portion of stem and minimal grinding on basal notch
21448	C1N	L16	Qe	MQ	(3.20)	(1.53)	0.48	(2.1)	1.21	1.08	Grinding on entire stem below shoulders including the basal projections
22888	E3S	L18	Qe	MQ	(2.94)	(1.53)	0.51	(2.7)	1.31	1.30	Grinding on edges of stem below the shoulder
24790	C2S	L31	Qe	Qe	(1.98)	1.67	0.56	(2.0)	1.51	1.45	Ground on edges of stem
28162	D3S	L17	Qe	MQ	(2.91)	1.72	0.57	(3.3)	1.21	1.01	Ground on entire edges of stem below the shoulder and on base
36362	D4S	L23	Qe	MQ	3.69	1.61	0.49	2.1	1.29	1.19	Grinding on the stem edge

Table 5: Type 3e, Mallory

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
8361	E3S	L11	Tuff	Qe	(2.10)	2.23	0.52	(2.7)	2.30	1.45	Minimally ground on the base and the sides of the base
23270	E4S	L18	Op	Ct*	(1.21)	(1.63)	(0.31)	(1.0)	1.70	0.90	No grinding
27393	B3S	L12	Qe	MQ	(1.53)	(1.43)	(0.30)	(0.7)	1.40	missing	No grinding

Figure 2: Types 4a and 4b

Reference for Figure 2: Types 4a and 4b

		C1	C2	C3	C4	C5	C6
Type 4a	**R1**	782	11053	12894	14760	17901	18453
	R2	19098	20032	31120			
Type 4b	**R3**	1025	1427	2875	14255	14570	17250
	R4	19436	19967	23205	27744	29769	

Table 6: Type 4a, Expanding Stem

Catalog Number	Square	Level	Rathbun Material Type	Revised Material.l Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
782	D4S	L6	Qe	MQ	(2.81)	1.89	0.49	(2.9)	1.71	1.50	No grinding
11053	E4S	L6	PW-GM	PW	(1.63)	(1.58)	(.53)	(1.5)	1.50	1.25	Grinding on notches
12894	F2S	L9	NMT	Qe	(2.24)	(1.54)	0.42	(1.8)	1.32	1.25	No grinding
14760	C3S	L10	PW-D	PW	(2.78)	2.13	0.65	(4.0)	1.81	1.61	Points of the shoulders are blunted. One shoulder has been ground to form a graver.
17901	C4S	L10	PW-GM	PW	(3.42)	2.09	0.51	(3.9)	1.50	1.20	No grinding
18453	C4S	L17	PW-GM	PW	(2.34)	1.60	0.68	(2.2)	1.49	1.25	Haftwear on notches
19098	C1N	L3	PW-D	PW	(2.29)	(1.51)	(0.46)	(2.2)	1.50	1.41	No grinding
20032	B1N	L2	PW-D	PW	3.74	1.94	0.43	(3.5)	1.71	1.32	No grinding
31120	G5S	L1	Qe	Qe	(2.41)	2.08	0.65	(4.0)	1.62	1.60	Grinding on portion of notch adjacent to shoulder

Table 7: Type 4b Rounded Stem

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
1025	D4	L6	Ag	Cy	(2.88)	(1.54)	(0.64)	(2.9)	(1.2)	0.99	Ground on the notches
1427	D3S	L4	Ag	Cy	3.19	1.71	0.52	2.4	0.82	0.72	No grinding
2875	Sfc	Sfc	Js	Js	(3.46)	1.89	0.61	(4.5)	1.20	1.10	Ground on the notches
14255	C3S	L4	PW-D	PW	3.28	2.00	0.61	3.4	1.03	0.98	Notches and a portion of the base are ground
14570	C3S	L7	Ag	Ct	3.61	2.42	0.42	(2.7)	1.15	1.00	No grinding
17250	C4S	L7	NMT	Ct	3.18	1.71	0.49	(2.3)	1.18	.95	No grinding
19436	C1N	L7	Qe	MQ	(2.66)	1.70	0.46	0.2	1.11	1.00	Notches are ground
19967	C1N	L11	PW-GM	PW	(1.56)	(1.39)	(0.36)	(0.8)	(1.2)	(.99)	Ground on the notch that's left
23205	C5	NVP	PW-GM	PW	3.63	1.90	0.53	3.1	0.99	0.90	Minimal grinding on notches
27744	D3S	L9	Cy	Cy	(2.78)	1.62	(0.43)	(2.2)	1.10	1.10	Grinding on intact edge of stem
29769	E5S	L14	PW-GM	PW	(1.10)	(1.66)	(0.35)	(0.7)	1.11	1.10	No grinding

Figure 3: Types 4c and 4d

Reference for Figure 3: Types 4c and 4d

		C1	C2	C3	C4	C5	C6
Type 4c	**R1**	3428	3798	5851	5933	8727	15063
	R2	16914	17979	18227	29757	34984	36252
	R3	37177					
Type 4d	**R4**	856	6603	9693	12680	18582	26855
	R5	27157	28316	31049	36286	37542	

Table 8: Type 4c, Ovate Side-Notched

Catalog Number	Square	Level	Rathbn Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
3428	E2S	L11	PW-GM	PW	(1.43)	(1.43)	0.45	(0.9)	1.39	1.20	Ground on the edges of the stem
3798	D1S	L2	Op	Op	(1.44)	(1.55)	(0.64)	(1.5)	.95	--	No grinding
5851	B3S	L11	Js	PW	(2.12)	(1.43)	(0.59)	(2.1)	1.14	1.15	Ground on the notches and edge of base
5933	B2N/2	L4	Ag	Cy	3.93	(1.74)	(0.61)	(3.8)	1.20	1.12	Ground on the notch and the base
8727	C1S	L2	Ct	PW	(2.95)	1.70	0.59	(2.9)	1.31	(1.22)	Ground on remnant portion of the base
15063	C3S	L14	PW-D	PW	(1.72)	(1.67)	(0.64)	(1.8)	1.20	1.02	Ground on the notches and base
15398	C3S	L18	PW-GM	PW-GM	(3.71)	(1.55)	(0.62)	(3.8)	-	-	-
16914	C2S	L20	PW-GM	PW	(2.10)	1.71	0.78	(3.0)	1.48	1.38	Ground on the notches and all around the base
17979	C4S	L11	PW-D	PW	2.65	1.48	0.68	2.3	1.34	1.20	Grinding on intact portion of the base
18227	C4S	L14	PW-GM	PW	(1.30)	1.40	0.39	(0.9)	1.30	1.10	Ground below shoulders and on base
29757	E5S	L14	PW-GM	PW	(1.23)	(1.41)	(0.54)	(1.0)	1.40	1.03	Ground on notches and base
34984	B3S	L24	PW-GM	PW	2.94	1.66	0.55	2.3	1.32	1.30	Ground below shoulder area
36252	A3S	NVP	Op	Js	(3.16)	(1.53)	(0.59)	(2.3)	1.05	-	No grinding
37177	B3SW	L10	PW-D	PW	(1.39)	(1.40)	0.46	-	1.40	1.25	Ground on the base and possibly a small amount on the notches

Table 9: Type 4d, Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
856	D4S	NVP	PW-D	PW	(2.83)	(2.04)	0.47	(3.1)	1.30	1.10	No grinding
6603	B1S	L14	PW-GM	PW	(2.88)	1.95	0.60	(3.5)	1.40	1.30	Ground on the notches
9693	C2S	L4	Qe	MQ	(1.66)	(1.61)	(0.25)	(0.8)	1.23	1.55	No grinding
12680	E6S	L6	PW-D	PW	(1.93)	1.57	0.54	(1.6)	1.45	1.25	No grinding
18582	C4S	L20	PW-D	PW	(1.59)	(1.49)	(0.49)	(1.3)	1.20	0.80	Grinding on base
26855	B2N	L1	Ag	Js	(1.24)	(1.92)	0.55	(1.2)	(1.48)	1.30	Ground on one notch
27157	B2S	L12	PW-D	PW	(3.15)	1.75	(0.64)	(3.3)	1.49	1.32	No grinding

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
28316	D3S	L21	PW-D	PW	(2.63)	(1.45)	(0.36)	(1.4)	1.25	1.20	Minimal grinding on the lower part of the notches
31049	E3SW	L3	Op	Op	(1.69)	(1.92)	(0.42)	(1.5)	1.52	1.25	Ground on the notches
36286	A3S	NVP	Qe	MQ	(1.78)	1.88	0.49	(1.5)	1.32	1.20	Ground on one notch but not the other
37542	A3S	L11	Op	Ct	(1.57)	(1.78)	(0.50)	(1.6)	1.60	1.19	Ground on the base

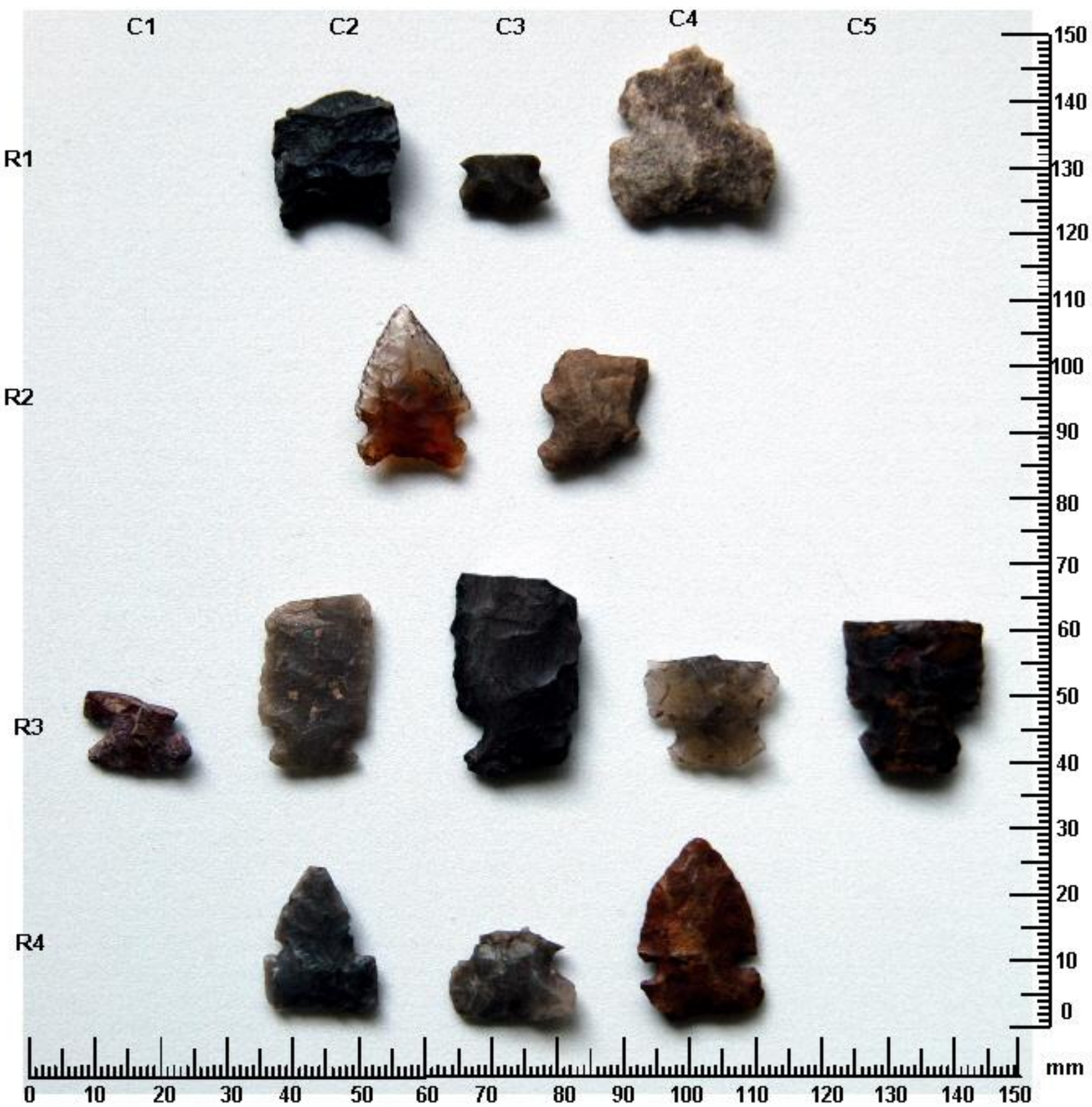

Figure 4: Types 5, 6, 7, 8, 9, and 10

Reference for Figure 4: Types 5, 6, 7, 8, 9, and 10

		C1	C2 (Type 5 ↓)	C3 (Type 6 ↓)	C4 (Type 7 ↓)	
	R1		3173	9808	31087	
Type 8	R2			19879	21785	
Type 9	R3	8451	11656	21605	27970	37806
Type 10	R4		5108	16898	32374	

Table 10: Type 5, Concave Base

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
3173	E2S	L8	Ag	Ct	(2.12)	2.04	0.66	(2.6)	1.72	1.71	Grinding on ears

Table 11: Type 6, Mt. Albion

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
9808	C2S	L5	Qe	MQ	(0.84)	(1.39)	(0.46)	(0.6)			Grinding on basal edge

Table 12: Type 7, Sudden

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
31087	G3SW	L3	Qe	Qe	(2.37)	(2.47)	0.50	(3.2)	2.42	1.60	Ground on one side of base

Table 13: Type 8, Northern Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
19879	C5	L11	Ag	Cy	2.43	1.73	0.49	1.8	1.63	1.28	No grinding
21785	C2N	L3	Qe	Qe	(1.93)	(1.54)	0.47	(1.8)	br	br	Grinding on notch

Table 14: Type 9, Besant

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
8451	E3S	L12	Op	Js	(1.11)	1.61	0.34	(0.8)	1.60	1.10	No grinding
11656	E4S	L12	Qe	Qe+	(2.50)	1.64	0.38	(2.2)	1.30	1.10	Minimal grinding on notches
21605	D5S	NVP	PW-D	PW	(3.04)	(1.99)	0.43	(4.2)	(1.52)	1.22	Minimal grinding on base
27970	D3S	L13	Ag	Cy	(1.62)	(1.85)	0.47	(1.8)	1.40	1.20	Ground on one small spot on the base
37806	F7S	L6	PW-D	PW	(2.22)	2.05	0.55	(3.2)	(1.45)	1.23	No grinding

Table 15: Type 10, Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
5108	D2S	L7	Op	Ct	(2.09)	1.71	0.46	(1.4)	1.70	1.05	No grinding
16898	C1N	L10	Ct	Ct	(1.28)	(1.87)	(0.44)	(1.2)	1.90	1.15	No grinding
32374	C3N	L5	Qe	MQ	2.52	(1.73)	0.42	(2.4)	(1.74)	1.10	No grinding

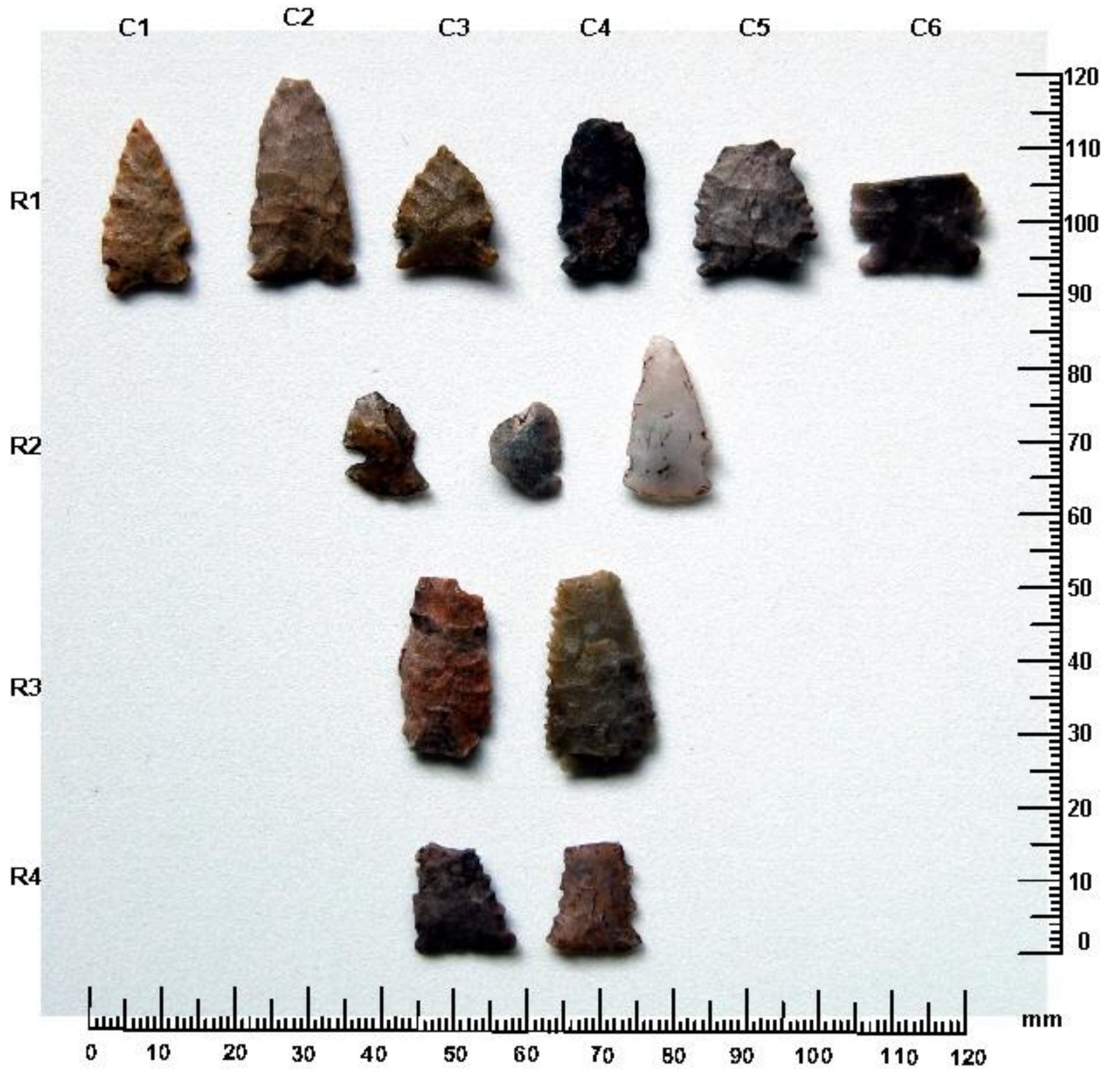

Figure 5: Types 11a, 11b, 11c, and 11d

Reference for Figure 5: Types 11a, 11b, 11c, and 11d

		C1	C2	C3	C4	C5	C6
Type 11a	**R1**	3246	4945	5531	16263	23861	37396
Type 11b	**R2**		3664	8721	26514		
Type 11c	**R3**			26003	32872		
Type 11d	**R4**			10035	32646		

Table 16: Type 11a, Small Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
3246	E2S	L9	Qe	MQ	2.50	1.32	0.34	1.0	1.23	1.05	No grinding
4945	D1N	L7	Qe	Qe	(3.02)	1.49	0.39	(2.0)	1.59	1.30	No grinding
5531	B3S	L5	Qe	MQ	1.86	1.59	0.32	(0.9)			No grinding
16263	C1S	L20	Qe	Qe	(2.34)	1.34	0.38	(1.4)	(1.12)	0.92	No grinding
23861	D2S	L6	Qe	Qe	(1.92)	1.80	0.43	(1.6)	1.50	1.32	No grinding
37396	A3S	L9	Qe	Qe	(1.37)	(1.92)	(0.35)	(1.2)	1.83	1.28	No grinding

Table 17: Type 11b, Small Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
3664	D1S	L1	Ag	Cy	(1.56)	(1.25)	(0.25)	(0.5)			No grinding
8721	C1S	L2	Qe	Qe	(1.19)	(1.25)	(0.30)	(0.4)			No grinding
26514	B2N	L9	Cy	Cy*	(2.33)	(1.27)	(0.43)	(1.2)			No grinding

Table 18: Type 11c, Small Corner-Notched, Lanceolate Form

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
26003	E5S	L8	Qe	Qe	(2.56)	(1.35)	0.37	(1.5)	1.00	missing	No grinding
32872	B3SW	L4	Qe	Qe	(2.87)	1.62	0.37	(1.9)			No grinding

Table 19: Type 11d, Small Side-Notched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Max Haft Width	Min Haft Width	Haft Element Analysis
10335	E3S	L16	Qe	Qe	(1.60)	(1.46)	0.32	(0.7)			No grinding
32646	C2S	NVP	Op	Cy	(1.57)	1.35	0.38	(0.8)	1.40	0.98	No grinding

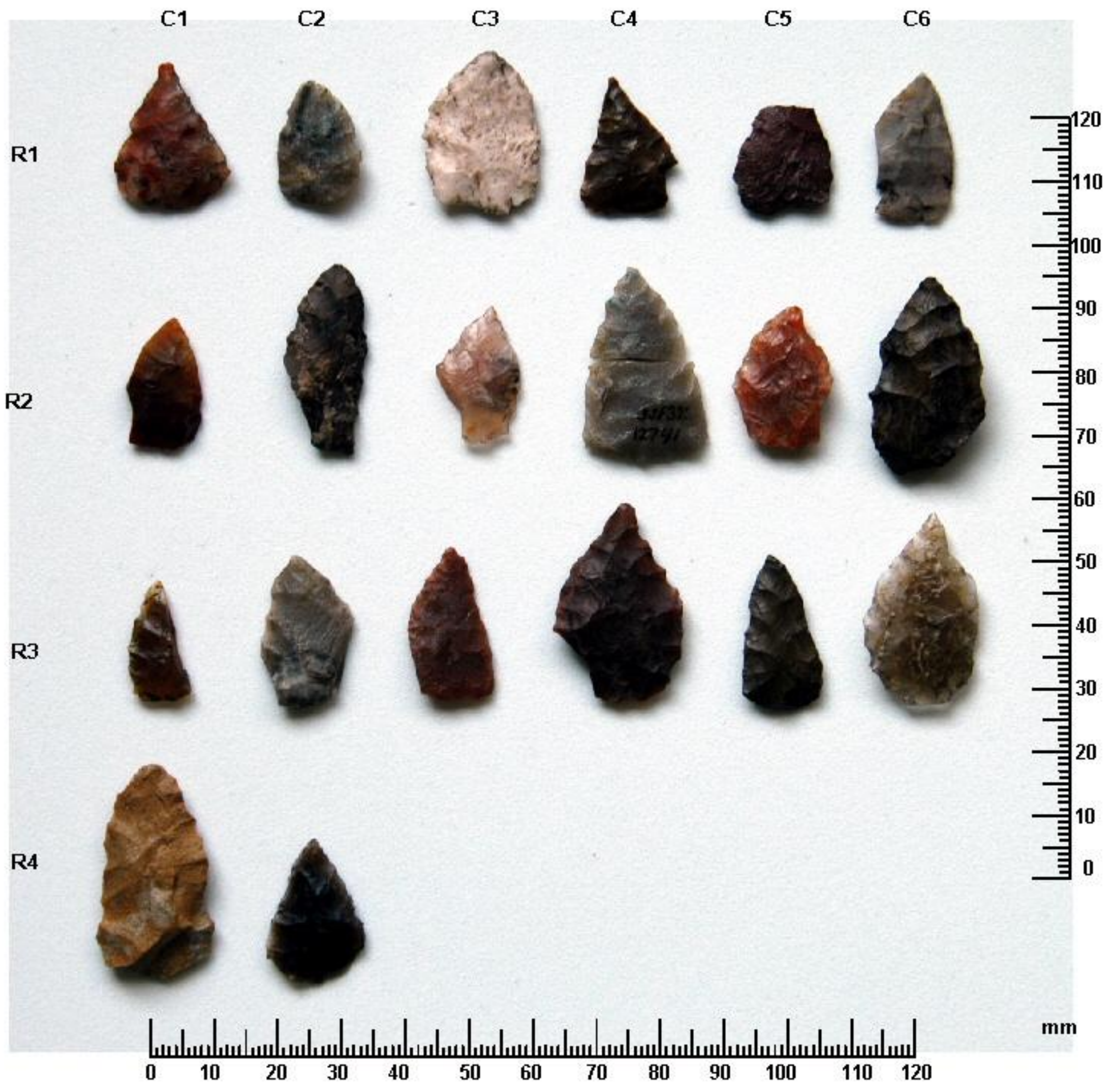

Figure 6: Type 12

Reference for Figure 6: Type 12

		C1	C2	C3	C4	C5	C6
Type 12	**R1**	1164	1884	3265	3472	3952	5926
	R2	5955	8453	10993	12741/29738	13318	14204
	R3	14314	14347	23416	23529	23599	26385
	R4	27224	32121				

Table 20: Type 12, Unnotched

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)	Haft Element Analysis
1164	D3S	L3	Op	Ct	(2.37)	(1.92)	(0.43)	(1.6)	No grinding
1884	D3N/2	L7	Qe	Qe	(2.04)	(1.40)	(0.36)	(0.9)	No grinding
3265	E2S	L9	Op	Ct	(2.62)	(1.96)	(0.39)	(2.2)	No grinding
3472	E2S	L12	PW-D	PW	(2.23)	1.56	0.28	(0.9)	No grinding, has a single notch
3952	D1S	L3	Qe	Qe	(1.81)	(1.60)	(0.32)	(1.0)	No grinding
5926	B2S	L2	PW-GM	PW	(2.48)	(1.28)	0.32	(0.9)	No grinding, has a single notch and flake scars
5955	B2N/2	L5	Ag	Ct	(2.12)	(1.22)	(0.36)	(0.9)	No grinding
8453	E3S	L12	PW-D	PW	(3.08)	(1.32)	(0.38)	(1.4)	No grinding
10993	E4S	L5	Ag	Cy	(2.24)	(1.36)	(0.33)	(0.8)	No grinding
12741	E5S	L13	NMT	Qe+	(1.61)	(1.99)	(0.37)	(1.6)	No grinding, refits 29738
13318	F3S	L10	Ag	Ct	(2.31)	(1.58)	(0.41)	(1.3)	No grinding
14204	C3S	L3	PW-D	PW	(3.16)	(1.84)	(0.80)	(3.8)	No grinding
14314	C3S	L5	Ag	Cy	(1.94)	(0.97)	(0.32)	(0.4)	No grinding
14347	C3S	L5	Qe	Qe	(2.42)	(1.50)	(0.35)	(1.2)	No grinding
23416	D2	L1 - L2	Qe	Qe	(2.44)	(1.25)	(0.31)	(0.6)	No grinding
23529	D2S	L3	PW-GM	PW	(3.12)	(2.05)	(0.41)	(2.3)	No grinding
23599	D2S	L4	PW-D	PW	2.45	1.28	0.39	1.2	No grinding
26385	B2N	L8	Ag	Cy	(3.07)	(1.82)	(0.44)	(2.1)	No grinding
27224	B2S	L15	Qe	MQ	(3.32)	(1.84)	(0.56)	(3.0)	No grinding, has very shallow notches
29738	E6S	L7	NMT	Qe+	(1.53)	(1.52)	(.29)	(0.6)	No grinding, refits 12741
32121	B4S	NVP	Ag	Cy	(2.24)	(1.55)	(0.38)	(1.0)	No grinding

Figure 7: Type 13a

Reference for Figure 7: Type 13a

		C1	C2	C3	C4	C5	C6	C7	C8
Type 13a	**R1**	3	465	596	1110	1584	1602	1649	1886
	R2	2386	2689	2693	2849	3119	3123	3519	3618
	R3	3655	4240	4518	4575	5522	5534	6298	6436
	R4	6706	6956	7073	7113	77173	7400	7427	7615
	R5	7698	8120	8656	8678	8738	8876	8968	9410
	R6	9418	9528	9691	10132	10572	10771	11153	11950

Figure 8: Type 13a

Reference for Figure 8: Type 13a

		C1	C2	C3	C4	C5	C6	C7	C8
Type 13a	**R1**	12408	12703	12715	12830	12858	13002	13118	13655
	R2	14202	14355	14490	14558	14742	15154	15324	16994
	R3	17060	17089	17137	17176	17195	17328	17849	17902
	R4	18846	18853	19010	19085	19124	20191	20731	21866
	R5	22695	23032	23040	23372	23397	23623	23692	23780
	R6	23974	24149	24180	24181	24219	24220	24243	24250

Figure 9: Type 13a

Reference for Figure 9: Type 13a

Type 13a		C1	C2	C3	C4	C5	C6	C7	C8
	R1	25382	25421	25428	25658	26272	26969	30934	31159
	R2	31164	32157	33214	33791	34059	35695	35792	37802
	R3	37803	37896						

Table 21: Type 13a, Hogback

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
3	D4S	L6	Qe	Qe	(1.38)	(1.10)	(0.22)	(0.2)
465	D4S	L11	PW-D	PW	(1.46)	(1.18)	(0.31)	(0.4)
596	D4S	L12	Qe	MQ	(1.95)	(1.46)	(0.34)	(0.9)
1110	D3S	L1	Op	Ct	(1.27)	(1.27)	(0.24)	(0.3)
1584	D3S	L4	Qe	Qe	1.51	(1.09)	(0.27)	(0.3)
1602	D3S	L4	Ct “	Ct “	(2.19)	(1.49)	(0.25)	(0.6)
1649	D3S	L5	Ag	Cy	(1.60)	(1.52)	(0.35)	(1.0)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
1886	D3N/2	L7	Qe	Qe	(1.89)	(1.38)	(0.31)	(0.6)
2386	D3N/2	L15	Js	Js	(1.36)	(1.49)	(0.28)	(0.6)
2689	E2S	L4	Qz-Crystal	Qz-Crystal	(1.76)	(1.33)	(0.24)	(0.4)
2693	E2S	L4	Qe	Qe	(1.84)	(1.29)	(0.25)	(0.5)
2849	E2S	L5	Js	Js	(1.93)	(1.47)	(0.22)	(0.5)
3119	E2S	L7	Qe	Qe	1.37	(1.36)	0.30	(0.5)
3123	E2S	L7	Ag	Ct	(1.27)	(1.17)	(0.29)	(0.3)
3519	E2S	L13	Ag	Cy	(1.43)	(1.03)	(0.27)	(0.4)
3618	D1S	L1	Op	Ct*	(1.77)	(1.17)	(0.29)	(0.6)
3655	D1S	L1	Op	Op	(2.39)	1.66	0.38	(1.2)
4240	D1S	L6	Qe	Qe	(1.31)	(0.99)	(0.38)	(0.6)
4518	D1N	L1	Op	Ct*	(2.21)	(1.65)	(0.36)	(1.0)
4575	D1N	L2	Op	Qe	(1.46)	(1.20)	(0.28)	(0.4)
5522	B3S	L5	Ag	Cy	(1.56)	(1.58)	(0.17)	(0.5)
5534	B3S	L5	Qe	Qe	(1.53)	(1.11)	(0.29)	(0.3)
6298	B2S	L3	Ag	Cy	(1.68)	(1.10)	0.30	(0.6)
6436	B1S	L11	Qz-Crystal	Qz-Crystal	(1.77)	(1.28)	(0.25)	(0.6)
6706	B1S	NVP	Ag	Ct	(2.58)	1.71	0.42	(1.4)
6956	E3S	L3	PW-D	PW	(0.69)	(1.01)	(0.21)	(0.2)
7073	E3S	L4	Qe	MQ	(1.23)	(1.5)	(0.32)	(0.6)
7113	E3S	L4	Ag	Ct	(2.57)	(1.40)	0.31	(1.0)
7173	E3S	L4	Qe	Qe	(1.46)	(1.17)	(0.35)	(0.5)
7400	E3S	L5	Ag	Ct	(1.50)	(1.33)	(0.27)	(0.4)
7427	E3S	L5	Ag	Cy	(1.36)	(1.00)	(0.25)	(0.3)
7615	E3S	L6	Ag	Cy	(1.45)	(1.06)	(0.33)	(0.4)
7968	E3S	L7	Ag	Cy	(1.47)	(1.23)	(0.26)	(0.3)
8120	E3S	L9	Js	Js	(1.98)	(1.41)	(0.22)	(0.6)
8656	C1S	L1	PW-D	PW	(1.45)	(0.95)	(0.27)	(0.3)
8678	C1S	L1	Js	Ct	(1.76)	(0.85)	0.28	(0.5)
8738	C1S	L2	Ag	Cy	(1.89)	(1.90)	(0.31)	(0.9)
8876	C1S	L4	Qe	Qe	(1.78)	(1.15)	(0.31)	(0.6)
8968	C1S	L5	Ag	Cy	(1.68)	(1.02)	(0.20)	(0.1)
9410	C2S	L2	Ct-Kremmling	Ct*	(2.56)	(1.71)	(0.30)	(1.1)
9418	C2S	L2	Op	Op	(1.73)	1.14	0.30	(0.4)
9528	C2S	L3	PW-D	PW	(1.55)	(1.37)	(0.28)	(0.5)
9691	C2S	L4	Ag	Cy	(2.25)	(1.44)	(0.23)	(0.7)
10132	C2S	L10	Qe	Qe	(1.44)	(0.85)	(0.17)	(0.2)
10572	E4S	L3	Ag	Ct	(1.88)	(1.19)	(0.22)	(0.3)
10771	E4S	L4	PW-D	PW	(1.15)	(1.07)	(0.25)	(0.2)
11153	E4S	L7	Qe	Qe	(1.42)	(1.00)	(0.22)	(0.3)
11950	E1S	L2	Qe	Qe	(2.14)	(1.32)	(0.29)	(0.6)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
12408	F6S	L3	Qe	Qe	(1.67)	(1.10)	(0.23)	(0.4)
12703	E6S	L6	NMT	MQ	(1.88)	(1.45)	(0.32)	(0.5)
12715	E6S	L6	Cy	PW	(2.12)	(1.37)	0.29	(0.6)
12830	F2S	L5	Op	Ct	(1.44)	(1.17)	(0.22)	(0.5)
12858	F2S	L6	Ag	Ag	(2.17)	(0.89)	(0.22)	(0.3)
13002	F3S	L2	PW-D	PW	(1.88)	(1.30)	(0.29)	(0.7)
13118	F3S	L7	PW-D	PW	(1.44)	(1.18)	(0.29)	(0.4)
13655	F3S	L12	Qe	Qe	(1.57)	(1.30)	(0.13)	(0.1)
14202	C3S	L3	Qz-Crystal	Qz-Crystal	(1.52)	(1.26)	(0.25)	(0.3)
14335	C3S	L5	Qe	Qe	(1.69)	(1.14)	(0.28)	(0.4)
14490	C3S	L6	Op	Ct	(1.76)	(1.27)	(0.19)	(0.3)
14558	C3S	L7	Qe	Qe	(1.38)	(0.84)	(0.32)	(0.3)
14741	C3S	L9	Cy	Cy	1.72	(1.04)	0.23	(0.3)
14742	C3S	L9	PW-D	PW	(1.04)	1.49	0.31	(0.4)
15154	C3S	L14	Op	Js	(1.11)	(0.89)	(0.21)	(0.2)
15324	C4S	L17	Cy	Cy	(1.32)	(0.62)	(0.24)	(0.2)
16994	C4S	L2	Cy	Ct*	(1.76)	(1.64)	(0.26)	(0.6)
17060	C4S	L5	Op	Ct	(1.75)	(1.58)	(0.35)	(0.8)
17089	C4S	L5	Cy	Cy	(2.20)	(1.19)	(0.21)	(0.6)
17137	C4S	L6	PW-D	PW	(1.44)	(1.53)	(0.25)	(0.6)
17176	C4S	L6	Ag	Cy	(1.36)	(0.92)	(0.20)	(0.2)
17195	C4S	L6	PW-D	PW	2.34	1.97	0.32	1.0
17328	C4S	L7	Ag	Ag	(1.96)	(1.57)	(0.34)	(0.9)
17849	C4S	L9	Ag	Cy	(2.71)	(1.70)	(0.32)	(1.4)
17902	C4S	L10	Qe	Qe	(2.07)	(0.95)	(0.32)	(0.5)
18846	C1N	L1	Qe	MQ	(2.01)	(1.57)	(0.24)	(0.7)
18853	C1N	L1	Cy	Ct	(1.40)	(1.46)	(0.26)	(0.6)
19010	C1N	L2	Op	Ct	(1.03)	(0.91)	(0.26)	(0.2)
19085	C1N	L3	Qe	Qe	(1.27)	(1.61)	(0.37)	(0.7)
19124	C1N	L3	Qe	Qe	(2.30)	(1.82)	(0.25)	(1.1)
20191	B1N	L4	Ag	Cy	(1.56)	(1.30)	(0.27)	(0.2)
20731	B2N	L2	Op	Ct*	(1.91)	1.44	0.28	(0.6)
21866	C2N	L3	PW-GM	PW	(1.77)	(1.50)	(0.25)	(0.7)
22695	F4S	NVP	Op	Ct	(2.76)	(1.49)	0.36	(1.0)
23032	F4S	NVP	PW-D	PW	(2.22)	(1.46)	(0.25)	(0.7)
23040	E5	NVP	Qe	Qe	(1.16)	(1.38)	(0.36)	(0.5)
23372	D2	L1 -L2	PW-GM	PW	(2.44)	(1.57)	(0.29)	(1.0)
23397	D2	L1 -L2	Op	Ct	(2.08)	(1.66)	(0.37)	(1.2)
23623	D2S	L4	Op	Ct	(2.29)	(1.20)	(0.34)	(0.5)
23692	E4S	L18	Op	Js	(1.60)	(1.16)	(0.25)	(0.3)
23780	D2S	L5	Qe	Qe	(1.82)	(1.33)	(0.32)	(0.6)
23974	B1S	L3	Ag	Cy	(1.46)	(1.29)	(0.28)	(0.5)
24149	B1S	L6	Op	Ct	(1.87)	(1.08)	(0.33)	(0.4)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
24180	B1S	L7	Qe	Qe	(1.65)	(1.44)	(0.26)	(0.5)
24181	B1S	L7	Op	Ct	(1.68)	(1.10)	(0.37)	(0.5)
24219	D4S	L1-L2	Qe	Qe	(1.60)	(1.37)	(0.24)	(0.4)
24220	D4S	L1-L2	Qe	Qe	(2.00)	(1.60)	(0.30)	(0.9)
24243	D4S	L3	Js	Js	(2.35)	(1.55)	(0.36)	(1.1)
24250	D4S	L3	Op	Js	(2.17)	(1.75)	(0.27)	(0.9)
25382	F5S	L4	PW-D	PW	(1.85)	(1.42)	(0.24)	(0.7)
25421	F5S	L4	Op	Ct*	(2.29)	(1.48)	(0.33)	(1.0)
25428	F5S	L5	PW-GM	PW	1.81	(1.26)	0.25	(.3)
25658	F5S	L8	Ag	Ct	(1.96)	(1.24)	0.36	(0.9)
26272	B2N	L6	Js	Ct	2.92	(1.71)	0.28	(1.1)
26969	B2S	L5	Ag	Cy	(1.43)	(1.78)	(0.28)	(0.9)
30934	C3SW	L2	PW-D	PW	(2.50)	(1.44)	(0.40)	(1.2)
31159	A3S	NVP	PW-D	PW	(1.56)	(1.09)	(0.34)	(0.5)
31164	A3S	NVP	Ag	Cy	(2.41)	(1.41)	(0.36)	(1.1)
32157	D5S	NVP	Op	Ct*	(2.53)	(1.78)	(0.36)	(1.4)
33214	F4S	L4	PW-D	PW	(2.09)	(1.23)	(0.29)	(0.6)
33791	E7S	L2	Ag	Cy	(2.11)	(1.35)	(0.22)	(0.8)
34059	E3S	NVP	Qe	Qe	(2.12)	(1.32)	(0.29)	(0.8)
35695	A3S	NVP	PW-D	PW	(1.84)	(1.31)	(0.25)	(0.5)
35792	D5S	NVP	Qe	Qe	(1.57)	(1.47)	0.30	(0.5)
37802	F7S	L6	PW-D	PW	(1.42)	(1.03)	(0.22)	(0.2)
37803	F7S	L6	PW-D	PW	(1.99)	(1.27)	(0.29)	(0.7)
37896	E7S	L5	Qe	Qe	(1.92)	(1.38)	(0.37)	(0.7)

Figure 10: Type 13b

Reference for Figure 10: Type 13b

Type 13b		C1	C2	C3	C4	C5	C6	C7	C8
	R1	945	1043	1646	2062	2499	2686	3237	3772
	R2	3795	4016	4050	4148	5201	6699	9700	10533
	R3	14212	17020	17170	18384	21087	21880	23709	23947
	R4	24038	24890	26007	26305	26870	27691	29676	31129
	R5	33270	35345	36340	36344				

Table 22: Type 13b, Small Corner-Notched, Wide Base

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
945	D4S	L18	Ct	Ct*	(2.11)	(1.13)	0.39	(1.0)
1043	D4S	L19	Ag	Cy	(1.79)	(1.00)	(0.30)	(0.3)
1646	D3S	L5	Ag	Cy	3.06	2.05	0.40	1.8
2062	D3N/2	L10	Qe	Qe	(2.52)	(1.63)	(0.30)	(1.3)
2499	E2S	L3	Qe	MQ	3.12	1.91	0.34	1.2
2686	E2S	L4	Qe	Qe	(2.04)	(1.57)	(0.40)	(1.2)
3237	E2S	L9	Qe	Qe	(2.20)	(1.16)	(0.29)	(0.8)
3772	D1S	L2	Ag	Cy	(1.66)	(1.43)	(0.26)	(0.6)
3795	D1S	L2	Op	Ct*	(2.11)	(1.60)	(0.29)	(0.7)
4016	D1S	L4	Qe	MQ	(2.14)	(1.67)	(0.44)	(1.5)
4050	D1S	L4	Op	Js	(2.37)	(1.47)	(0.39)	(1.4)
4148	D1S	L5	Qe	Qe	(2.77)	1.87	0.37	(1.6)
5201	D2S	L9	Qe	Qe	(2.98)	1.69	0.42	(2.2)
6699	B1S	NVP	Qe	Qe	(2.37)	(1.44)	(0.28)	(1.1)
9700	C2S	L4	Cy	Cy*	2.55	(1.46)	(0.22)	(0.8)
10533	E4S	L2	Cy	Cy	(2.10)	(1.7)	(0.33)	(1.2)
14212	C3S	L3	Ag	Ct	(2.08)	(1.73)	(0.30)	(1.0)
17020	C4S	L4	PW-D	PW	(1.89)	(1.43)	(0.30)	(0.7)
17170	C4S	L6	Qe	MQ	(1.90)	(1.53)	0.36	(1.2)
18384	C4S	L16	Op	Ct*	(1.66)	(1.38)	(0.32)	(0.7)
21087	C1N	L14	PW-D	PW	(3.54)	(1.67)	(0.49)	(1.8)
21880	C2N	L3	Cy*	Cy	(1.21)	(1.29)	(0.29)	(0.6)
23709	E5S	NVP	Js	Js	(1.69)	(1.59)	(0.28)	(0.9)
23947	B1S	L3	PW-D	PW	(2.03)	(1.54)	(0.43)	(1.3)
24038	B1S	L4	Ag	Cy	(1.59)	(1.64)	(0.33)	(0.9)
24890	C1N	L19	Qe	MQ	(3.01)	1.66	0.49	1.9
26007	E5S	L8	Js	Js	(2.64)	(1.2)	0.40	(1.5)
26305	B2N	L7	Qz-Vein	Qz-Vein	(2.10)	(1.49)	(0.37)	(1.0)
26870	B2S	L1	PW-D	PW	2.87	(1.85)	0.43	(1.9)
27691	D3S	L7	Ag	Cy	(1.64)	(1.12)	(0.37)	(0.7)
29676	E5S	L12	Qe	Qe+	2.93	1.56	0.51	(1.9)
31129	B1S	NVP	Qe	Qe	(2.63)	(1.7)	(0.38)	(1.3)
33270	F4S	L5	NMT	Cy	(2.07)	(1.48)	(0.28)	(1.0)
35345	B4S	L8	PW-D	PW	(2.50)	(1.7)	(0.39)	(1.4)
36340	D45	L22	PW-D	PW	(2.10)	(1.44)	(0.31)	(1.0)
36344	D4S	L22	PW-D	PW	(1.11)	1.67	(0.36)	(0.7)

Figure 11: Type 13c

Reference for Figure 11: Type 13c

		C1	C2	C3	C4	C5	C6	C7	C8
Type 13c	R1	4568	6288	6849	8732	9545	11147	14067	22307
	R2	24011	24369	29438	32626	33258	33504	35569	35791

Table 23: Type 13c, Rose Spring

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
4568	D1N	L2	Op	Ct*	(2.33)	1.37	0.36	(0.8)
6288	B2S	L3	Ag	Cy	(1.25)	1.28	0.32	(0.5)
6849	E3S	L1	Js	Js	(2.62)	(1.10)	(0.27)	(0.6)
8732	C1S	L2	Js	Js	1.76	(1.35)	0.30	(0.6)
9545	C2S	L3	Ag	Cy	(2.08)	(1.44)	(0.34)	(0.8)
11147	E4S	L7	Ag	Cy	2.07	1.23	0.36	(0.7)
14067	F4S	L2	Qe	MQ	(2.55)	(0.95)	(0.27)	(0.7)
22307	F5S	L2	PW-D	PW	(2.41)	(1.21)	(0.28)	(0.8)
24011	E5	NVP	Ag	Cy	(2.51)	(1.13)	(0.31)	(0.6)
24369	D4S	L4	Qe	Qe	1.95	1.16	0.36	0.5
29438	D2S	L14	PW-D	PW	2.34	1.80	0.28	0.8
32626	C2S	NVP	Qe	MQ	(2.14)	(1.24)	(.22)	(0.3)
33258	F4S	L5	PW-D	PW	(2.13)	(1.44)	(.33)	(0.7)
33504	F5S	NVP	Ag	Cy	(1.52)	(1.13)	(.23)	(0.3)
35569	B4S	NVP	Qe	MQ	(1.75)	(1.31)	(.26)	(0.5)
35791	D5S	NVP	PW	Cy	(2.24)	(1.16)	(.21)	(0.5)

Table 24: Projectile Point Base Fragments

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
641	D5S	Sfe	Ag	Cy	(1.80)	(1.55)	(.4)	(1.1)
1117	D3S	L1	NMT	Js	(1.20)	(0.73)	(0.34)	(0.2)
3445	none		NMT	PW	(0.82)	(1.44)	(0.34)	(0.4)
3599	D1S	L1	Ag	Cy	(1.26)	(1.92)	(0.37)	(0.9)
3948	D1S	L3	PW-D	PW-D	(1.77)	(1.63)	(0.41)	(1.3)
5526	B3S	L5	Ag	Cy	(1.03)	(0.64)	(0.21)	(0.1)
5811	B3S	L10	Js	PW	(1.85)	(1.64)	(0.30)	(0.9)
5839	B3S	L11	Qe	Qe	(0.69)	(1.54)	(0.29)	(0.4)
5896	B2S	L1	Op	Ct	(1.32)	(1.65)	(0.54)	(1.2)
6379	B1S	L10	PW-D	PW-D	(2.12)	(1.06)	(0.39)	(0.9)
6485	B1S	L12	PW-GM	PW-GM	(1.39)	(0.63)	(0.28)	(0.1)
6491	B1S	L12	Op	Ct	(1.05)	(1.95)	(0.70)	(1.3)
8300	E3S	L10	Op	Js	(1.48)	(1.27)	(0.49)	(0.9)
10722	E4S	L4	Ct	Ct	(0.44)	(1.17)	(0.18)	(0.1)
11184	none		NMT	Js	(1.59)	(.81)	(.41)	(0.5)
11483	E4S	L10	Op	Op	(2.54)	(1.76)	(0.48)	(1.8)
11855	E4S	L14	Qe	Qe	(0.69)	(1.56)	(0.25)	(0.3)
13000	F3S	L2	Js	Js	(2.29)	(1.22)	(0.44)	(0.9)
13329	F3S	L10	Op	Js	(0.91)	(1.53)	(0.37)	(0.6)
13602	F3S	L12	Ag	PW	(1.46)	(1.68)	(0.51)	(1.3)
13870	F3S	L14	PW-D	PW-D	(1.01)	(0.57)	(0.15)	(0.1)
15024	C3S	L13	Op	Js	(0.84)	(2.16)	(0.56)	(1.2)
15071	C3S	L14	Qe	Qe	(1.99)	(1.49)	(0.46)	(1.6)
16952	C2s	L21	Qe	Qe	(0.84)	(1.29)	(0.36)	(0.3)
17193	C4S	L6	Op	Ct	(1.78)	(1.90)	(1.01)	(3.3)
17751	C4S	L8	PW-D	PW-D	(1.41)	(2.28)	(0.39)	(1.6)
18295	C4S	L15	Qe	MQ	(0.74)	(1.19)	(0.33)	(0.4)
19405	C1N	NVP	PW	PW	(1.08)	(1.28)	(0.47)	(0.6)
20159	B1N	L4	Op	Ct	(0.54)	(1.08)	(0.23)	(0.1)
22884	E3S	L18	Op	Js	(1.33)	(1.52)	(0.39)	(0.8)
22952	F3S	L18	PW-D	PW-D	(1.47)	(0.68)	(0.33)	(0.4)
23103	E4S	L17	PW-GM	PW-GM	(2.37)	(1.71)	(0.70)	(2.9)
23504	D2	L3	Ag	Ct	(1.50)	(2.10)	(0.46)	(1.4)
23695	D2S	L1-L2	PW-D	PW-D	(1.12)	(0.98)	(0.31)	(0.4)
24437	B1S	L4	Op	Cy	(0.97)	(.62)	(.19)	(0.1)
24471	D4S	L5	Op	Ct	(1.35)	(1.72)	(0.62)	(1.4)
26598	D2N	L10	PW-D	PW-D	(1.19)	(1.93)	(0.44)	(1.2)
26899	B2S	L3	Op	Ct	(1.47)	(1.61)	(0.61)	(1.6)
27319	B3S	L1-2	PW-D	PW-D	(1.56)	1.6	.26	(.7)
27478	B3S	L15	PW-GM	PW-GM	(0.79)	(1.47)	(.39)	(0.7)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
27741	D3S	L9	Ag	Ct	(1.15)	(1.49)	(0.43)	(0.7)
29064	E4S	L19	Qe	Qe	(1.17)	(1.76)	(0.48)	(1.2)
29804	E5S	L15	PW-D	PW-D	(1.00)	(1.36)	(0.51)	(0.6)
30644	B2S	L23	Ag	Ct	(1.44)	(1.79)	(0.31)	(1.0)
30996	C3SW	L6	Ag	Cy	(1.25)	(1.44)	(0.41)	(0.9)
31099	G3SW	L4	Js	Js	(1.33)	(1.41)	(0.47)	(1.1)
31127	A1S	NVP	PW-GM	PW-GM	(0.76)	(1.29)	(0.44)	(0.3)
31479	A2S	L6	Js	Js	(1.25)	(1.74)	(.36)	(0.6)
32226	C3N	L3	Ag	Cy	(1.39)	(2.05)	(0.32)	(0.8)
32651	Cav		Qz-Vein	Qz-Vein	(1.61)	(1.66)	(0.50)	(2.4)
32877	B3SW	L4	PW-GM	PW-GM	(1.24)	(1.54)	(0.44)	(0.8)
32883	D2N	L6	PW-D	PW-D	(0.87)	(1.61)	(0.41)	(0.6)
33215	F4S	L4	Qz-Vein	Qz-Vein	(1.17)	(1.28)	(0.19)	(0.2)
33354	F6S	L8	Ag	Ct	(0.95)	(1.51)	(0.32)	(0.6)
33931	D5S	NVP	Ag	Ct	(1.61)	(1.61)	(0.61)	(1.9)
35997	A2S	NVP	Op	Ct	(0.90)	(1.60)	(0.44)	(0.7)
36668	F7S	L5	NMT	Js	(0.58)	(1.57)	(0.32)	(0.2)
36803	C4S	L29	Js	Js	(1.01)	(1.71)	(.5)	(1.0)
37962	B4S	NVP	NMT	Cy	(2.22)	(0.61)	(0.22)	(0.3)
37981	D2S	NVP	NMT	PW-GM	(1.62)	(1.83)	(0.46)	(1.5)

Table 25: Projectile Point Fragments

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
73	D4S	L7	Qe	Qe	(1.40)	(1.84)	(0.29)	(0.8)
160	D4S	L7	Ag	Ct	(1.78)	(0.66)	(0.41)	(0.6)
165	D4S	L8	Ag	Cy	(0.93)	(1.34)	(0.34)	(0.4)
277	D4S	L9	PW-D	PW-D	(1.84)	(1.35)	(0.18)	(0.3)
752	D4S	L14	Ag	Cy	(1.11)	(1.48)	(0.36)	(0.5)
1081	D4S	L7-L10	Js	Js	(0.81)	(1.51)	(0.45)	(0.7)
1169	D3S	L3	Ag	Cy	(1.74)	(0.91)	(0.26)	(0.4)
1182	D3S	L3	Qe	MQ	(0.59)	(1.48)	(0.42)	(0.3)
1307	D3S	L3	Qe	Qe	(1.16)	(1.40)	(0.37)	(0.6)
1332	D4S	L21	PW-D	PW-D	(1.87)	(1.89)	(0.60)	(1.8)
1422	D3S	L4	PW-GM	PW-GM	(1.11)	(2.24)	(0.48)	(0.8)
1518	D3S	L3	Js	Ct	(1.08)	(1.16)	(0.36)	(0.6)
1701	D3S	L6	Ag	Cy	(1.86)	(0.76)	(0.29)	(0.2)
1997	D3N/2	L8	NMT	PW	(1.36)	2.03	0.64	(2.3)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
2070	D3N/2	L10	Ag	Cy	(1.88)	2.50	0.61	(3.6)
2431	E2S	L2	Op	Ct	(0.96)	(1.22)	(0.24)	(0.2)
3594	D1S	L1	Qe	Qe	(0.97)	(0.86)	(0.38)	(0.3)
4940	D1N	L7	Meta	Qe	(1.21)	(1.43)	(0.38)	(0.8)
4968	D1N	L8	Op	Ct	(0.63)	(1.02)	(0.27)	(0.2)
5001	D1N	L10	Op	Ct	(1.50)	(1.04)	(0.44)	(0.6)
5240	D2S	L9	Qz-Crystal	Qz-Crystal	(1.69)	(1.35)	(0.36)	(0.7)
5493	B3S	L4	Op	Ct	(1.34)	(2.40)	(0.60)	(2.1)
5809	B3S	L10	Op	Ct	(1.60)	(0.81)	(0.33)	(0.4)
5831	B3S	L10	Js	Ct	(2.06)	(1.51)	(0.40)	(0.9)
6282	B2N/2	L3	PW-D	PW-D	(1.65)	(1.20)	(0.46)	(1.0)
6766	D1N	NVP	Qe	Qe	(1.10)	(1.61)	(0.47)	(0.9)
6836	E3S	L1	Ag	Cy	(1.19)	(0.77)	(0.20)	(0.1)
6982	E3S	L3	Op	Ct	(2.15)	(1.35)	(0.52)	(1.4)
7140	E3S	L4	Op	Ct	(1.14)	(0.99)	(0.29)	(0.2)
7596	E3S	L6	Qe	Qe	(2.26)	(1.51)	(0.29)	(0.6)
8153	E3S	L9	Op	Ct	(1.47)	(1.25)	(0.41)	(0.4)
8321	E3S	L11	PW-D	PW-D	(1.49)	(1.36)	(0.43)	(1.0)
8559	E3S	L13	Op	Ct	(1.78)	(1.47)	(0.37)	(0.6)
8691	C1S	L1	Qe	Qe	(2.02)	(0.62)	(0.23)	(0.3)
9507	C2S	L3	Qe	Qe	(2.60)	(1.12)	(1.90)	(0.6)
9711	C2S	L4	Op	Js	(1.00)	(1.43)	(0.43)	(0.7)
9909	C2S	L5	Qe	Qe	(0.63)	(1.13)	(0.39)	(0.2)
9936	C2S	L7	Ag	PW	(1.54)	(1.14)	(0.25)	(0.5)
10503	E4S	L1	PW-D	PW-D	(1.74)	(1.24)	(0.31)	(0.5)
10733	E4S	L4	Ag	Ct	(1.63)	(0.97)	(0.34)	(0.5)
11189	E4S	L7	PW-D	PW-D	(1.14)	(1.25)	(0.51)	(1.0)
11583	E4S	L11	Qe	Qe	(0.86)	(1.45)	(0.33)	(0.4)
12257	E6S	L2	Js	Js	(1.24)	(1.10)	(0.38)	(0.6)
12459	F6S	L4	Op	Js	(1.15)	(1.04)	(0.29)	(0.2)
12497	F6S	L4	Op	Ct	(1.19)	(1.53)	(0.34)	(0.5)
12707	E6S	L6	Qe	Qe	(0.93)	(0.81)	(0.17)	(0.1)
12735	E6S	L7	Op	Ct	(1.15)	(1.50)	(0.32)	(0.6)
12764	E6S	L7	Qe	Qe	(1.25)	(0.91)	(0.18)	(0.1)
13653	F3S	L12	Ag	Ct	(1.67)	(1.20)	(0.37)	(0.8)
13664	F3S	L12	PW-GM	PW-GM	(0.76)	(0.74)	(0.24)	(0.6)
13801	F3S	L14	PW-D	PW-D	(1.70)	(1.99)	(0.44)	(1.5)
13827	F3S	L14	Qe	Qe	(1.59)	(2.38)	(0.80)	(3.3)
14701	C3S	L8	Qz-Crystal	Qz-Crystal	(1.48)	(0.89)	(0.30)	(0.3)
14822	C3S	L11	Qe	Qe	(0.87)	(0.76)	(0.17)	(0.1)
15235	C3S	L15	Op	Js	(1.22)	(0.95)	(0.35)	(0.3)
17011	C4S	L3	Qe	Qe	(1.70)	(2.13)	(0.57)	(2.2)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
17050	C4S	L4	Ag	Cy	(1.40)	(0.69)	(0.27)	(0.3)
18169	C4S	L13	PW-GM	PW-GM	(1.70)	(1.01)	(0.32)	(0.5)
18620	C4S	L21	Qe	Qe	(2.48)	(1.77)	(0.63)	(2.9)
18914	C1N	L2	Op	Js	(1.94)	(1.14)	(1.14)	(0.3)
20543	B1N	L8	PW-GM	PW-GM	(1.12)	(2.08)	0.56	(1.8)
20889	B2N	L4	Op	Cy	(2.72)	(1.61)	(.35)	(0.9)
21062	B2N	L4	PW-D	PW-D	(1.42)	(1.21)	(0.63)	(1.0)
21827	C2N	L3	Ag	Cy	(2.04)	(0.59)	(0.21)	(0.3)
22072	D1N	L14	Ag	Ct	(0.67)	(1.34)	(0.48)	(0.3)
22688	F5S	L3	Op	Js	(0.81)	(0.86)	(0.22)	(0.2)
22817	F3S	L17	Qe	Qe	(1.65)	(0.50)	(0.13)	(0.1)
23374	D2	L2	Cy	Cy	(1.15)	(1.39)	(0.35)	(0.8)
23413	D2	L2	PW-D	PW-D	(1.51)	(1.29)	(0.33)	(0.7)
23585	D2S	L4	Op	Cy	(1.92)	(0.59)	(0.17)	(0.1)
23842	D2S	L6	Cy	Cy	(1.52)	(2.01)	(0.32)	(0.8)
23866	Cav		PW-D	PW-D	(1.05)	(1.15)	(0.36)	(0.5)
23891	B1S	L3	Ag	Js	(1.89)	(1.04)	(0.37)	(0.8)
23969	B1S	L3	PW-D	PW-D	(2.42)	(2.06)	(0.41)	(2.1)
23975	B1S	L3	PW-D	PW-D	(1.80)	(1.76)	(0.34)	(1.0)
24414	D4S	L2	PW-D	PW-D	(1.58)	(0.93)	(0.26)	(0.4)
25398	F5N	L4	NMT	Qz-Vein	(1.39)	(1.86)	(0.47)	(1.5)
25786	E5S	L3	Qe	MQ	(1.95)	(1.24)	(0.45)	(1.1)
26551	B2N	L8	Qe	Qe	(1.31)	(1.64)	0.33	(1.00)
26604	C2N	L14	Cy	Ct	(0.71)	(1.33)	(0.22)	(0.2)
26681	B2N	L11	Ag	Cy	(1.54)	(1.38)	(0.44)	(0.8)
26879	B2S	L2	NMT	Qz-Vein	(1.36)	(.77)	(.22)	(0.2)
26901	B2S	L3	Op	Js	(0.87)	(.61)	(.28)	(0.1)
27043	B2S	L9	PW-GM	PW-GM	(7.54)	(1.80)	(0.52)	(1.7)
27151	B2S	L12	PW-GM	PW-GM	(1.48)	(1.87)	(0.42)	(1.2)
27158	B2S	L12	PW-D	PW-D	(1.86)	1.50	0.50	(1.8)
27174	B2S	L13	Ag	Cy	(1.31)	(1.84)	(0.47)	(1.2)
27362	B3S	L4	PW-D	PW-D	(1.09)	(1.43)	(0.26)	(0.4)
27560	B3S	L17	Qe	Qe	(1.70)	(0.87)	(0.33)	(0.7)
27562	B3S	L17	Qz-Crystal	Qz-Crystal	(1.66)	(1.80)	(0.44)	(1.5)
27584	B3S	L17	Ag	Ct	(1.17)	(0.89)	(0.36)	(0.3)
28814	E2S	L17	Qe	Qe	(1.48)	(1.85)	(0.51)	(1.7)
29950	F5S	L12	Qz-Vein	Qz-Vein	(1.48)	(2.04)	(0.70)	(1.8)
30486	A2S	NVP	Ag	Cy	(1.28)	(1.87)	(0.47)	(1.2)
31020	D3SW	L2	PW-D	PW-D	(0.83)	(1.44)	(0.54)	(0.6)
31080	F3SW	L4	Op	Cy	(1.45)	(1.72)	(0.52)	(1.3)
31320	B3S	L20	Ct	Ct	(2.22)	(2.36)	(0.67)	(4.7)
31495	A2S	L10	Qz-Vein	Qz-Vein	(1.56)	(1.74)	(0.38)	(1.2)
31807	B3N	L13	Cy	Ct	(0.73)	(1.46)	(0.27)	(0.3)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
32700	B3N	L12	Cy	Cy	(1.43)	(.37)	(.17)	(0.1)
32925	E3SW	L5	PW-GM	PW-GM	(1.91)	(2.16)	(0.50)	(2.1)
33143	H6S	L12	PW-D	PW-D	(3.65)	(2.04)	(0.61)	(4.2)
33254	F4S	L5	PW-GM	PW-GM	(1.73)	(2.04)	(0.56)	(2.3)
33804	E7S	L3	Op	Ct	(1.54)	(1.41)	(0.38)	(0.6)
34009	C1N	NVP	Cy	Ct	(0.98)	(1.90)	(0.36)	(0.4)
34105	G5S	NVP	Ag	Cy	(1.64)	(0.58)	(0.23)	(0.1)
34240	F7S	L2	PW-GM	PW-GM	(2.62)	1.68	0.78	(3.9)
35492	C3SW	NVP	Ag	Cy	(2.02)	(1.10)	(0.34)	(0.7)
35577	B4S	NVP	PW-D	PW-D	(1.27)	(1.80)	(0.49)	(1.1)
35687	A3S	NVP	PW-D	PW-D	(2.40)	(1.04)	(0.37)	(1.0)
35696	A3S	NVP	PW-D	PW-D	(2.62)	(1.67)	(0.63)	(2.6)
36020	B2S	NVP	PW-GM	PW-GM	(1.02)	(1.91)	(0.59)	(1.0)
36360	A1S	NVP	NMT	Js	(0.94)	(1.68)	(0.54)	(0.9)
36495	C5S	NVP	Op	Js	(1.61)	(1.78)	(0.40)	(1.1)
36685	A3S	L3	Op	Ct	(0.84)	(.97)	(.44)	(0.4)
36814	C4S	L26	Qz-Crystal	Qz-Crystal	(1.28)	(1.91)	(0.47)	(1.1)
36926	A3S	L8	Qz	Qz	(1.32)	(1.80)	(0.63)	(1.6)
37180	B3SW	L10	PW-GM	PW-GM	(1.96)	(1.65)	(0.54)	(2.1)
37544	A3S	L11	Qz-Vein	Qz-Vein	(1.45)	(0.80)	(0.20)	(0.2)
38068	D5S	NVP	NMT	Js	(1.82)	(.73)	(.25)	(0.3)

Table 26: Notched Projectile Point Fragments

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
17	D4S	L6	Op	Cy	(1.13)	(.74)	(.2)	(0.1)
1157	D3S	L3	Ag	Cy	(1.61)	(1.32)	(0.37)	(0.8)
1161	D3S	L3	PW-D	PW-D	(1.94)	(1.58)	(.44)	(1.3)
1337	D4S	L21	Js	Js	(1.08)	(0.82)	(0.31)	(0.2)
3260	E2S	L9	Op	Ct	(1.03)	(1.50)	(0.50)	(0.8)
3365	E2S	L10	Js	Js	(1.25)	(1.57)	(0.36)	(0.8)
4036	D1S	L4	Ag	Cy	(1.82)	(0.99)	(0.33)	(0.7)
4811	D1N	L5	PW-GM	PW-GM	(2.12)	(1.66)	(0.39)	(1.5)
9158	C1S	L7	Ag	Cy	(1.66)	(0.89)	(0.30)	(0.4)
9160	C1S	L8	Op	Js	(1.04)	(1.32)	(0.54)	(0.5)
9710	C2S	L4	Ag	Cy	(0.79)	(1.03)	(0.24)	(0.2)
11554	E4S	L11	Ag	Ct	(0.85)	(1.67)	(3.0)	(0.2)
11781	E4S	L13	Qe	Qe	(1.30)	(1.30)	(0.38)	(0.7)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
12336	E6S	L4	Qe	Qe	(1.07)	(1.37)	(0.51)	(0.9)
12759	E6S	L7	Ag	Cy	(1.92)	(1.36)	(0.33)	(0.9)
13689	F3S	L12	PW-D	PW-D	(1.89)	(1.74)	(0.50)	(1.4)
13791	F3S	L13	PW-D	PW-D	(3.53)	(2.11)	(0.60)	(4.9)
14166	C3S	L2	Js	PW	(1.99)	(1.69)	(.43)	(1.5)
14242	C3S	L4	Op	Ct	(1.84)	(1.69)	(.32)	(0.7)
15162	C3S	L16	Qe	Qe	(0.98)	(1.87)	(0.38)	(0.9)
18106	C4S	L12	Ag	Ct	(1.43)	(0.92)	(0.28)	(0.3)
18714	C5S	NVP	PW-D	PW-D	(1.40)	(.72)	(.22)	(0.2)
18821	C1N	NVP	Op	Js	(1.85)	(1.43)	(0.31)	(0.3)
18848	C1N	L1	Ag	Ct	(1.25)	(0.67)	(0.32)	(0.3)
19499	C1N	L2	Op	Js	(0.69)	(0.99)	(0.18)	(0.1)
20113	B1N	L3	Ag	Ct	(0.93)	(.108)	(.31)	(0.3)
23414	D2	L1 - L2	Qz-Crystal	Qz-Crystal	(1.02)	(.5)	(.18)	(0.1)
23510	D2	L3	PW-D	PW-D	(1.62)	(1.02)	(0.26)	(0.4)
23760	D2S	L5	PW-GM	PW-GM	(3.10)	(2.90)	(0.50)	(4.0)
24045	B1S	L4	Op	Js	(2.36)	(1.84)	(0.48)	(2.1)
24052	B1S	L4	Op	Cy	(2.38)	(1.87)	(0.37)	(1.2)
24393	D4S	L4	Ag	Cy	(1.79)	(0.91)	(0.31)	(0.7)
24485	D4S	L5	NMT	Qe	(1.63)	(0.66)	(0.29)	(0.4)
26877	B2S	L1	Js	Js	(0.73)	(1.29)	(0.30)	(0.2)
26994	B2S	L3	Ag	Cy	(1.40)	(1.15)	(.26)	(0.8)
27914	A2S	NVP	PW-D	PW-D	(1.50)	(1.67)	(0.42)	(0.8)
28368	A2S	NVP	Qe	Qe	(2.01)	(1.35)	(.22)	(0.6)
28897	D3S	L18	PW-D	PW-D	(1.03)	(1.97)	(0.41)	(0.9)
30192	F5S	L14	Ag	Ct	(2.18)	(1.35)	(0.27)	(0.7)
31162	A3S	NVP	Qe	Qe	(1.24)	(2.19)	(0.45)	(1.2)
32197	C3N	L3	Ag	Cy	(1.93)	(1.1)	.30	(0.8)
32424	F2S	L11	NMT	Qe	(0.33)	(2.42)	(.44)	(2.6)
32896	B3SW	L5	Js	PW	(1.30)	(1.12)	(.28)	(0.4)
33221	F4S	L4	Qz-Crystal	Qz-Crystal	(0.61)	(1.08)	(0.25)	(0.1)
33606	E3S	NVP	Op	Cy	(1.83)	(0.99)	(0.23)	(0.4)
35491	C3SW	NVP	NMT	Ct	(1.36)	(1.05)	(.36)	(0.5)
37124	F4S	L6	NMT	PW	(1.85)	(1.94)	(0.46)	(1.7)

Table 27: Stemmed Projectile Point Fragments

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
209	D4S	L8	PW-D	PW-D	(3.22)	(1.51)	(0.45)	(2.3)
5400	D2S	L12	Js	Js	(3.89)	2.63	(0.71)	(6.7)
5764	B3S	L9	PW-GM	PW-GM	(2.40)	(1.92)	(0.51)	(2.6)
10580	E4S	L4	PW-D	PW-D	(1.74)	(0.77)	(0.51)	(1.6)
12207	B2S	L12	Op	Cy	(2.57)	(2.21)	0.53	(2.5)
14992	C3S	L13	Ct	Ct	(2.18)	(1.84)	(.43)	(1.7)
18109	C4S	L12	Cy	Ct	(1.86)	(0.92)	(0.45)	(0.8)
18657	C4S	L21	PW-D	PW-D	(2.15)	(2.05)	(0.47)	(2.2)
20626	B1N	L9	PW-D	PW-D	(1.43)	(1.04)	(0.33)	(0.6)
20869	B2N	L4	PW-D	PW-D	(1.26)	(1.56)	0.52	(1.3)
21015	C1N	L12	PW-GM	PW-GM	(1.11)	(1.61)	(0.38)	(0.7)
21750	C2N	L2	PW-GM	PW-GM	(2.46)	(1.55)	.52	(2.4)
28625	E1S	L8	PW-D	PW-D	(3.22)	(2.42)	0.56	(4.0)
33693	E5S	NVP	PW-D	PW-D	(2.96)	(1.55)	(0.59)	(2.8)
36432	C5S	NVP	Op	Cy	(2.70)	(1.59)	(0.54)	(2.7)

Table 28: Projectile Point Tip Fragments

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
18	D4S	L6	PW-D	PW-D	(1.10)	(.78)	(.25)	(0.2)
72	D4S	L7	Ag	Cy	(1.24)	(1.02)	(0.21)	(0.2)
200	D4S	L8	Ct	Ct	(2.18)	(2.76)	(.46)	(2.4)
309	D4S	L9	Cy	Cy	(1.21)	(1.02)	(0.19)	(0.3)
421	D4S	L11	NMT	Ct	(1.11)	(1.09)	(0.02)	(0.2)
489	D4S	L11	PW-D	PW-D	(1.73)	(1.9)	(.59)	(1.8)
654	D4S	L13	Ag	Js	(2.12)	(1.61)	(.55)	(1.8)
708	D4S	L14	PW-D	PW-D	(1.69)	(1.28)	(0.34)	(0.5)
776	D4S	L15	Js	PW	(1.48)	(.76)	(.17)	(0.1)
1120	D3S	L2	NMT	Ct	(1.07)	(1.19)	(0.30)	(0.3)
1168	D3S	L3	Ag	Cy	(1.37)	(1.28)	(0.27)	(0.4)
1485	D3S	L3	Js	Ct	(1.10)	(1.20)	(0.21)	(0.3)
1505	D3S	L3	Qz-Crystal	Qz-Crystal	(0.95)	(.87)	(.22)	(0.2)
1687	D3S	L5	PW-D	PW-D	(1.23)	(1.56)	(.47)	(0.4)
1809	D3S	L5	Qz	Qe	(1.13)	(.69)	(.28)	(0.1)
1829	D3S	L5	Ag	Cy	(1.56)	(1.57)	(0.31)	(0.6)
1930	D3S	L6	PW-GM	PW-GM	(0.88)	(1.22)	(0.25)	(0.2)
2280	D3S	L15	Op	Ct	(1.18)	(1.06)	(0.43)	(0.4)
2604	E2S	L3	Ag	Cy	(0.94)	(1.19)	(0.23)	(0.1)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
2679	E2S	L4	Qe	Qe	(2.73)	(1.58)	(.4)	(1.6)
2780	E2S	L5	Ag	PW	(1.63)	(1.65)	(.38)	(0.7)
2787	E2S	L5	Ag	Cy	(1.37)	(1.12)	(.27)	(0.3)
2812	E2S	L5	Op	Op	(0.95)	(1.26)	(0.21)	(0.2)
2994	E2S	L6	Ag	Ct	(1.06)	(1.25)	(.42)	(0.4)
3271	E2S	L9	PW-GM	Ct	(1.37)	(1.41)	(0.54)	(0.7)
3523	E2S	L13	Qe	Qe	(1.34)	(1.01)	(.19)	(0.1)
3596	D1S	L1	Ag	Ag	(1.34)	(1.5)	(.24)	(0.4)
3738	D1S	L2	Ag	Cy	(0.80)	(.96)	(.19)	(0.1)
3739	D1S	L2	Js	Js	(0.96)	(1.31)	(0.21)	(0.2)
3750	D1S	L1	Qz-Vein	Qz-Vein	(2.06)	(1.74)	(.37)	(1.6)
3784	D1S	L2	Op	Ct	(2.08)	(1.47)	(0.37)	(0.8)
3821	D1S	L2	Js	Js	(1.23)	(1.2)	(.32)	(0.4)
3934	D1S	L3	Qe	MQ	(2.35)	(1.48)	(.37)	(1.4)
3943	D1S	L3	Qz-Vein	Qz-Vein	(0.93)	(.93)	(.26)	(0.3)
4167	D1S	L5	Qe	MQ	(1.10)	(1.15)	(.27)	(0.3)
4390	D1S	L8	Ag	Cy	(1.04)	(.61)	(.18)	(0.1)
4564	D1N	L2	Op	Cy	(2.33)	(1.0)	(.5)	(1.1)
4584	D1N	L2	Op	Ct	(2.16)	(1.55)	(0.44)	(1.1)
4689	D1N	L3	Js	Js	(1.45)	(1.12)	(.21)	(0.3)
4816	D1N	L5	Ag	Cy	(1.15)	(.85)	(.21)	(0.2)
4824	D1N	L5	Op	Ct	(2.04)	(1.81)	(0.45)	(1.4)
4936	D1N	L7	Op	Ct	(1.81)	(1.42)	(0.49)	(1.3)
5034	D2S	L7	Ag	Ct	(0.94)	(1.14)	(0.29)	(0.2)
5119	D2S	L8	Qe	Qe	(1.00)	(.87)	(.27)	(0.2)
5127	D2S	L8	Qe	Qe	(1.70)	(1.12)	(0.31)	(0.5)
5148	D2S	L8	PW-GM	PW-GM	(1.54)	(1.49)	(.44)	(1.1)
5215	D2S	L9	Op	Ct	(2.05)	(1.91)	(.29)	(0.9)
5533	B3S	L5	Qz-Vein	Qz-Vein	(1.93)	(.98)	(.37)	(0.8)
5604	B3S	L6	Cy	Ct	(1.73)	(1.27)	(0.33)	(0.5)
5635	B3S	L6	PW-D	Js	(0.63)	(.67)	(.19)	(0.5)
5680	B3S	L7	Op	Ct	(1.21)	(.68)	(.15)	(0.1)
5687	B3S	L8	Ag	Cy	(1.04)	(.67)	(.2)	(0.1)
5690	B3S	L8	Op	PW	(1.26)	(1.28)	(.26)	(0.3)
5802	B3S	L10	Qe	MQ	(1.65)	(2.17)	(.51)	(1.9)
5852	B3S	L11	Js	Js	(2.47)	(1.82)	(.5)	(2.3)
5912	B2S	L2	Ag	Cy	(1.28)	(1.01)	(.17)	(0.2)
6085	B2NE/4	L9	Js	Js	(1.48)	(1.18)	(.39)	(0.5)
6317	B1N/2	L9	PW-D	PW-D	(2.15)	(1.49)	(0.45)	(1.4)
6319	B1N/2	L9	Meta	Qe	(1.35)	(1.21)	(.3)	(0.4)
6478	B1S	L12	Qe	MQ	(1.09)	(1.25)	(0.26)	(0.3)
6585	B1N/2	L14	Op	Ct	(1.30)	(1.31)	(0.25)	(0.3)
6602	B1S	L14	Op	Ct	(1.23)	(1.03)	(0.37)	(0.3)
6784	B2S	Cav	PW-D	PW-D	(2.55)	(1.23)	(0.30)	(0.8)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
6829	D2S	L15	Qe	Qe	(1.34)	(1.11)	(0.28)	(0.3)
6834	E3S	L1	Ag	Cy	(1.21)	(1.38)	(0.31)	(0.3)
6847	E3S	L1	Ag	Cy	(0.94)	(.89)	(.25)	(0.1)
6882	E3S	L2	Ag	Cy	(0.90)	(1.04)	(0.22)	(0.1)
7014	E3S	L2	Op	Ct	(0.81)	(.72)	(.12)	(0.1)
7121	E3S	L4	Ag	Cy	(1.88)	(2.00)	(0.36)	(1.3)
7152	E3S	L4	Op	Ct	(2.21)	(1.26)	(.27)	(0.5)
7183	E3S	L4	Qz-Crystal	Qz-Crystal	(1.45)	(1.06)	(0.28)	(0.4)
7344	E3S	L5	Qe	Qe	(1.10)	(1.54)	(.37)	(0.4)
7369	E3S	L5	Qe	Qe	(2.02)	(1.11)	(.32)	(0.5)
7454	E3S	L5	PW-D	Js	(2.10)	(1.02)	(.23)	(0.4)
8467	E3S	L12	Qe	Qe	(1.58)	(1.12)	(.32)	(0.5)
8554	E3S	L13	Ag	Ct	(1.76)	(1.34)	(.22)	(0.4)
8672	C1S	L1	PW-D	PW	(2.08)	(1.34)	(0.40)	(0.9)
9425	C2S	L2	Op	Ct	(1.18)	(.55)	(.25)	(0.1)
9596	C2S	L3	Qe	Qe	(1.38)	(1.61)	(0.28)	(0.4)
9785	C2S	L5	PW-D	PW-D	(2.60)	(1.24)	(.34)	(0.6)
9809	C2S	L5	Qe	Qe	(1.28)	(1.31)	0.28	(0.5)
9871	C2S	L6	Op	Js	(1.54)	(0.54)	(0.19)	(0.1)
10030	C2S	L8	NMT	Qe	(1.51)	(1.42)	(.33)	(0.4)
10066	C2S	L9	Ag	Cy	(1.63)	(1.58)	(0.38)	(0.8)
10145	C2S	L10	Ag	Cy	(3.09)	(1.68)	.29	(1.0)
10445	D3S	L20	Qe	Qe	(2.51)	(1.65)	(.5)	(1.7)
10576	E4S	L3	Ag	Cy	(.96)	(1.15)	(.25)	(0.1)
10868	E4S	L5	Op	Ct	(0.76)	(.96)	(.26)	(0.1)
10970	E4S	L5	NMT	Ct	(0.72)	(.44)	(.11)	(0.1)
11140	E4S	L6	PW-D	PW-D	(1.35)	(1.26)	(0.38)	(0.5)
11152	E4S	L7	Qe	MQ	(2.11)	(1.95)	(.53)	(1.9)
11532	E4S	L11	Qe	Qe	(1.95)	(1.32)	(.37)	(0.9)
11579	E4S	L11	Op	Ct	(1.46)	(1.14)	(0.32)	(0.4)
11768	E4S	L13	Qe	Qe	(1.17)	(1.42)	(.29)	(0.5)
11985	E1S	L2	PW-GM	PW-GM	(2.57)	(1.45)	(.48)	(1.6)
12366	F6S	L2	PW-GM	PW-GM	(1.85)	(1.27)	(.40)	(.8)
12732	E6S	L7	PW-D	PW-D	(1.48)	(1.69)	(.43)	(0.9)
12762	E6S	L7	Qe	Qe	(1.38)	(.8)	(.21)	(.05)
12902	F2S	L9	PW-D	PW-D	(1.12)	(1.22)	(.26)	(0.2)
12966	none		NMT	Ct	(1.73)	(1.20)	(0.47)	(1.0)
13481	F3S	L10	Ag	Cy	(1.23)	(2.07)	(0.26)	(0.7)
13937	F3S	L15	PW-D	PW-D	(1.32)	(1.34)	(0.34)	(0.4)
13998	F4S	L1	PW-D	PW-D	(1.11)	(1.31)	(.31)	(0.4)
14178	C3S	L2	Qe	Qe	(1.46)	(1.6)	(.42)	(0.9)
14215	C3S	L3	PW-D	PW-D	(1.22)	(1.36)	(.18)	(0.2)
14312	C3S	L5	Js	Js	(2.38)	(.98)	(.22)	(0.4)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
14427	C3S	L6	Op	Op	(1.87)	(1.44)	(.55)	(1.3)
14429	C3S	L6	Qz-Crystal	Qz-Crystal	(1.56)	(1.13)	(.36)	(0.4)
14485	C3S	L6	Op	Js	(1.26)	(1.05)	(0.33)	(0.3)
14761	C3S	L10	PW-D	PW-D	(2.39)	(1.59)	(0.44)	(1.6)
15173	C3S	L16	PW-D	Ct	(2.02)	(2.26)	(.69)	(2.8)
15628	C3S	L24	Qe	Ct	(1.37)	(0.95)	(0.48)	(0.4)
15745	C1S	L11	Ag	Cy	(1.43)	(.52)	(.20)	(0.1)
16072	C1S	L16	PW-D	PW-D	(1.84)	(1.92)	(0.35)	(1.2)
17087	C4S	L5	Cy	Cy	(2.62)	(1.04)	(.31)	(0.7)
17187	C4S	L6	PW-D	PW-D	(2.46)	(2.38)	(.65)	(2.3)
17266	C4S	L7	PW-D	PW-D	(2.24)	(1.36)	(.22)	(0.5)
17749	C4S	L8	Op	Js	(2.75)	(1.48)	(.39)	(1.4)
17882	C4S	L10	Cy	Cy	(2.04)	(1.15)	(.28)	(0.8)
17938	C4S	L11	Qe	Qe	(2.31)	(1.58)	(.31)	(1.0)
18082	C4S	L11	Op	Js	(1.51)	(1.36)	(.32)	(0.6)
18213	C4S	L14	Op	Js	(1.83)	(1.67)	(.36)	(0.6)
18225	C4S	L15	Qe	Qe	(1.07)	(0.99)	(0.35)	(0.3)
18285	C4S	L15	PW-D	PW-D	(0.91)	(.85)	(.2)	(0.1)
18363	C4S	L16	Op	Ct	(1.30)	1.98	0.61	(2.2)
18459	C4S	L17	PW-GM	PW-GM	(2.51)	(1.59)	(.58)	(1.8)
18484	C4S	L18	PW-D	PW-D	(1.12)	(1.17)	(0.18)	(0.2)
18535	C4S	L19	PW-D	PW-D	(2.55)	(1.74)	(.52)	(2.2)
18570	C4S	L20	Qe	MQ	(2.57)	(1.28)	(.4)	(1.2)
18954	C1N	L2	Qe	MQ	(1.14)	(1.13)	(0.28)	(0.2)
19004	C1N	L2	Qe	Ct	(1.53)	(1.61)	(0.23)	(0.6)
19087	C1N	L3	PW	PW	(1.01)	(.78)	(.22)	(0.1)
19228	C1N	L4	Op	Ct	(1.12)	(1.19)	(0.25)	(0.2)
19352	C1N	L6	PW	PW	(2.56)	(1.27)	(.21)	(0.7)
19489	C1N	L7	PW-D	PW-D	(2.32)	(1.5)	(.41)	(1.3)
20014	B1N	L2	PW-D	Ct	(1.64)	(1.21)	(.22)	(0.4)
20055	B1N	L2	Qe	Qe	(1.58)	(1.91)	(.42)	(1.0)
20878	B2N	L4	Op	Ct	(2.84)	(1.41)	(.46)	(1.4)
22147	C2N	L5	Qe	Qe	(1.65)	(1.56)	(.3)	(0.7)
22357	F5S	L2	Js	Js	(1.00)	(.84)	(.15)	(0.1)
22424	D2N	L3	Op	Ct	(1.61)	(1.16)	(.25)	(0.3)
23038	E5S	NVP	NMT	Cy	(1.27)	(0.94)	(0.28)	(0.3)
23207	C5	NVP	Ag	Cy	(1.74)	(1.5)	(.29)	(0.6)
23508	D2	L3	Qe	Qe	(1.65)	(1.31)	(.24)	(0.5)
23527	D2	L3	PW-D	PW-D	(1.49)	(1.78)	(0.32)	(0.6)
23549	D2S	L4	PW-D	PW-D	(1.26)	(1.35)	(0.33)	(0.6)
23615	D2S	L4	PW-GM	PW-GM	(0.90)	(.96)	(.23)	(0.1)
23646	D2S	L4	Ag	Cy	(2.04)	(1.35)	(0.39)	(0.5)
23651	D2S	L4	PW-GM	PW-GM	(1.28)	(.52)	(.22)	(0.1)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
23767	D2S	L5	Ag	Ct	(1.79)	(1.0)	(.22)	(0.4)
23925	D2S	L5	Ag	Ct	(1.46)	(1.08)	(0.30)	(0.4)
23939	B1S	L3	PW-D	PW-D	(1.53)	(.57)	(.36)	(0.2)
23983	B1S	L3	Op	Ct	(1.51)	(.95)	(.37)	(0.5)
24213	D4S	L2	Cy	Cy	(1.72)	(1.58)	(2.5)	(0.7)
24229	D4S	L3	Op	Ct	(1.15)	(0.92)	(0.20)	(0.2)
24469	D4S	L5	Op	Ct	(1.09)	(.68)	(.3)	(0.2)
24470	D4S	L5	Qe	Qe	(2.77)	(1.32)	(.25)	(0.8)
24501	D4S	L5	PW-GM	Ct	(1.34)	(1.46)	(0.39)	(0.6)
24573	D4S	L6	Qe	Qe	(1.80)	(1.33)	(.26)	(0.3)
24614	D5S	L9	Ag	Ag	(2.17)	(1.46)	(.27)	(0.6)
24982	C2N	L7	Qe	Qe	(1.03)	(1.16)	(0.33)	(0.1)
25372	F5S	L4	Op	Ct	(0.95)	(1.01)	(.23)	(0.2)
25496	F5S	L6	Qe	Qe	(2.27)	(1.84)	(.36)	(1.4)
25503	F5S	L6	Qz-Vein	Qz-Vein	(0.79)	(.93)	(.38)	(0.2)
25646	F5S	L8	Qz-Crystal	Qz-Crystal	(1.85)	(1.52)	(.39)	(1.3)
25912	E5S	L6	Cy	Cy	(0.96)	(.82)	(.17)	(0.1)
25951	E5S	L7	Qe	Qe	(2.10)	(1.86)	(.64)	(2.8)
25970	E5S	L8	Qe	Qe	(0.47)	(1.19)	(0.38)	(0.7)
26612	B2N	L10	PW-GM	PW-GM	(2.80)	(1.7)	(.56)	(2.8)
26882	B2S	L2	Qe	Qe	(1.35)	(1.31)	(0.33)	(0.5)
26996	B2S	L8	NMT	Ct	(1.13)	(.86)	(.2)	(0.1)
27041	B2S	L8	Op	Ct	(1.54)	(1.07)	(0.31)	(0.5)
27110	B2S	L10	Op	Ct	(2.82)	(1.98)	(.56)	(2.4)
27141	B2S	L7	Op	Ct	(1.05)	(.64)	(.35)	(0.2)
27342	B3S	L3	PW-D	Ct	(0.87)	(.84)	(.22)	(0.1)
27349	B3S	L3	PW-D	PW-D	(1.37)	(1.26)	(.25)	(0.3)
27365	B3S	L4	PW-D	PW-D	(1.22)	(1.0)	(.17)	(0.2)
27485	B3S	L15	PW-D	PW-D	(2.41)	(1.43)	(0.45)	(1.1)
27498	B3S	L15	Qe	Qe	(1.14)	(1.34)	(0.29)	(0.4)
27503	B3S	L15	Qe	Qe	(2.73)	(1.68)	(.66)	(2.4)
28515	E1S	L6	Js	Js	(1.68)	(1.8)	(.37)	(0.9)
28695	E1S	L10	Qe	Qe	(3.20)	(1.7)	(.5)	(2.1)
29240	E4S	L22	Op	Cy	(1.76)	(.88)	(.35)	(0.5)
29414	D2S	L16	Qe	Qe	(2.66)	(1.93)	(.46)	(1.9)
29510	D2S	L18	Ag	Ct	(1.34)	(1.51)	(.28)	(0.3)
29626	E5S	L10	PW-D	PW-D	(2.52)	(1.87)	(0.49)	(2.2)
30782	A1S	L3	Cy	Cy	(1.18)	(.77)	(.2)	(0.2)
30867	A2S	L3	PW-D	PW-D	(1.04)	(.96)	(.23)	(0.2)
30879	B3SW	L1	PW-D	PW-D	(2.15)	(1.43)	(.47)	(1.1)
30935	C3SW	L2	PW-D	PW-D	(1.44)	(1.42)	(0.42)	(0.5)
31160	A3S	NVP	Ct	Ct	(1.84)	(1.62)	(.26)	(0.8)
31416	F5S	L17	Qe	MQ	(2.19)	(1.45)	(.37)	(1.0)

Catalog Number	Square	Level	Rathbun Material Type	Revised Material Type	Length (cm)	Width (cm)	Thickness (cm)	Weight (gm)
31547	A2S	L11	NMT	PW	(1.50)	(1.88)	(0.62)	(1.8)
32065	C3N	L1	Op	PW	(0.87)	(1.01)	(0.31)	(0.3)
32066	C3N	L1	Qe	Qe	(1.11)	(1.14)	(.24)	(0.1)
32114	B4S	NVP	PW-D	Ct	(1.47)	(1.04)	(.18)	(0.3)
32119	B4S	NVP	NMT	Cy	(1.63)	(1.41)	(0.21)	(0.4)
32882	C5S	NVP	NMT	Cy	(0.98)	(0.63)	(0.25)	(0.1)
32894	B3SW	L5	NMT	Ct	(1.71)	(1.07)	(.35)	(0.4)
33010	H6S	L5	Qe	Qe	(2.88)	(2.08)	(.72)	(4.0)
33470	E6S	L7	Js	Ct	(1.05)	(.95)	(.16)	(0.1)
33494	E6S	L8	Qe	Qe	(1.86)	(1.26)	(0.36)	(0.7)
33881	C2S	NVP	Op	Ct	(2.57)	(1.10)	(0.38)	(0.8)
33882	C2S	NVP	Ag	Cy	(1.80)	(1.45)	(.27)	(0.6)
34075	D5S	L3	Qe	Qe	(1.08)	(1.40)	(0.31)	(0.4)
34078	D5S	L3	NMT	PW	(1.55)	(1.18)	(0.29)	(0.6)
34193	B4S	NVP	Qe	Qe	(1.29)	(1.4)	(.31)	(0.5)
34486	B3SW	L4	PW-D	PW-D	(2.08)	(1.16)	(.32)	(0.7)
34842	B1N	L26	NMT	Cy	(2.49)	(2.34)	(.6)	(3.0)
35303	A2S	NVP	PW-D	PW-D	(0.88)	(.99)	(.26)	(0.1)
35500	B4S	NVP	Qe	MQ	(2.23)	(1.84)	(.49)	(1.7)
35697	A3S	NVP	Op	Ct	(2.80)	(1.48)	(0.33)	(1.2)
35851	A1S	NVP	Qe	Qe	(3.44)	(1.74)	(.46)	(2.4)
36239	C5S	NVP	PW-GM	PW-GM	(2.12)	(1.93)	(.53)	(2.0)
36273	D3SW	L6	PW-GM	PW-GM	(1.42)	(1.02)	(0.36)	(0.4)
36718	A3S	L5	PW-D	Js	(1.25)	(.87)	(.22)	(0.2)
36729	A3S	L5	Ag	Cy	(2.86)	(1.32)	(.33)	(1.2)
36730	A3S	L5	Ag	Cy	(2.04)	(1.32)	(.31)	(0.6)
37027	C4S	L31	Qe	MQ	(3.33)	(1.87)	(.67)	(3.7)
37543	A3S	L11	Qe	Qe	(1.99)	(1.32)	(.44)	(1.3)
37992	F7S	L9	NMT	PW	(0.96)	(1.39)	(0.30)	(0.3)

Appendix C: Lithic Data

Compiled by Diane Rhodes and Jeannette L. Mobley-Tanaka

The lithic tools other than projectile points (See Chapter 10) were described and analyzed by Bill Hammond and Wilford Couts for the report. In addition, Diane Rhodes was asked to create data spreadsheets for each artifact class. As work progressed, multiple versions of the spreadsheets were created in response to shifting views about what to include. As a result, multiple versions of each spreadsheet existed when the Oversight Committee took over efforts to publish the Swallow site report.

Included here are copies of Rhodes's spreadsheets deemed most complete by the committee. While we believe the information on the spreadsheets to be accurate, we do not know if they include all tools currently in the Swallow assemblage at the OAHP.

Each spreadsheet contains detailed information including catalog number, provenience information as recorded in the field, material types, measurements, weights, and miscellaneous other observations made by CAS lithic analysists.

The spreadsheets are as follows:

C.1 Bifaces (excluding projectile points)
C.2 Scrapers
C.3 Drills, Gravers, and Awls
C.4 Choppers
C.5 Manos
C.6 Metates
C.7 Flakes. Unlike the other spreadsheets in this appendix, the lithic flake spreadsheet was created by Jeannette Mobley-Tanaka in order to analyze the flakes for the final report. Information was taken directly from the lab analysis sheets and contains all analyzed lithic lots as well as the 20% sample of point plotted large flakes included in the report. The remaining 80% of the large flakes have not been analyzed and do not appear on any data spreadsheet.
C.8 Cores

Double-click the icon to access the other lithics data spreadsheets:

Appendix D: Ceramic Data

Compiled by Jeannette L. Mobley-Tanaka

Multiple people contributed research on the ceramics assemblage from Swallow. William Lucius conducted materials analysis on clay and inclusions (Chapter 12), Bill Hammond and Audrey Marlar recorded and described cord mark patterns, and Jeannette Mobley-Tanaka synthesized the information from those two analyses and conducted spatial and temporal analyses as well (Chapter 13).

The ceramic data spreadsheet contains data generated by all these efforts. It was compiled by Mobley-Tanaka around 2010 as part of her analysis.

The columns included on the spreadsheet are as follows:

Cat. #: the catalog number of each artifact, assigned in the DC-CAS lab and affixed to the artifact in ink

R.F. #: Refiring number, assigned by Lucius in his refiring study. As not all sherds were included in the refiring study, not all have this number.

Unit, Level: vertical and horizontal provenience information for each sherd as recorded in the field.

Cord Style: Cord styles were developed by Hammond and Marlar. Descriptions of each cord style can be found in Chapter 13.

Refire Color: Munsell colors of refired sherds from Lucius's sample.

Weight: weight, measured in grams

Vsl#: this column designated a MNI for vessels based on a cross referencing of cord style and refire color.

Refit: indicates the catalog number of sherds that can be refit together

Tray: at the time Mobley-Tanaka conducted her analysis, all sherds were kept in Riker Mount-style trays that were numbered. Whether or not the sherds remain in these trays is not known.

Comments: includes general observations made in research as well as notes that were present with the sherds at the time of Mobley-Tanaka's analysis, including notes about other analyses that were done and sherds that were not present at the time of Mobley-Tanaka's work.

Double-click the icon to access the ceramic data spreadsheet:

Appendix E: Faunal Data

Katherine Bryant, Shirley Rathbun, Jean Smith, Charlotte Bechtold, and Betty McCutcheon

Explanation of the Tables of Faunal Data from Swallow Site (5JF321)

Since the site is laid out in an alpha-numeric system, the vertical columns on the tables represent the east-west direction at the site and go from A to F. The horizontal lines represent the north-south direction at the site and go from 3N to 7S. The area within each block represents one two meter grid, so that the blocks under column A represent the grids identified as A3N, A2N, A1N, A1S, A2S, A3S, A4S, A5S, A6S, and A7S.

Each item within the blocks represents the cultural period, depth, number of bones and features such as burning, tool, butcher marks, carnivore chewing or rodent gnawing that describes the bones. The cultural periods are indicated by symbols, so that # equals Early Ceramic (EC) cultural period, x equals the transition period between Early Ceramic and the Middle/ Late Archaic cultural period, and fill or rock fall, m equals the Middle and Late Archaic (MLA) cultural period, > equals the Upper Early Archaic (UEA) period, and e equals the Lower Early Archaic (LEA) period. These symbols are shown first followed by a number which represents the level at which the bone was found. The number in the parentheses represents the number of bones found at this level. Significant features of the bone are indicated by letters. These include a number of B for burned, a number of T for tools, a number of Bu for butchered, a number of C for carnivore chewed, and a number of R for rodent gnawed. Each of the following tables show the distribution of one of the various animal species identified at the site.

The deer bone fragments are divided into their various bone elements and are shown on separate tables.

***Bison bison* (buffalo)**

Grid	A	B	C	D	E	F
3N		#4(2) #5(1) m8(1)1T	#5(1)			
2N		#5(3)		#5(1)		
1N		#2(1) #6(1)1T	x7(1)1T	#3(1) #5(4)		
1S		x7(4) m8/9(1) m10(2) m11(1) m12(1)1T	#1(1)1T m10(1) m12(1) m19(1) m25(1)1T	#2(1) #3(1) #5(1)		
2S	#4(1)	#3(1) m16(1)	#3(1)1T m8(1) m10(1)1T e32(1)	#1/2(2)1B	m8(1)	
3S	m11(1) m13(1)		m17(1)1B	m10(1) m11(4)1T m14(2) x32(1)	#4(1) x7(1)	m16(2)
4S			#5(1) #6(1)	m9(1) m12(1) m18(1)1T1R >19(1)	#4(1) m11(1) m12(1)	

5S						m9(1)1T
6S						
7S					#2(1)	

Large Indeterminate Mammal

Grid	A	B	C	D	E	F
3N		m9(1)				
2N		#3(1) #4(1)1B #5(1) #6(2) m8(1) m9(1) m10(1) m13(1)1B m14(1)	#2(2) #3(4) #4(1) #5(2) x7(1)1B m10(2)1B	#5(3)1B1Bu		
1N	#1(1)	#3(1) #5(1)1B #6(1) x7(2) m9(2) m18(1)1B	#2(3) #3(1) #4(1)1B #5(1)1B #6(1) m8(8)2B m10(2)1B m11(2) m15(1) m16(2)1B1T m21(1) m23(1) m25(1)1B e26(1) e28(1)	#1(3) #2(2) #3(6)1R #4(1)1B #5(2) #6(1) x7(3) m9(1) m10(2) m12(1) m13(1) m17(1)1B1T1Bu		
1S	m9(1) m11(2)1B m12(2)1B	#1/2(1) #3(3) #5(1) x7(1)1T m8/9(1) m10(2)1B m14(10) m16(2)1B m19(1)1T e27(1)	#1(1)1B #3(2)1B #4(2) #5(1) #6(2)1B x7(2)1B m8(2)1B m9(1) m10(2) m11(3)1B m13(3)1B1T m17(2) m19(3)3B m21(1) e29(1) e30(1)	#1(5)1B #2(11)3B1T #4(2) #5(24)9B2Bu1T1C #6(2)1B x7(9)4B m8(8)3B m9(3)1B m10(3)3B1Bu m15(1)1B1T m16(1)1B m17(1) m18(1)1B1T m21(3)1B e28(5) e29(1)	#1(2) #2(5) #3(4)1B #5(1)1B #6(5)4B x7(1) m8(3)1B1C	
2S	m12(1) m`13(2)1B	#1(1)1B #2(1)1B #3(3)2B #4(3)1B #5(1)1B #6(1)1B m11(1)1B m12(1) m13(2)1B m24(1) m27(1)1B	#1(4)1B #2(5)2B #3(4) #4(3)2B #5(2)1B #6(5)1B m8(1) m9(2)1C m10(4)1Bu1T m11(2)1B m12(6)1B m13(1)1B m15(4)1B1T m16(1) m17(4)1Bu m18(1)1Bu e30(1)1B e31(2)1B e32(3)2B e33(2)1B e36(1)	#1/2(4)3B #4(7) #5(1) #6(3) m8(1)1B m9(1) m10(3)2B m11(4)1B m12(16)4B m14(4)2B1T m15(1) m19(1)1B	#2(2)1B #3(7) #4(4)1B #5(8)2B #6(22)2B1Bu x7(19)4B m8(3)1B m9(10)2B m10(11) m11(2) m12(6)3B m13(7)3B m23(1) m25(1)	#4(1) #5(4) #6(1) m8(1)1B m10(3)1B m11(1) m12(3)1B1Bu 1T m13(2)1B1T
3S	m9(4)3B m10(1)1R	#4(1) #5(5)1B	#3(1)1Bu #4(16)2T	#3(1)1T1R #4(5)2B	#1(1) #2(3)2B	m8(6)1T m9(4)1B

		#6(1)1B x7(4) m8(6) m9(3)2B m10(2) m11(1) m14(1) m15(1) m17(1) m19(1) m22(1)1B x32(2)2B e35(3)2B	x7(3)2B m8(3)1B m9(7) m10(11) m12(3)1B m13(2)1B m14(2)1B m15(4) m16(2)1B m17(2)1B2T m18(3)1B >19(2)1Bu1T >20(2) >21(5)3B1T x22(2) e30A(1)1B e33(1)1B e35(5)	#5(12)2B2Bu1T #6(18)4B x7(13)1B1T m8(4)3B m10(5)1B1Bu1T m11(7)4B m12(2) m13(6)1B m14(3) m15(4)1B m16(3) m18(3)3B x24(1) x32(1)1B e35(1)1B	#3(15)3B #4(15)4B2T #5(4)2B #6(6)3B1C x7(1)1B1T m8(2) m9(2) m10(5) m11(2)1B m12(5)2B m13(1) m14(1) m15(1) m17(2)1B2T >20(1) >21(1) x22(1)	m10(3)1T1R m11(1)1B m12(7)3B m13(1) m14(2)1B1R m15(2)1B m16(5)1B1T1R m17(4)1B m18(1)1B
4S			#4(2)1B #5(3) #6(1) x7(3)1B m9(1) m10(5)1Bu m11(1) m12(4)1B1Bu m13(2)1Bu1T m14(2) m15(4)1B m17(4)1B >20(1)1B >21(1)1T x22(1)1B1Bu x26(1)	#1(1) #3(5) #4(1)2B1Bu #5(1)1T #6(13)1B x7(5) m8(9)2B m9(17)3B m10(4)3B1T m11(8)2B m12(4) m13(3)1B m14(2)1B1T m15(8) m16(3) m17(1) >19(5)3B >20(2)1B >21(7)1T1C x27(1)	#2(4)1C #3(4)2B #4(3) #5(15)6B #6(10)1B x7(6)1B m9(1) m10(2) m11(1)1B m14(2)2B m15(1)1B m17(2) m18(1)1B1T >20(2)1B >21(1) x22(2)	#1(1) #2(17)1Bu1T #3(1)1B #4(1)
5S					m8(1)1B m9(1) m10(1) m11(1) m12(1)1B	#2(1) #4(2)1B m8(2) m10(1) m11(1) m13(3)2B1T m14(2)
6S					#4(4)1B1Bu #5(6)1B #6(2)1B x7(1)1B	#1(1) #2(2) #3(9)3B1C #4((1) #6(1)1B
7S					#2(1)1B	m9(4)2B

Medium sized indeterminate mammal

Grid	A	B	C	D	E	F
3N		#1(1)				
2N			#3(3)			
1N			#6(1) m9(2)1B m25(1) e26(2)1B	#3(4)1B #5(1)1B		
1S		#5(1) m11(1) m16(1)	#6(1) m9(1) m11(1) m20(1)	#2(1) #5(2)	#2(1) #4(1) #5(3) #6(1)1B m8(2)1C	
2S		m11(2) m13(2)1Bu	#4(1)1B #6(2) x7(1)1B m9(1)	m8(2) m9(3) m12(1) m15(1)	#2(3)1B #3(4)1Bu #4(2) #5(5)	m13(1)

			m10(3) m16(4) m18(1)1T m20(1)1T		#6(1) x7(2)2B m8(2)2B	
3S		m21(1)	#4(5) x7(1)1B m9(4)2B m14(1)1B1Bu	#3(5)2B #4(2) #5(2)2B m11(1)1B m14(4)1B m16(1)	#3(4) #4(2)1B1Bu #5(2) #6(7)3B x7(1)1B1Bu1T m10(1) m13(1) m14(1) m16(1) x22(1)	#3(1) #4(1) m8(2)1B m9(1) m10(6)1B m11(1)1T m12(4)2B m13(1) m15(1)
4S			#6(2)1B m11(1) m13(1) m14(1) m15(1)1B m17(1)1B >21(3)	#6(2)1B x7(4) m8(1) m9(2)1B m10(6) >19(1)1B >21(3)1R1C	#5(3)1B1Bu x7(1) m10(2) m14(1)1B m18(1)1T	#1(1) #3(1)
5S					m14(1)	m13(1)1B
6S					#4(2)1B #5(1)1B #6(1)1B	
7S						#6(1)

***Cervus elaphus* (Elk)**

Grid	A	B	C	D	E	F
3N		#3(2) m8(1) m9(1) m11(1)				
2N		#3(1)1T	#2(2)1Bu #3(6) #4(1) #6(1) m13(1)1T	#6(1)		
1N		#6(1)	#6(1) m10(1)	#2(1)1B #3(1)1T x7(1) m14(1)1B		
1S		#3(1) #5(1) #6(1) m8/9(1) m16(1)1T	#4(1) m8(1) e30(3)	#1(7)1Bu #2(3) #3(1) #6(1) m13(1)1T		
2S	#2(1) #3(1)1C1R	m9(1) m13(2) m15(1)	#1(1) #5(1) #6(1) m12(1) m13(1) m15(1)	#3(1) #4(1) #5(1) #6(1) m8(1) m11(4) m12(1)1Bu m17(1)	#3(3) #5(2)1B1Bu #6(2) m8(1) m14(1)1Bu1T m15(1) m16(1)	m10(1)
3S	x7(1)	x7(1) m17(1) m19(1)	x7(1) m16(2)1B1T	#6(1) x7(6) m10(1) m11(1)1B m12(2)1Bu x33(1)1B e36(1)1B	#4(1)1T #5(1)1Bu #6(1) m10(3) m11(1) m12(1)	m8(1) m9(1) m12(1)1B m16(1)1T
4S			m8(1) m9(3)2Bu m10(1)1Bu1T m13(1) m18(1)	#3(2) #6(2) m8(2) m9(1) m10(3)1Bu1T1C m11(2) m12(2)1Bu	#6(1)1Bu1T x7(2) m12(1) m16(6)1Bu >19(1)	#2(1) #3(1)1Bu

				m14(1)1C m17(1) >19(1)1Bu		
5S					m14(1)	m10(1)1T m14(2)
6S						x7(1)1C m8(1)1T
7S						

Antelocapra americana **(antelope)**

Grid	A	B	C	D	E	F
3N						
2N			m16(2)			
1N			m17(1)			
1S		#4(1)				
2S						
3S				#5(1) m17(1)		
4S			m11(1)1Bu1C1R		x7(1)	
5S						
6S						
7S						

Canis latrans **(coyote)**

Grid	A	B	C	D	E	F
3N		#3(1)				
2N			#4(1) #6(1)1Bu1T			
1N			m12(1)	#2(1) #4(1) m10(1)		
1S	m12(1)	#4(1) x7(1) m15(1)	#4(1) #5(1) #6(1) x7(2) m14(1)1B m15(1)1Bu1T	#1(1) #6(1) m11(1)1B m18(1)	#1(1) #3(1)1Bu1T x7(1)1C	
2S		#4(3)1B x7(1) m14(1) m26(1)1B		#1/2(2) #3(2) #5(1) #6(3)2B m8(1)1Bu1T m9(1)	#3(1) m16(1)	m12(1)
3S		#5(1) m8(1)	#4(10) m18(2) e39(3)	#2(1) #3(2) #6(1) m9(1) m13(1)1Bu1T m16(2)	#2(1) #4(1) m11(1)1B m12(1)	m12(1)
4S			#6(1) x7(1)	#5(1) #6(4) m10(1) m13(3)	#4(3) #5(1) m8(1) m11(1)1B m14(1) m16(3)	
5S						#1(1)1Bu1T
6S					#3(1)	
7S						

Vulpes sp. **(fox)**

Grid	A	B	C	D	E	F
3N		#3(1) m12(1)				
2N			m11(1)			
1N		#3(1)	#5(1)	#5(1) m13(2)		
1S		#3(1)	#1(1) #4(1) x7(1)	#1(1) #3(1) m11(1)		

				m22(1)		
2S	m16(1)			#1/2(2) #3(1)1B #5(2)1B	#3(1) #5(2)	
3S	#5(1)1B	m15(1) m19(2)1T m27(1)	#6(1) m17(2)	m14(1) m15(1) m18(5) x24(1)1C	#2(1)	m8(1) m12(1) m17(2)1T1R
4S			x7(1) m14(1) >19(1) x26(3)	#3(2) #5(8) #6(3)1B x27(2)1Bu	#2(2)1B m11(1) m17(1) m18(1)	#1(2)
5S					x7(2)1T m8(1)	
6S						x7(1)
7S						

***Ursus americanus* (Black bear)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S						
2S						
3S				e34(1)		m17(1)
4S						
5S						
6S						
7S						

***Felis americanus* (mountain lion)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S						
2S						
3S						m12(1)
4S			m9(1)			
5S						
5S						
7S						

***Lynx rufus* (bobcat)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S						
2S			m13(1)			
3S						m8(1)
4S				#3(1)		
5S						
6S						
7S						

Indeterminate carnivore

Grid	A	B	C	D	E	F
3N						
2N			#3(1)			
1N						
1S				#3(1)	#4(1)	
2S		m26(1)1B	m19(1)1B		#6(1)	#6(1) m9(1)
3S			x7(1)1B m18(1)			m9(1)
4S				#6(1)	#3(1) #5(1)	
5S					#3(1)	

6S						
7S						

***Canis familiaris* (domestic dog)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S					#5(1)	
2S						
3S		#4(1)	m18(1)			
4S						
5S						
6S						
7S						

***Procyon lotor* (raccoon)**

Grid	A	B	C	D	E	F
3N			#4(1)			
2N						
1N			m22(1)			
1S		m12(1) m14(1)1B m15(1) m20(1)	#3(1)1B #5(1)	#2(2) #5(1)	#1(1) #4(1)	
2S				#6(1) x7(1)	#4(1) #5(1) x7(1) m10(1)	
3S		x7(1)	m14(1)1B m17(2)	m10(1) m13(1)	#3(1) #4(1)	m10(4)
4S			x7(1)	m17(1) m18(1)	m8(1) m12(1)	
5S						
6S						m8(1)
7S						

***Erethizon dorsatum* (porcupine)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S			e30(1)1B			
2S						
3S			e40(1)	>21(1)		m15(1)
4S			x26(1)		#4(1)	
5S					m13(1)	
6S						
7S						

***Marmota flaviventris* (marmot)**

Grid	A	B	C	D	E	F
3N						
2N			#3(1)			
1N						
1S						
2S		#5(1)	m16(1)1Bu	#1/2(1)		
3S						
4S				m10(1)		
5S						
6S						#1(1)
7S						

***Ondatra zibethica* (muskrat)**

Grid	A	B	C	D	E	F
3N			#1(1)			
2N						
1N				#5(1)		
1S						
2S						

3S				#6(1)		
4S						
5S						
6S						
7S						

***Scuiridae sp.* (squirrel)**

Grid	A	B	C	D	E	F
3N		m9(1)				
2N		m17(1)	#2(1) m9(1)			
1N			x7(1) m9(1) m12(1)	#1(6) #2(1) #3(2) #4(1) m9(1)		
1S		m14(1)	#4(1) #5(1) #6(1) m20(2)1B	#1(1) #5(1) m8(2) m9(1) m15(1)	#1(1) #5(2) x7(1)	
2S	#6(1)	#6(1) m12(1)	#4(1)	#4(1) #6(2) x7(3) m8(1) m10(1) m15(2)	#1(1) #4(1) #5(1) #6(1) x7(1) m8(1)	#6(1) x7(1) m12(1) m13(1)
3S			m18(1)	#6(2)* m17(1)	#2(2) #3(4) #4(1)	#1(1) m11(12) m12(3) m15(5) m16(1) m17(1)
4S			m9(1) m17(2) m18(5) >19(4) >20(2) <21(3) e38(1)	m9(1) m11(1)		#1(1) #4(1)
5S					m15(1)	
6S					#4(1)	#3(1) m8(1)
7S						

**Scuirirus aberti*

***Sylvilagus sp.* (rabbit)**

Grid	A	B	C	D	E	F
3N		#1(13) #2(5)1C #3(6) #4(9)2B #6(1)1B x7(6) m8(3) m9(3) m10(3) m11(2)1B m12(2) m14(1)	#1(15) #2(15)1B1Bu #3(11)1B #4(2) #5(1) #6(1)			
2N		#1(2) #2(7)1B #3(8)1B1Bu1T #4(10) x7(6)1B m8(8) m9(6)5B m10(4) m11(4) m12(3)	#1(7)1Bu1T #2(13)1B #3(20)2B3Bu3T1C #4(14)2B #5(6)1T #6(9)1B x7(3) m9(6) m10(3) m11(6)	#3(14) #4(5) #5(3)1T #6(1) x7(2)1B1T		

			m12(4)1B1C m13(1) m14(1)1B m16(2)			
1N	#1(1)1T	#2(2) #3(4)2T #4(8) #5(2)1B1Bu1T #6(7)1Bu1T x7(3)1B m9(6)2B m11(5) e29(1)1T	#1(3)1B1Bu1T #2(13)4B1Bu1T #3(10)1B #4(9) #5(5) #6(6)1B x7(6)3B m8(13)5B m9(14)4B m10(6)1B m11(3)2B m12(4) m13(4) m14(3) m17(1) m18(1) m19(1) m21(1) m23(1) e26/27(3)	#1(10) #2(21)8B #3(11)1T #4(4)2B1Bu1T #5(10)2B #6(10) x7(6)2B1T m9(2) m10(1) m14(1)1B		
1S	#1(1)1B #4(1)1T #5(1) x7(1)1B m10(2)1B m11(1)1C m14(1)	#3(2)1T #4(4)1B #5(1) #6(1) x7(7) m8/9(4) m10(4)1B m11(2)1B m12(5)2B m13(1)1Bu1T m14(7)1B1T m15(2)1B1Bu1T m17(2)1B m21(1) e27(1)	#1(3)1B #2(1)1Bu1T1R #3(9)1B #4(15)1T1C #5(9) #6(18)9B x7(7)2B1T m8(2)2B m10(11)4B m11(7)1B m12(4)1B1Bu1T m13(4)2B m14(5)1B m15(4)2B m16(10) m17(2)1B1Bu m18(3) m20(1) m21(2)1B m23(1) e29(2)2C e30(5)1B1T e32(1)	#1(13)2B1Bu1T #2(21)3B #3(6)4B2Bu2T #4(9)1C #5(8)1B2C #6(4) x7(5)1B m8(4)2B m9(6)2B m10(2) m12(7)3B m13(9)1C m15(4)1B m16(5) m17(3) m18(2) m19(1) m20(1) m23(1) m24(2) m25(1)	#1(4) #2(11)2B1C #3(17)4B2Bu1C #4(12)1B1Bu1T #5(16)3B3Bu3T #6(6)2B x7(17)3B m8(4) m9(4)2B	
2S	m9(2) m11(1) m13(2) m15(1)	#1(2) #3(1)1B #4(4)1B1T x7(3) m8(2) m9(7)1B m10(3) m11(12)1B m12(11)1Bu1T m13(2) m14(1) m15(6)1B m16(3) m17(1) m23(1) m25(1) m29(1)1B e32A/32(2) e33(3)1Bu1T	#1(2) #2(3) #3(11)1B #4(5)2B #5(14)1B1C #6(2)1T x7(8)1Bu1T1C m9(3) m10(6) m11(7)1T m12(10) m13(2)1B m14(7) m15(6)1B1Bu1T m16(4) m17(3) m18(3) m19(1) m20(2)1B1T e29(1)1B e30(2)1Bu1T e31(1)1C e32(2)1B1T	#1/2(21)10B1Bu1T #3(12)7B1C #4(9)2B2Bu2T #5(18)3B #6(14)4B1Bu1T x7(7)3B m8(6)1B m9(2)1B m10(6)1T m11(1) m12(1)1B m13(1) m14(2)1B m15(4) m16(3)2B m17(1)	#1(1)1B #2(16)5B1Bu2T #3(24)8B1T #4(28)7B1Bu #5(39)11B #6(16)6B x7(10)2B m8(13)2B m9(14)3B1Bu1T m10(6)4B m11(10)4B m12(12)4B m13(9)2B m14(9)4B m15(8)1B m16(1) m17(2) m18(5) m19(3) m20(2) m23(2) m28(2) m30(2)	#2(2) #4(4)2B1Bu1T #5(8) #6(1) x7(5) m8(6)3B1Bu1T m9(8)3B m10(9) m12(6)1B m13(3)

			e33(2)1B1Bu1T				
3S	#1(1) x7(2) m10(1) m11(3) m12(3)1Bu1T	#1/2(2) #3(1) #4(1) #5(5)2B1Bu1T #6(8)1B x7(4)1B m8(3) m9(12)5B m10(2) m11(3)2B m12(2) m13(2) m14(3)2B m15(2) m16(7)2B m17(3)1B m19(2) m20(2) m23(2)1C m26(1) m27(1) m31(1) m33(1)1B	#3(1) #4(7) #5(16) #6(9)5B x7(3) m8(11)2B1T m9(4)2B m10(4)1B m11(6) m12(5)1T m13(1) m14(2)1Bu2T m15(11)4B m16(2)1B m17(4)2B m18(3) >19(6)1B >20(6)3B >21(2) x22(5)1B x23(2) x25(3) x26(2)1B x27(1) x28(1) e35(1) e36(1)	#1(2) #3(11)4B1C #4(9)1R #5(18)3B1Bu2T #6(20)5B2Bu2T x7(21)5B m8(17)8B m9(5)1Bu1T m10(8)4B m11(12)4B m12(12)4B m14(1) m15(5)3B1Bu1T m16(6)2B m17(14)1B m18(2)1B >19(2)1B >20(4)3B >21(2) x23(1) x24(4)2B x25(1) x28(2) e35(1)1B e39(1)1Bu1T	#1(2) #2(7)2B #3(25)1B2Bu2T #4(53)12B1T #5(34)13B #6(46)17B1Bu1T x7(24)13B m8(7)4B m9(26)12B1Bu1T m10(7) m11(5)1B m12(4) m13(5)2B m14(5)2B m15(4)1B m16(1) m17(4)1B m18(3)1B >19(2) >21(1) x23(1)	#1(3) #2(11) #3(11)3B #4(14)5B #5(8)3B #6(3) x7(5) m8(15)4B1Bu1T m9(18)1B m10(23)1B1C m11(17)3B m12(16)2B1T1C1R m13(1) m14(20)1B m15(10) m16(14)4B m17(9)2B m18(5)2B
4S			#4(2)1B #5(3)1B #6(6)1B x7(4) m8(5) m9(11)1B m10(4) m11(13)3B m12(12)2B9C m13(4)2Bu1T m14(10)1B m15(2) m16(8)1B m17(3)1B m18(5)2B >19(21)4B1Bu2T >20(5)1B >21(7) x22(2) x26(1)1B	#1/2(2)1B1Bu1T #3(11)2B #4(12)2B1Bu2T #5(15)3B #6(14)2B1Bu1T x7(14)4B1Bu m8(12)1B1Bu1T m9(18)4B m10(10)3B1Bu1T m11(2) m12(9)1Bu1T m13(4)2B1Bu m14(8)3B m15(3) m16(1) m17(7)1B m18(8)1T >19(12)3B1Bu2T >20(8) >21(6)3B x22(1) x23(2) x24(4) x26(1) x31(1) e38(1) e40(4)1Bu1T	#2(4) #3(22)2B1Bu1T #4(32)7B1Bu1T #5(22)6B1T #6(8)1B x7(17)5B m8(7)2B m9(5) m10(6)4B m11(9)4B m12(9)2B1Bu2T m13(5)3B m14(11)2B m15(1) m16(7)3B m17(3)1B m18(5)2B >19(1) >20(6)1B >21(4) x22(4)4B	#1(3) #2(3)1B #3(3)2Bu2T #4(15)8B #5(17)2B
5S					#2(1) #3(3) #4(3) #5(4)1B #6(2) x7(2) m8(9)1Bu1T m10(2)1B1Bu1T m11(7)2B m12(6)1B1T m14(3) m15(8)	#1(1) #2(5) #3(1) #4(12)3B #5(7) #6(8)1B1Bu1T x7(7) m8(10)3B m9(10)3B m10(4) m11(7)1B m13(12)1B m14(8)1B m15(4)1B

						m16(7)1B m17(3)
6S					#2(7)1B #3(1) #4(6)1B #5(2) #6(1) x7(1) m8(1)	#1(7)3B1Bu1T #2(2) #3(5) #4(2)1B1C #5(1) #6(6) x7(5) m8(7)3B
7S					#6(1)	#6(1) x7(1) m8(1) m9(1)

***Lepus californicus* (jack rabbit)**

Grid	A	B	C	D	E	F
3N						
2N		m9(1)	#2(1) #3(1) #4(1) m16(1)1B			
1N		#6(1)	#6(1) m12(1) e26/27(1)1C			
1S			#3(2) #6(1) m11(1) m12(1) m19(1)	#2(1) m15(1) m23(1)		
2S		#6(1)1B m13(1)1B m14(2)	#6(1) m18(2) m27(1) e33(1)1B	#1/2(1) #4(1) #5(1) #6(1) m8(1) m17(1)	#2(1) #3(1) #5(1) #6(1) m8(1) m10(2) m15(1) m17(4) m19(1) m20(1) m29(1)	m8(1)
3S		m15(1) m21(1)	m8(1) m16(1) m18(1) >19(2)	#6(1) x7(1) m8(1) m10(1) x24(1)	#3(2) #4(2)1C #6(1) m11(1)	x7(1) m8(2) m12(2)1C m14(1)1B m15(2) m17(2)
4S			m17(1) m18(1)	#5(2) #6(2) x7(1) m10(2)1Bu1T m12(1)	m8(1) m9(1) m12(1) m18(1)	#2(1)
5S					#6(1)	#4(1)
6S						#4(1)1C #6(1)
7S						m9(1)

***Cynomys ludovicianus* (prairie dog)**

Grid	A	B	C	D	E	F
3N		#3(1) #4(1) m13(1)				
2N		#5(1) m10(1) m12(1)	#4(1) m8(1) m11(1)			
1N		#3(1) #4(1) m8(1) m9(1) m12(2)	#2(1) #3(1) x7(1) m9(2) m10(2)	#1(3) #2(1) #3(1) #6(1) x7(1)		

		m18(2)	m11(1) e26/27(3)	m9(1)		
1S	m9(1)	m8/9(1) m14(2)	#3(1) #4(1) #5(1) #6(2) m10(1) m11(2) m15(2)	#1(1) #6(2) m12(3) m16(1) m19(1) m24(1) e28(1)	#3(1) #4(2) #6(1) m8(1) m9(2)	
2S		#4(1) #6(1) m8(1) m22(1)	x7(1) m9(1) m10(1) m12(1) m18(1) e30(1)	#3(1) #4(1) #5(1) x7(1) m10(1)1B m12(1) m16(1)	#2(3) #4(7) #5(6)2B m8(2) m10(1) m11(1)1B m12(4) m13(1) m14(1) m15(2) m22(1) m26(1)	#1(1) x7(1) m9(1) m10(3)
3S		#1/2(5) #3(1) #4(2) m17(1)	#6(1) m12(1) >19(2) >20(1)	#3(1) #6(1) x7(6) m10(2) m13(1) m16(1) >21(1) x28(1)	#1(1) #3(1) #4(1) #5(1) #6(1) m8(2) m10(1) m12(2)	#2(1) #3(3) #4(1) #6(1) m10(1) m12(2) m13(2) m14(1) m17(2)
4S			#2(1) m11(1) m13(1) m15(2) m16(2) m17(4) m18(1)1B >19(41) >20(1)	#1/2(2) #3(1) #5(1)1B m9(1) m12(2) m16(2) m17(1) >20(1) x24(1)	#4(1) #5(2) #6(3)1B x7(4) m8(1) m9(1) m11(2) m12(2) m14(1) m16(1) m17(2) m18(1) >19(1)	#3(1) #4(6) #5(2)
5S					#6(4) m12(2)	#1(1) #6(1) m12(2) m13(2) m14(1) m15(2)
6S						
7S						

***Mephitis mephitis* (skunk)**

Grid	A	B	C	D	E	F
3N						
2N						
1N			m8(1)			
1S						
2S			m16(1)		#6(1)	
3S	m8(1)				#5(1)	m12(1)
4S						
5S						
6S					m8(1)	
7S						

***Mustela frenata* (weasel)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						

1S						
2S						
3S						m10(1)
4S						#2(1)
5S						
6S						
7S						

***Taxidae taxus* (Badger)**

Grid	A	B	C	D	E	F
3N						
2N						
1N				#4(1)		
1S						
2S						
3S						
4S				m8(1)		
5S						
6S						
7S						

Turtle

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S				#4(1)		
2S		#6(1)			x7(1)	
3S				m10(2)1T	#5(2) m13(1)1B1T m17(1)1T	
4S					m16 (1)	
5S					m11(2)	
6S						
7S						

Indeterminate large Aves

Grid	A	B	C	D	E	F
3N						
2N						
1N				#3(1)		
1S			m13(1)	m9(1)		
2S						
3S					#5(1) m11(1)1Bu1T	
4S				x7(1)1Bu1T m8(1)		
5S						
6S						
7S						

Indeterminate Aves (ib) and indeterminate medium Aves (im)

Grid	A	B	C	D	E	F
3N						
2N				#5 ib(1)1T		
1N						
1S			#3 ib(1)1T #4 ib(1)1T m9 im (1) e33 ib(1)1T	#2 ib(1)1T #3 ib(1)1T #4 ib(1)1T #5ib(1)1T m10 ib(1)1T m14 ib(1)1T		
2S			m17 ib(1)1T m18 im(1)1T		#6 ib(1)1T	
3S					m8 ib(1)1T m9 ib(1)1T	m11 ib(2)2T
4S			x7 im (1) m10 ib (1)1Bu1T			

5S						
6S						
7S						

***Aquila chrysactos* (golden eagle)**

Grid	A	B	C	D	E	F
3N						
2N						
1N			m23(1)1Bu1T			
1S						
2S					#4(1)1Bu1T	
3S				x28(2)		
4S				#6(1)	m15(1)	
5S					m8(1)	
6S						
7S						

***Cathartes aura* (turkey vulture)**

Grid	A	B	C	D	E	F
3N						
2N						
1N		#4(1)				
1S						
2S						
3S		#5(1)				
4S						
5S						
6S						
7S						

***Meleagris gallopavo* (turkey)**

Grid	A	B	C	D	E	F
3N						
2N			#6(2)			
1N			#2(1)			
1S			#3(1)			
2S						
3S			#5(1)			
4S				>21(1)		
5S						
6S						
7S						

***Bubo sp.* (owl)**

Grid	A	B	C	D	E	F
3N		#5(2)				
2N		#2(2) m9(1)	#3(1) m11(2)			
1N			x7(1) m8(1) e26/27(1)			
1S		m20(2)		#2(1)		
2S			#3(2)	#3(2)1B #6(1)1B1Bu1T x7(1)	m13(1) m14(1)	
3S		x7(1)1B		#4(1)	#4(2) #5(1)	#6(1) x7(1) m8(1) m10(4)
4S			x7(1) m8(3) m16(1)			
5S						
6S						
7S						

***Galliform sp.* (grouse, prairie chicken)**

Grid	A	B	C	D	E	F
3N						

2N						
1N			m19(1)			
1S						
2S					m9(1)	
3S				#4(1) x28(1)		
4S					x7(20)	
5S						
6S					#1(1)	
7S						

***Buteo sp.* (hawks, falcon)**

Grid	A	B	C	D	E	F
3N						
2N			#3(1)			
1N			#6(1) m10(1)			
1S			e30(1)	m12(3)		
2S			e27(1)		#5(1)1B	
3S		m19(1)				
4S						#4(1)
5S						#5(1)
6S					#1(1)	
7S						

***Larus sp.* (gull)**

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S						
2S				#4(1)		
3S						
4S						
5S						
6S						
7S						

***Corvus sp.* (crow, raven)**

Grid	A	B	C	D	E	F
3N						
2N		m11(1)	#1(1) m10(1)			
1N			#2(1) m8(1) m11(4)	#4(1)		
1S		#5(1)		#3(1) m13(1)	m9(1)	
2S		m22(1)		#4(1) m14(1) m18(2) m19(1)	#5(1)	
3S				m10(1)	#2(1)	#5(1)
4S				#6(4) m16(1)		
5S					m8(1)	
6S						
7S						

***Zanaida macroura* (dove)**

Grid	A	B	C	D	E	F
3N			#5(1)			
2N						
1N						
1S						
2S				m8(1)	#4(1)	
3S					#3(1)	
4S						
5S						m16(1)
6S						

7S						

***Anas sp.* (Duck)**

Grid	A	B	C	D	E	F
3N			#2(1)			
2N			#2(1) #3(1)			
1N			#2(1) m8(1) m11(1)			
1S 1S			#1(1) #3(1)	#3(1) #5(1)		
2S				#6(2)	#6(1)	
3S		m20(1)	#6(4)		#4(1)	x7(1) m10(1) m13(1)1B m16(1)
4S				m16(1)1B	m8(1)	
5S					#2(2) #3(1)	#2(1) #4(1)
6S						m8(1)
7S						

***Columba sp.* (pigeon)**

Grid	A	B	C	D	E	F
3N						
2N				#3(1)		
1N			#3(1)	#1(1) #5(1)		
1S		m16(1)	#3(1)	#1(1)		
2S				#4(1)		
3S						
4S						
5S						
6S						#6(1)
7S						

***Branta canadensis* (goose)**

Grid	A	B	C	D	E	F
3N			#3(1)			
2N						
1N						
1S						
2S						
3S						
4S						
5S						
6S						
7S						

Explanation of deer bone from Swallow Site (5JF321)

As in the other tables the first symbol stands for the time periods in the site so that # = Early Ceramic period. x = the transition time between the Early Ceramic and Middle and Late Archaic as well as fill, m = Middle and Late Archaic, > = Upper Early Archaic and e = Lower Early Archaic. The number following the symbol represents the level followed by the number of bones in the group discussed in ( ). The following number and symbols indicates B=the number of burned bone, Bu = number of butchered bone, T = number of tools, C = number of carnivore chewed, R = the number of rodent gnawed, L = left, r = right, [ ] shows the age in years. Molars and premolars are listed separately and identified as 1, 2, 3 for upper teeth and 1, 2, 3 for lower teeth. The unknown age of a tooth is shown by ? or by 1/2/3? for upper or lower or unknown tooth.

Petrous and bulla

Grid	A	B	C	D	E	F
3N						
2N			#1(1) #2(2) #4(4)2B #5(1)			
1N		#6(2)1B1r m15(1) m19(1)	#5(1) m20(1)			
1S		m13(1) m14(1)	#3(1) x7(1)1B m10(1)	#1(1) #2(2)1B #4(2) #6(1)1B1r m12(1) m13(1) m14(1)1B m15(1)1B m21(1) m23(1)1B	#2(1) x7(1)1B	
2S	m16(1)	#4(1(1B #5(2) m10(1) m12(1)	#2(3) #3(1) #6(2)1B m10(2) m17(1)	#3(1) #5(1) m10(1)	#4(1) #5(1)	m12(1)1L
3S		#3(1) m8(1) m9(2) m17(1) m20(1) m22(1) m23(1)1B	#4(1)1B #6(1) m13(2) m16(2) e33(1) e34(1)	#3(3)1B #4(1) #5(1)1r #6(2) m8(2) m9(1)1L m16(4)3B1r m18(2)1B x28(1)1B x33(1)1L	#3(2) #4(1) #6(3)1B1r m8(1)	x7(1) m12(1) m16(2) m17(4)1B
4S			#6(2) m9(1) m10(2)2B m11(1) m14(1) m17(1) x22(1)	#5(1) x7(1) m13(1)1r m17(1)1B x24(1)	#2(2) #3(1) #4(1) #5(3)1B m12(1) m13(1) >20(1)1B	#5(1)
5S					#3(1) m10(1)	#2(3) #6(2)1r x7(1) m14(1)
6S					#3(1) #4(1) #6(1)1B	#4(1)
7S						m9(1)

Skull

Grid	A	B	C	D	E	F
3N		#2(5) #3(1) #4(1) #5(1)	#3(8) #4(3)3B			

		#6(1)1B x7(1) m8(2) m10(1) m12(1) m13(2)				
2N	#2(1)	#4(2) #5(1) #6(7)1B m8(2)	#1(5)3B #2(7)4B #3(13(4B #4(6)1B #6(4) x7(2) m11(2) m13(1)	#5(3) x7(1)		
1N		#4(3) #6(2)1B m8(1) m10(1) m12(1)	#1(1) #2(15)11B #3(10)2B #4(11) #5(2) #6(2) x7(6) m8(5)1B m9(12)3B m10(5)1B m11(1)1B m12(1) m18(4)2B m19(3) m20(1)1B	#2(8)3B #3(1)1B #4(1)		
1S	#6(2) m15(2)	#6(1) m8/9(2) m10(2) m11(1) m12(4)1B m13(1) m14(4) m15(7) m17(1)	#3(2) #5(3)1B 6(7)2B x7(3) m10(3) m11(2) m12(6) m14(6) m15(6) m16(3) m18(5) m19(1) m20(3) m23(1)1B e30(2)	#1(4) #2(12) #3(6) #4(3) #5(1) #6(3)1B m9(1) m14(1)1B m16(1) m17(3) m18(2) m26(1) m27(1)	#1(1) #2(7) #4(5) #5(6) #6(8) x7(2) m8(4)1B	
2S	#5(2)1B x7(2)1B m8(1) m14(1) m17(2)1B	#3(2)2B #4(2) #5(5)2B m10(2) m11(6) m12(2) m13(5)1B m14(1) m15(1) m16(1)1B m17(1) m22(3) m23(1)	#1(1) #2(10) #3(14) #4(3) #5(4) #6(5) x7(5)2B m8(5)2B m9(1)1B m10(2) m11(4) m13(3)1B m14(6) m15(7)2B m17(1) m19(1) m20(4) m26(1) e33(2)	#1/2(6) #3(9) #4(1) #5(22)2B #6(21)2B m8(6) m10(3) m11(1) m12(1) m15(6) m16(3) m17(3)	#2(8)1B #3(4)1B #4(17)3B #5(25)5B #6(26)3B x7(7) m10(5) m12(1) m14(1) m16(1) m17(2) m19(2) m20(1)1B m24(1)	#6(2) x7(2) m9(1) m10(1) m13(5)

3S	#3(1)1B m8(3) m9(2) m11(1)	#4(2) x7(4) m9(3)1B m10(5)4B m11(4)1B m12(1) m13(1) m15(8) m16(3) m17(1)1B m18(1) m22(1) m23(1)	#5(6) #6(1) x7(1) m8(1) m15(4) m16(7) m18(3)	#3(2) #4(8) #5(14)2B #6(9)5B x7(5) m8(6) m9(6) m10(8) m11(7) m12(4) m13(8) m14(1)1B m15(3)1B m16(9) m17(4) m18(15) >19(6) >21(1) x24(1) x31(1) x32(2)2B	#2(4) #3(10)3B #4(9)1B #5(4) #6(17)5B x7(8)3B m8(1) m9(2) m10(7)1B m12(2) m13(4)1B1T1Bu >21(1)	#2(2) #3(4) #5(1) m8(8) m10(1) m11(5)1B m12(3) m14(1) m15(3) m16(13)9B m17(3)1B m18(2)1B
4S			#3(2) #5(7) #6(1) x7(8)1B m9(9)1B m10(7)2B 11(2) m12(5)2B m13(20)5B1Bu m14(8) m15(15)3B m16(1)1B m17(9)5B >19(6)3B >20(2)2B >21(5) x22(5) x24(2) x26(1) x31(1)	#3(11)1B #4(10) #5(17)9B #6(10)3B x7(12)2B m8(7) m9(2)1B m10(4)1B m11(6) m12(8)3B m13(9) m14(7) m15(1) m16(1) m17(8) >19(2)1B >21(1) x22(7)1B x24(4) x27(1) x28(1)	#2(3) #3(2) #4(5) #5(16)3B #6(15)1B x7(1) m8(12)2B m9(6) m10(2) m11(21)1B m12(3) m16(2) m17(2) m18(1) >19(1) >20(1) x22(2)	#1(1) #3(2) #4(10) #5(8)
5S					#4(1) #5(2) #6(1) x7(1) m8(3) m10(1) m12(1)	#2(1) #4(5)1B #5(1)1B #6(10) m8(5)1B m11(2)1B m12(4)3B m14(2) m13(1) m14(2) m15(2) m16(4)
6S					#1(1) #2(2) #4(5) #5(1)	#3(1) #4(1) m8(3)
7S					#6(1)	m9(1)

Undifferentiated tooth fragments

Grid	A	B	C	D	E	F
3N		#2(1) #4(1) #6(1) m9(3) m11(1) m12(1)	#3(2)			
2N		#3(2)	#2(2)	#4(1)		

2N		#4(1) #5(6) #6(3) x7(4) m9(2) m10(4) m12(2) m14(1)	#3(4) #4(7) #5(7) #6(3) m8(1) m9(2)1B m11(4) m13(1) m15(1)	#5(2)1T		
1N	#1(1)1T	#2(1) #4(6) #5(5) #6(4) x7(3) m8(1) m9(1) m10(2) m12(1) m15(3) m16(1)	#1(4) #2(6) #3(2) #4(1) #5(3) #6(7) x7(1) m8(5) m9(8) m10(2) m11(8)2B m12(1) m14(2) m18(1) e28(1)	#2(5) #3(3) #4(4) #5(1) #6(5) x7(4) m8(1) m9(1) m10(1) e29(1)		
1S	#5(1) x7(1) m9(11) m11(1) m12(5)	#3(6) #4(2) #5(5) #6(4) x7(2) m8/9(2) m10(9) m11(3) m12(1) m14(3) m15(1) m17(1) e27A(1)	#1/2(1) #3(12) #5(2) #6(6) x7(1) m10(9)2B m11(3)1B m12(3) m14(2) m15(3) m17(2)1B m18(2) m19(3) m20(1) m22(1) m23(4)	#2(5)1T #4(2) #5(7) #6(2)1Bu x7(2) m8(5) m9(2) m11(1)1B m14(1) m16(1) m17(1) m18(4) m21(1)1B	#2(3) #3(3) #4(4) #5(38) #6(2) x7(7)	
2S	#2(1) #4(1) m9(1) m11(5) m13(4) m14(3) m15(1)	#2(3) #3(8) #4(5) #5(3) #6(8) x7(3) m8(5) m9(1) m10(3) m11(6) m12(4) m13(2)1T m14(5) m22(1) m32(1)	#2(5) #3(3) #4(4) #5(2) x7(2) m8(4) m9(1) m10(3) m11(3) m12(6) m13(2)2B m14(1) m15(6) m18(1) m19(1) m20(5) m21(1) e30(1)	#1/2(10) #3(2) #4(3) #5(3) #6(4) m8(2) m9(2) m10(3) m11(3) m12(2) m13(1) m15(1) m16(2) m17(1)	#1(1) #2(3) #3(6) #4(7) #5(7) #6(6) x7(4) m8(4) m9(1) m10(1) m11(3) m12(2) m13(2) m14(7) m15(2) m16(4) m17(1) m18(1) m19(1) m22(1) m24(1) m28(1)	#6(1) x7(1) m8(1) m9(1)
3S	#4(1) #6(1) m9(1) m10(1) m11(1)	#3/4(1) #4(4) #5(2)1B #6(7) m8(4) m9(2) m10(2) m11(6)	#3(2) #4(3) #5(25)1B #6(6) x7(2) m8(4) m9(11) m10(6)1B	#2(1) #3(1) #4(5) #5(2) #6(9) x7(4) m8(5) m9(10)	#1(4) #3(5) #4(12) #5(5) #6(5) x7(6) m8(3) m9(4)1B	#3(2) #5(2) #6(1) m8(4) m9(2) m10(6) m12(14)3B m14(3)

		m12(2) m13(7) m14(5) m15(9) m16(6) m17(16) m18(1) m19(3) m20(3) m23(2) m32(1)	m11(6)1B m12(9) m13(3) m14(3)1B m15(2) m16(10) m17(6) m18(12)1B >19(3) >20(1)1T >21(1) x22(1) x23(1) e34(1)	m10(4) m11(9) m12(1) m13(4) m14(2) m15(1) m16(7) m17(1) m18(1) >19(1) >21(2) x27(1) x29(1)	m10(1) m11(3) m13(1) m15(5) m16(2) m17(2) m18(2)1B >19(1)	m15(9) m16(12) m17(6) m18(1)
4S			#3(2) #5(1) #6(5) x7(2) m8(3)1B m9(5) m10(1) m11(5) m12(4) m13(6) m14(2) m15(6) m16(2) m17(9) m18(10) >19(10) >20(3) x22(1) x26(3) x30(6) x31(1) e40(1)	#3(1)1B #4(5) #5(8) #6(15) x7(6) m8(5) m9(6) m10(18) m11(4) m12(2) m13(9) m14(5) m17(2) >21(9) x22(3) x24(2) x25(4) x26(6) x27(4) x29(2)1B x36(4) e39(3)	#2(1) #3(3) #4(5) #5(11) #6(2) x7(2) m8(3) m9(6) m10(5) m11(9)1[-2yr] m12(4) m13(5) m14(6) m16(4) m17(3) m18(5) >19(2) >20(3) >21(1)	#1(1) #2(7) #3(3) #5(1)
5S				#3(1)	#3(1) #5(3) #6(2) x7(2) m8(1) m10(1) m11(1) m12(3) m14(2) m15(4)	#2(1) #4(4) #5(13) m8(4) m9(3) m10(2) m11(1) m12(1) m13(11)1B m14(7) m15(3) m16(2) m17(1)
6S					#2(1) #4(8) #5(2)	#1(1) #3(2) #4(4) #6(7) x7(1) m8(4)
7S					#6(1)	#6(2) m9(2) m10(1)

Incisors

Grid	A	B	C	D	E	F
3N		#5(1)1[1.5+]				
2N		#4(1)	#5(1)1[5+] x7(2)1[1.5]			
1N			#5(2)1[5+] m9(1)1[1+]	#3(3)		
1S		#3(1)1[1.5+] #5(1) #6(1)1[1.5+]	e29(1)1[5+]	e29(1)1[1.5+]	#3(1)1[-1] #4(1)1[1.5+] x7(1)1[1.5+] m8(3)1[1.5+]	

					&1[-1]	
2S		#4(1)1[1.5+] m12(1) m13(1)1[1.5+] m14(1)1[1.5+]	#4(1)1[1.5] x7(1)1[1.5] m11(1)1[1.5] m24(1)1[1.5]	#1/2(1)1 root m8(1)1[1.5+] m9(1)1[1.5+] m11(1)1[1.5+] m15(1)1[1.5+] m19(1)[1.5+]	m8(1)[1] m10(1)1[1.5+]	#6(1)1[1+] x7(1)1[1.5+] m10(1)1[12+]
3S		#5(1)1[1.5+] x7(1) m16(1)	m8(1)1[1.5] m15(1)1[1.5+] >20(1)1[1.5+]	x7(1)1[1.5] m10(1)1[0.5] m16(1) >20(1)1[1.5+]	#4(1)1[1.5+] #6(1)1[1.5+] m15(1)1[1.5+] m18(1)1[1.50	#5(1)1[1.5+] x7(1)1[1.5+] m10(1) m11(1)1[1.5+] m14(1)1[1+] m16(1)1[1.5+]
4S			#6(1)1[1.5] m11(1)1[1.5+] m12(1)1[1.5] m13(1)1[1.5+] m14(1)1[1.5] .>20(3)1[1.5+] >21(1)1[1.5+] x26(1)	#3(1)1[1.5+] #5(1)1[1.5+] #6(2)1[1.5+] m11(1)1[1.5+]1T m12(1)1[1.5+] m14(1)1[1.5] m15(1)1[1.5] m16(1)1[1.5]	#5(1)1[1] x7(1)1[1.5+] m8(1)1[1.5] m11(1)1[1.5]	#4(1)1[1.5] #5(1)1[1.5]
5S					#5(1)1[1.5+] m15(1)1[1.5+]	#5(1)1[1.5]1B x7(1)1[1.5] m8(1)1[1.5] m9(1)1[1.5]
6S					#4(1)1[1.5+]	
7S						

Mandible and Maxilla =max

Grid	A	B	C	D	E	F
3N		#2(1)L max #3(1)	#5(1)1r teeth			
2N		#2(2)	#2(1)r1 teeth m9(2)1L teeth	#4(1) #5(1)		
1N		#6(1)1L teeth m8(1)1r teeth m9(1)1r teeth m11(1)1L1B	#3(1) m10(1)max m12(2)1B teeth m13(1)1r teeth	x7(1)		
1S		#5(1) m11(2)max m12(2)	#2(1)1L #6(1)1L	m12(1) m14(1) m22(1)	#2(1)1T #3(1) #5(1)1r m8(1)1L	
2S	m8(1) m11(1)teeth m16(1)	#5(1) teeth (1)max x7(2) m8(1)r teeth m11(3)1B m15(1) m23(1) x34(1)1B	#2(1) #5(3)1Bu1L1teeth m10(1) m11(1) (1)max r teeth m14(1)1L (1)max L	#1/2(1) #3(3) #4(1)1L #5(1)1L m8(1) m15(1)	x7(1)r m9(1)1L m12(1)1B m16(1)1L m26(1)	#4(1)1r teeth x7(1)max teerh m9(1)1B
3S		m13(1) m17(2) m20(1)	#4(1) #6(2)1r&1L teeth (1)max L x7(1) m10(3) m15(1) m17(1)1r1Bu teeth (1)max L teeth m18(1)max r teeth e33(1)	x7(2)max L teeth m9(2)max L m11(1)1L m15(1)1L m17(1)max L teeth	#3(2)1r1B #4(8)1L #6(1) x7(1) m9(1) >20(1)1T	#5(1) x7(1) m12(1)1B m15(1) m16(3)1L1r1B m17(1) teeth
4S			x7(1) +(1)max L teeth m8((1) +(1)max L teeth m14(2) >20(1)1L >21(2)1B (1)max	#4(1)1r #5(1)r (1)max L m14(3)1L m16(1)1B m18(2)2r >19(1)1r x22(4) x26(2)	#3(1) #4(1) #6(1) m9(1)1L m15(1) m17(1)1r m18(1) x22(1)	#5(1)

5S						#2(1) #4(1) #5(1)max teeth #6(1) m12(1) m13(2) m15(1)1r teeth
6S					#4(1)1B	m8(2)1r
7S						

Molars 1, 2, 3

Grid	A	B	C	D	E	F
3N		#2L1[3-7] m8L2[1..5+]				
2N		m10L3[2.5+] m12r3[2.5]	#2r1,2[1..5-3]B #6r2[2.5-3.5] m9L2[1.5]			
1N		#6L?1[5.5-6] m8r?2[7-] m9r23[5-]	#2L?[?] m9r1[7-8] m10L23[3] m13r23[2.5+] m16r2[3-4]	m8L1[1+] m9r1[1+]		
1S			#1r1[1] #6L?[?] m14L2[1..5+] r2[1..5]		#5r12[3-7]	
2S	m10? m11?2 m14r2[1.5+]	#5L123[2.5+] m8r12[1.5+] m13[1-3]	#5L12[2.5+] m11r123[2..5+] m14?1[?] m21P/M?D[1-]*	m9r2[1.5+]	m8L3[2.5] m13r1[1+]	#5r12[2.5+] x7r123[2.5]
3S		m10 3[2.5+]B m16r3[2.5+]	#5r3[2..5+] #6r3[2.5+] L123[2.5+] m13L1[5+] m17L12[1.5+]Bu r3[2.5+]Bu m18r12[2.5+]	#5?3[2.5+] x7L12[2.5-3] L1[2.5-3] m15L123[8+] m17L2[1.5+]	#3?2[2.5]	m12 1L[3-7]+ (2)r1+1[3-7] m16L2[1.5+] m17?123[8]
4S			#6r1[7+] m8r1[7] L123[3] m13r2[3-5] m18r2[4.5] >20L1[1-3]	#4?1[8+] r123[2.5+] #5r2[1.5] m8L2[1.5] m14r1[1] L1[1+] m15L1[5+] r12[1-1.5] r1[?] m16L2[2.5+] r1[1+] m18(2)r1[2.5+] x26(2)L[5]	#1L3[2.5+] #3L3[2.5+] #5r1[3-] #6r1[3.5+] m17L1[2.5]	#4L1[5+]
5S						#3L1[7+] #5L12[2.5-3] m10L1[1-1.5]
6S					#3L1[3.5] #6r1[2-2.5]	x7r1[1]
7S					#4L1[3+]	

*****P/M?/D =1 deciduous tooth unknown side and tooth type

Premolars 1,2,3,4

Grid	A	B	C	D	E	F
3N		#2L234[3-7] L2[2.5+] #3?4[2.5+] #44[2.5+]	#5r2[2.5+]			
2N						
1N		#6L34[5.5-6] m8r1[7-] m9?34[5-]	m9r2[2.5]			
1S	x7?[2.5+]	#5L2[2.5] L4[2.5]	#3r4[2.5+] #5L3[2.5+]			

		m11r2[2.5]				
2S	m11?2[1-2.5]	#5L3[2.5+]	#5L4[2.5] m14[?] e32 L3[1]		#1?D[1-]* #5L3[2.5-3] m9L23[2.5+]	#5r234[2.5+] r2[2.5+] m13r3[3-7]
3S		m17L2[1.5+] m19L2[2.5+]	#6r3[2.5+] r2[2.5+] ?34[?] m10?2[3-7] m17?2[2.5] m18r4[2.5] >21L23[2.5]	#3L2[2+] x7L4[3-4] L234[2.5-3] m11L2[2.5] ?4[2.5+] L234[2.5] m13r4[2.5] m15L234[8] m18L4[2.5+] x25L2[2.5+]	#5L2[2.5] D[1-]* m11r3[2.5+] m12r2[3+] m17?3[2.5]	m10r2[2.5] m11 1r+lL3 [2.5+] m15r2[7] m16?4[2.5] m17?4[8+]
4S			#4r4[2.5+] x7L23[2.5+] ?4[2.5+] m8L234[3] m9r4[2.5] m10r3[2.5] >19r3[8+] x23? x26r2[5.5]	#5L2[2.5+] x7r4D[2.5+] m10L2D[1-] m15r2[2.5] L3[2.5] m16L4[2.5+] m18L23[2.5] >21L3[2.5] L3[2.5+] x22L2[1-]D L3D[1-] x22L2[3.5] x23r34[3.5]		
5S					#4L3[2.5] m13?2[2.5]	#3?2[2.5] m10?2[2.5] m15r34[2.5+]
6S					#3L4[3.5] #5r2[2-3.5]	
7S						

*D= deciduous tooth

Antler

Grid	A	B	C	D	E	F
3N						
2N		m10(1)	#6(1)1B			
1N		#5(2)	#2(1)1B	#3(1)1T		
1S	m12(1)1B	#4(2) x7(1) m17(1)1B	#3(1)	#1(1)	x7(2)2B	
2S		#3(1)1T #4(1)1B m11(1)	#4(1) e33(1)		#2(4)4B m22(1)1B	
3S		#1/2(1) m15(1)	x7(1)	x7(5)1T1C	m8(1) m12(1)1B	m10(1)1B
4S			m12(1) m16(1)	m10(2) >19(1)	#4(1) x7(1)	#3(9)
5S				#3(2)		
6S					#4(1)	#3(1)1B1T #4(1)1B1T
7S						

Hyoid

Grid	A	B	C	D	E	F
3N						
2N						
1N			m10(1)1B			
1S		m12(1)				
2S			m15(2)		x7(1)1Bu	
3S						
4S				#3(1) m9(2)		#5(1)
5S						m13(1)
6S						
7S						

Vertebra s=sacrum, t=thorasic, c=cervical, ca=caudal, v=generic vertebra, L=lumbar

Grid	A	B	C	D	E	F
3N		#4(1)v1B #3(1)v x7(1)v m9(1)v1B	#2(1)v #3(4)v1B #4(2)v			
2N		#4(1)v #6(1)v+(1)s m10(1)v1B	#1(1)v1B #2(1)v #3(6)v2B+(1)c +1t #4(1)v #6(3)v x7(2)v1B m9(1)t m13(1)v	x7(1)v		
1N		#4(1)v #5(1)v1B #6(1)v x7(1)v m11(1)v	#2(2)v1Bu #3(3)v3B m8(1)v m20(1)v m25(1)t	#2(11)v #5(1)v1B #6(1)v x7(1)v		
1S	m11(1)v	#4(1)v #5(3)v2B x7(1)v m10(1)v m12(1)v1B	#1(2)v #3(1)L+(2)v #4(2)v2B #5(1)v #6(6)v3B x7(1)v1B m9(1)v m10(1)v1B m11(1)v m14(2)L m17(1)v	#1(4)v2B #2(1)lL+(16)v4B #3(1)L1B #4(3)v1B #5(1)t+(1)v #6(1)v x7(1)v+(1)lL m9(2)v m10(1)t m12(1)t m13(1)v+(1)t m14(1)v m19(2)v2B m22(1)v1B	#1(2)v1B #2(2)v #3(1)v #4(1)t+(1)L #5(1)v #6(4)v m8(1)L1B m9(1)v	
2S		#3(1)v m9(2)v m11(1)v m12(1)t m13(1)t m23(1)v	#2(1)v #3(2)v #4(1)v #5(3)v x7(1)v m8(1)v m9(1)vB m10(1)v m11(1)v m14(1)v m15(1)v m16(1)v m17(1)vT m18(2)vB e30(3)v	#1&2(3)v2B2L (1)L1B #3(1)vB+(1)t #4(1)t+(2)v2B #5(6)v2B #6(1)L+(1)c +(1)ca x7(5)v1B m12(1)v m13(1)v m16(1)v	#1(1)v #2(2)v #3(11)v #4(2)v+(1)L #5(1)v+(1)L #6(11)v1B m8(3)v m9(14)v2B m10(1)v m11(2)v m12(1)v m13(1)v m17(1)v	#6(2)v1B m12(1)v
3S	m10(1)v	x7(2)v m8(2)v m9(3)v m10(2)v m16(1)t m22(1)v	#5(9)v1B #6(1)c x7(1)t+(2)v m8(1)l+(2)v m9(2)v1B+(1)c m12(1)v m13(1)v m18(2)v1B >19(4)v x24(1)v	#3(11)v3B #4(7)v2B+(1)L #5(4)v #6(1)t+(1)L+(8)v 1B x7(7)v2B+(1)c +(1)L m8(6)v m10(1)v m12(1)L m13(8)v2B m16(3)v1B m18(1)v >19(7)v2B x33(1)v	#2(1)v1B #3(1)c+(10)v5B 1Bu1T #4(12)v3B #5(11)v2B #6(4)v m8(2)v1B m9(1)v m10(1)v m11(2)v m17(1)v1B	#2(2)v #4(1)lL #5(4)v1B #6(1)v m8(1)t m9(5)v m11(3)v m12(4)v m13(1)v1B m16(1)v m17(3)v+(1)t
4S			#4(1)v #6(1)v m8(6)v2B m9(3)v1B m10(1)t+(2)v m11(2)v	#4(3)v #5(4)v2B #6(2)v+(1)c x7(6)v+(1)t+(1)L m8(1)v+(1)t1R +1L1B+(1)ca	#3(1)v1Bu+(1)v 1C #4(4)v+(1)t1B #5(3)v1B #6(3)v+(1)t x7(3)v1B	#3(2)v1T1C #4(1)v #5(1)v

			m12(1)v m13(1)v m16(2)v m17(1)v m18(3)v1B >19(2)v1B >20(1)v <21(1)v x22(1)v x23(1)v1B x27(2)v1B x29(1)v	m9(1)v1B m10(7)v1B m12(2)v1B m14(1)axis m15(1)ca m16(3)v m19(2)v	m8(2)v m10(1)v m14(1)v m17(1)v m18(1)axis m21(1)v1B	
5S					#5(1)v1B #6(1)v m12(1)v m15(2)v1B	#4(1)v #5(1)Atlas+(1)L +(2)v #6(1)v x7(4)v1B m8(2)v+(1)atlas m9(1)v m10(2)t m11(1)v m13(1)v m15(1)v
6S					#3(1)v #4(1)v #6(2)t m8(1)v	#3(4)v1B #4(2)v m8(1)v
7S						#6(1)v m8(1)v m10(1)v

Ribs

Grid	A	B	C	D	E	F
3N		#3(6) #4(1) x7(2) m11(1) m12(1)1B	#3(5) #4(4) #6(1)			
2N		#1(1) #2(2) #3(8) #4(2) #5(7) x7(3)2B m8(16)1R m9(5)1T m10(5) m11(2)	#1(3)2B #2(10)5B #3(30)10B #4(35)14B #6(4)1B x7(2) m8(6) m9(7)3B m11(1)1B m12(1)1B m16(2) m17(1)	#3(1) #4(7)1B #5(4) #6(4)2B x7(3)		
1N 1N		#1(1) #3(2)1B #4(22) #5(5)1B #6(3) m9(1) m10(1) m11(2) e28(1)1T	#2(20)1B #3(6)2B #4(23)1B1T #5(7) #6(1) x7(11)4B m8(16)4B m9(11)4B m10(9)3B m11(1)1T1Bu m12(3) m13(2)1B1Bu1R m14(3)3B m15(3)1B m16(1)1C m18(3)1B m19(3)	#2(41)9B #3(14)7B #4(2)2B #5(11)3B #6(14)2B x7(5)4B m8(2)1B m9(4)2B m10(1)1B m16(1) e28(1)	#6(2)2B	
1S		#3(3)1Bu1C #4(10)2B #5(9)	#1(3) #3(29)6B1C #4(19)1B	#1(10) #2(47)16B2Bu1T #3(19)6B	#2(27)4B1Bu #3(33)16B #4(2)	

		#6(15)1B x7(3) m8&9(7)1Bu m10(11)1C m11(4)2B m12(6)2B m13(2)1B m14(6) m15(6)2B m16(2) m18(2) m19(2)1B e31(5)2B	#5(5) #6(12) x7(3) m8(7)1B m10(19)3B m11(3)1B m12(7)4B m13(9)3B m14(9)3B m15(21)3B1Bu m16(2) m17(2) m18(4)1B m19(6) m20(3) m21(1)1B m22(1) e29(4)2B e30(1) e31(8) e34(2)1B	#4(6)3B #5(30)7B #6(9)2B x7(11)3B m8(12)2B m9(11)3B m10(6)1B m11(2)1B1Bu m12(10)1B1C m13(1) m15(3) m16(1)1B1T m17(5) m18(2)1B m19(3) m20(1) m21(6) m24(5)1B m25(1)1B e28(1)1B e29(2)	#5(13)4B #6(23)9B1Bu x7(17)2B1R m8(15)2B m9(10)4B	
2S	m8(1) m9(1) m11(1)1B m12(3)1B2R m13(10) m15(1)1B	#3(1)1B #4(13)1Bu1T #5(6)1B #6(10)2B x7(6)1B m8(5)2B m9(9)2B m10(7)1B m11(11)4B m12(9)2B m14(1) m15(8)1C m16(6) m17(4) m22(3) m24(5) m26(4) e32(1)1T	#1(7)2B #2(10) #3(7) #4(3)2B #5(25)1B #6(7)2B x7(2) m8(2) m9(10)2B m11(6)3B1T m12(5)2B m13(13)8B m14(15)3B1Bu 1T m15(14)5B1C m16(6) m17(18)6B m18(4) m20(5)1B m22(5)1B m23(1) m26(4) e28(1) e30(2)2B e31(3) e35(4)	#1&2(44)15B #3(20)5B #5(52)13B #6(19)6B x7(18)2B m8(16)4B m9(14)7B m10(22)3B1Bu 1C m11(16)5B1Bu m12(5) m13(3)2B1Bu m14(6)4B m15(5) m12(12)2B m17(9) m18(4) m19(2)	#1(2) #2(30)7B #3(49)16B1T #4(60)16B #5(107)32B1T #6(86)33B1T x7(51)7B1Bu m8(24)6B m9(31)4B m10(19)3B m11(12)5B m12(10)3B m13(32)9B m14(25)4B1Bu m15(20) m16(3) m17(12) m18(7) m20(3) m21(2)1B m22(2) m24(2) m27(1) m28(3)1B m30(3)	#2(4) #3(3)1B #6(20)3B x7(17)4B m8(10)2B m9(20)9B m10(19)6B1Bu 1R m11(2) m12(9)2B1T m13(13)2B1Bu 1T
	#5(3) #6(1) x7(2)1B m8(4)1B m9(2)2B m11(4) m12(12)3B	#1&2(1) #3(4) #4(7)5B #5(14)6B1C #6(14)6B x7(11)7B m8(9)3B m9(6) m10(9)4B m11(4) m12(21)5B m13(8)2B m14(1)1B m15(4)1B m17(5)2B m18(3) m19(3)1B m20(1)1B m22(2)1B m23(1)1B m24(3)1B m25(1)1B m27(1)1T	#1(3) #3(2) #5(39)6B1T #6(12) x7(3) m8(1)1C m9(2) m10(4) m11(10)1B m12(16)4B m13(1) m15(27)8B1Bu m16(56)6B1Bu m17(1)1Bu >19(11)1B >20(3)1B >21(3)2B x23(2)1T x24(4) x25(1) x29(1) e33(3)1B e38(1)	#3(13)1B1R #4(18)4B1Bu1C #5(19)6B #6(72)19B1Bu1R x7(64)14B m8(44)11B m9(25)8B m10(26)8B m11(24)6B m12(24)10B m13(32)12B1Bu m14(11)4B m15(12)3B m16(21)5B m17(19)2B1T m18(12)2B >19(23)8B >20(12) >21(5) x22(6) x23(10)2B x25(1) x26(2)	#1(2) #2(18)4B #3(57)25B #4(76)32B #5(66)25B #6(92)42B1Bu 2T 1C x7(58)17B m8(29)5B m9(36)15B m10(22)8B m11(28)10B m12(14)5B m13(13)4B m14(23)9B m15(16)7B m16(21)6B m17(8)3B m18(5)2B >19(5) x23(3)1B	#2(6)1B #3(13)4B #4(14)3B #5(12)3B x7(1) m8(21)6B m9(11)6B m10(2) m11(32)6B2Bu 1T m12(24)11B m14(11)2B1R m15(17)1B m16(64)10B m17(16)3B m18(6)1B

		m28(13)		x27(2) x32(2) e34(2)		
4S			#1(4) #3(2) #4(3) #5(7)2B #6(22)1T x7((32)8B2Bu2T 1C m8(17)4B m9(20)2B m10(12)3B m11(11)1Bu m12(7)4B m13(22)9B2C m14(16)10B m15(25)8B m16(19)1B m17(13)3B m18(1) >19(8)6B >20(17)3B .>21(9)3B1Bu x22(9)1B x23(8)6B x24(2) x26(8)1B x27(2)1B x28(1) x30(2)2B x31(1)	#1&2(7) #3(32)5B #4(36)7B #5(68)10B2Bu #6(59)15B1Bu1T x7(48)6B2Bu 3C1R m8(50)12B m9(38)6B m10(47)13B1Bu m11(17)2B1Bu m12(14)3B m13(17)3B1Bu m14(27)2B2C m15(10)2B m16(18)3B m17(27)7B1C m18(31)5B >19(8)1T >20(6)2B >21(16)3B x22(11)3B x23(1) x24(1) x25(2) x26(4) x27(3)1B x28(1) x29(1) e37(7)7B e38(1)1B	#2(18)4B #3(65)8B #4(98)18B #5(97)25B1Bu 1T #6(42)7B1C x7(38)8B m8(33)6B1Bu m9(66)8B m10(21)2B1R m11(24)5B m12(29)13B m13(21)5B m14(39)13B1C m15(1) m16(23)4B m17(16)4B m18(19)2B >19(6)2B1R >20(22)8B >21(14)6B x22(17)6B	#2(2)1C #4(37)12B1C #5(45)10B
5S				#3(2)	#1(2)2B #2(1) #3(6)2B #4(5)1B #5(8)2B1Bu1T #6(8)1B x7(12)5B m8(11)2B m9(11)3B m10(7)1B1Bu m11(12)3B m12(12)4B m13(9)2B m14(13)4B m15(18)6B1Bu	#1(1)1B1Bu1T #3(2)1Bu1C #4(45)10B1Bu #5(1)1Bu #6(3) x7(4)1B1Bu m8(16)3B1C m9(1) m10(1)1B1Bu m11(7)2B m12(9)1B m13(20)8B m14(17)5B m15(10)4B m16(14)4B1C m17(13)4B
6S					#2(10)2B #4(24)6B1C #5(14)2B x7(11)1B m8(5)1B	#1(2) #3(6)2B #4(6) #5(1) #6(12)2B x7(5) m8(15)2B
7S					#3(1) #4(1) #5(2)	#4(1)1B #6A(3) m10(1)

Scapula L=left, r=right

Grid	A	B	C	D	E	F
3N		#4(1)L				
2N		m13(1)	#5(3)			
1N		#4(1)1B x7(1)	m8(2)1Bu m9(1) m13(3)	#6(2)1B		

			m18(1)r			
1S		#1&2(3) #3(2) x7(2) m13(1) m14(5)	#4(1) #6(1) m11(1) m14(1) m15(5) m18(1)r1B e28(6)	#1(1)r1T m21(1)	#3(1)	
2S	#5(1) m16(1)	m8(3) m11(2)2r	#3(4)1Bu1R #4(1) x7(1) 13(1)1B e30(2)	#3(3)2B #4(1) x7(3) m9(2) m15(1)	#4(2)1B #5(1)1B1T+(1)r #6(1)+(1)L1T x7(5) m18(1)	m13(1)
3S	m8(1) m11(1)	#6(1)L x7(1) m8(2)2Bu1T m11(1) m12(4) m14(4) m15(1) m18(1)	#3(1) #4(2) #6(1) x7(1) m12(2) m13(1)1B m16(2)1L1Bu1C m17(1)1Bu1C	#4(1) #6(1) x7(2)1T1C m8(1) m9(1)r >20(3)1B e34(5) e35(1)1B1R	#4(6) #5(2) m12(1) m13(2)	#6(1) m10(1)L1C m11(1)L m12(3) m14(3) m15(2)1B
4S			#6(1)1B1C x7(1)r m9(2) m13(2)1C m14(1) m16(1)L x22(1)r e37(1)1B	#3(1)L1T #4(1)1T x7(2) m8(4)1Bu m9(1)r1B m10(2)1C m14(4) m18(6) x23(2)2B x24(1)1B1Bu1T x26(2)2L	#2(1) #4(1) #5(1) #6(1)1C m9(1)1Bu m12(3) m13(2)2r m14(6) m15(2)1B m16(1)1B m17(4) m18(1)1B	#4(2)
5S					m15(1)1Bu1C	
6S					#4(1)L1B #5(6)	
7S						

Humerus

Grid	A	B	C	D	E	F
3N						
2N		m13(1)1T1C				
1N			#5(1) m8(1)L[1+] m10(1)r1Bu	#2(1)1B	#6(1)	
1S		#5(2)1B #6(1)1B	#5(1) m10(1)1Bu m17(1) m25(1)1T	#1(1)1B #3(1) #4(2)L1Bu1T m11(1)	#2(1)	
2S	#4(1)		#5(1)L1Bu1C m9(1)r m14(1)	#1&2(1)L[1.5] m9(1) m10(1)	#6(1)r[3.5] m12(1)[6+]	
3S		m18(1)r1Bu1T +(1)L[1+]	#2(1) #4(2)r1T #6(1) m9(1)L1T1C[1+] m17(1)	#5(1) #6(1) m12(1)L[1-2.5] m16(3) m17(1)L >19(1) x29(1)		m15(1)L1B
4S			x7(2)2r[1.5] m8(2)2L1C m11(1)L1Bu m12(1)	#4(1)r[1.5] #6(1)L x7(1)L[1.5] m9(1) m11(1)r m14(1)L1R1C [6+] m16(1) x25(1)	m8(1)L m14(1) m15(1)r	
5S						m11(1)1B
6S					#1(1)	#5(1)1T[1-]
7S						#6(1)

Radius

Grid	A	B	C	D	E	F
3N		m10(1)1T1R				
2N		#2(1) m8(1)1R	#3(1) #5(1)1T	#6(1)1B		
1N		x7(1)[3.5-]	#2(1)L[1.5] #5(1)[2.5-] m8(1) m9(1)L1Bu[6+] m11(1)1T1R m13(1)1R			
1S		m10(1)1Bu1T m11(1)	#1(1)r[1.5] #6(1)1Bu m14(2) m17(4) e31(1)	m9(1) m17(2)1B		
2S		m10(1)L1B1T [1.5-]	#3(2)[6+] #5(1)1R m10(2)1Bu1C m14(1)L[6+] m17(2)1R	#1&2(2) #4(1)L #5(1)r[3-] m10(2)1B	#3(1) #4(1) #5(1)1T #6(3)1B m15(1)* m24(1)L[1.5+]	
3S		#3(3) #6(1)1B x7(1)1B m9(1)L m12(1)1B m19(3) m20(1)r[1.5-]	#4(1)1B #5(1) m8(1)1T m10(1)1T m11(1)1Bu1T m12(2) m14(1)L1C m16(2)	#4(1) #5(1)r1C[3-] #6(2)[3.5-] m11(1)L[6+] m12(1)L m15(1) >19(3)[1.5-] >20(1) x33(1)1B[6+] e37(1)1B1T	#5(1)r[6+] #6(1) x7(1)1B m14(1)r1B[1.5] x22(1)	#6(1)L1B[6+] m15(1)
4S			#5(2) #6(5)1Bu x7(2)2Bu+(1)L [1.5] +(1)*1Bu1T m9(1) m14(2)1T+(1)L[6+] m15(1)1Bu m17(1)1Bu1T m18(3)1B1Bu x24(1)r x28(1)r	#5(8)2Bu3C [6+]+(2)L1T m8(1) m10(1)L[3.5-] m14(2) m18(1) >21(1)	#4(1)1B1T #5(1)r[3.5-] m8(1)1B m14(1)r[3-] x22(1)	#1(1)1T #2(1)
5S					#6(1)1C m9(1)	#5(1) m16(1)
6S						#1(1)L1Bu1T1R #6(1)*1T1C
7S						m8(1)

*radius/ulna

Ulna

Grid	A	B	C	D	E	F
3N						
2N		m8(1)1B	#4(1)	#5(1)[3.5+]		
1N		m9(1)r1Bu1T				
1S			m10(1)r		#5(1)L	
2S		m8(1)	14(1)r m16(1)		#4(2)L+(1)r #5(1) #6(1) m31(1)	x7(1)1B
3S			m8(3)r m16(1)1R[3+]1T	#4(1)r[3.5+] #5(1)1B m9(1)r m18(1)1B	#3(1) x7(1)L m10(1)L	m15(1)[5+]
4S			x7(1)1Bu1T m10(5) >19(1)[3.5+] >20(1)1Bu	#3(1)r1B #5(1)L #6(1)L x7(2)1r m15(1)r1C	#6(1)1B x7(1) m16(1)	#1(1)1B

				>19(1)1T[6+]		
5S						m10(1)1B
6S					#3(1)[2.5-]	x7(1)r
7S						

Metacarpal

Grid	A	B	C	D	E	F
3N		m13(1)1B				
2N		#2(1)	#3(1) #5(1)1T			
1N		x7(1)1Bu1C	m9(1)1B	#2(1) #3(1) #4(1)L		
1S			#3(2)1L1B #4(1)L[6+]	#2(1) #3(1) x7(1)	#6(1)r	
2S		#6(1) m11(1) m24(1)r	#2(1) x7(1)		#4(1)L #6(2)[3.5+] m9(1)1B	m8(1)L
3S		m8(1)L[6+]	x7(1)1B1T m15(1)L[6+] m17(1)1B >19(1)r	#6(2)1L1C x7(1)L[6+] m9(1)L m10(2)1L1B1C m11(3)1r	#4(4)1r1B m10(1)1B m12(1)1C m13(1)1B1Bu1T	m12(1)1B m16(1)r1B
4S			m8(1)L	#6(1)1T x7(2)1B1C m8(3)2L1r1B1R1T m10(3)1B m14(2)1r1L1T m16(1)L >20(2)1B >21(2)	#5(1) #6(1)r m12(1)	#3(1)r[6+]
5S					x7(2)[6+]	#5(1)r m14(1)L1B m15(1)L
6S						#4(1) #6(1)L
7S						x7(1)1B[6+]

Femur

Grid	A	B	C	D	E	F
3N						
2N		#3(2)[6+] #4(1)	x7(2)			
1N		#3(1)[3.5-]1B	#2(1)[6+]	#2(2)2B		
1S	m8(2)1T m9(1)[3.5-]	x31(1)1B	m14(5)1B m17(1)[6+]r e29(2)1Bu1R	#2(1) #3(1)1R #6(1)1Bu1T m8(1)1B		
2S		#3(1) m8(1)	x7(1)L1T m11(2)1Bu1T e31(1)1Bu		#3(1) #5(2)[3.5]1L m13(1)1Bu m20(1)	m10(1)
3S			#2(1) #4(1) #5(3)1[2.5]1T #6(2)1[3]1Bu1[3.5] m17(2) x27(1) e35(1)	#5(1)1C #6(1)	#3(3)[3.5]1Bu #4(2)1Bu #6(2)	x7(1)1L[3.5-] m8(1) m10(1)1C m12(2)1r[6+]1B m14(4) m17(1)
4S			m10(1) m17(1) m18(1)	#3(1) #4(2)[3.5-]1B #6(2) x7(1)[3.5-] m8(1)L m10(1)1C m13(2)1L[6+] m15(3)1[6+]1Bu1C	m18(1)1Bu1T	

				m17(1) m18(1) >20(1)[3.5-]		
5S					m9(2)1Bu m14(1)1Bu m15(1)	m8(1)
6S					x7(1)	#4(4) #6(1)
7S						

Tibia

Grid	A	B	C	D	E	F
3N		m13(1)L[1.5-6]				
2N			#3(1)			
1N		x7(1)	x7(1) m9(1) m10(1)L[?]1B m15(1)L1T1C	#2(1) m14(1)1r		
1S		m12(1)	#1(1)r[1.5-6] #3(3)1L1B[?] #5(2)1B m10(1) m13(1)[1.5-6]1R	#1(1) #2(2)1B1C #3(1) #5(1) m8(1)L[1.5-]		
2S		#3(1)1r1B1Bu1T #5(2)1Bu m22(1)	#5(1) m11(1)[1.5-6] 1Bu	#3(1)r[3.5+] x7(1)	#2(13)	
3S		#4(2)1r1Bu1C m9(1)L m16(1)1C m18(2)[1.5-5.5] (1)L[1.5-5]	#5(1)1r[1.5] #6(1)r[5]1Bu m8(1)L1Bu m10(1) m12(2)1r1Bu (1)L1C e36(1)L e37(1)	#3(1)1r #5(2)1r1[6]1Bu #6(1)[6]1T m12(1)1Bu1T m16(1) e34(3)1R	m10(1) m12(1)1C (1)r1Bu	#5(1) m12(1) m15(1)1R
4S			x7(1)L+1r[1.5] m8(1)L[1-3.5] m9(1)+(1)L[3.5-] m12(1) m16(2)1T1C m17(1)	#5(11)[3.5-]1B 9L1r[6-] #6(1)r1B x7(2)1r +(1)L[1-6] m12(1)L >19(1) x23(1)1T	#4(1)r[1.5] >19(1) x22(1)	#4(3)1C
5S					m15(1)	#3(1)L1T
6S						m8(1)1T1Bu +(1)L
7S						

Metatarsal

Grid	A	B	C	D	E	F
3N						
2N		#3(1)1B #4(1)1B1T	#2(1)L x7(2)1T1Bu m8(1)	#4(1)1T		
1N		#5(1)1T x7(1)1B	#2(4)3B #5(1)1T1R x7(1) m9(1) m16(1)1B1R	x7(5)1L m18(1)1L		
1S	m14(1)	#6(1)	#1(1) #3(2)1B #4(1)1B x7(1)1Bu m8(1)1r m14(1) m17(1)1Bu m18(1) m19(1)1B m21(1)1T	#1(2)1r1B1R #2(1) x7(1)1B m9(1)1B m12(2)1L1Bu	#2(1)1L1T #3(1) x7(2)2B1T 1Bu m9(1)	
2S		#5(1) e32(1)	#4(3)1B+2L x7(1)1T1Bu	#1&2(1)[6+] #3(1)1B	#3(1)1B m11(2)[6+]2B	m11(1)

			m9(2) m10(3)1Bu1R m11(1) m15(4)1Bu1C m17(1)1T1Bu	#5(1)1T1C x7(1) m10(1)1Bu m11(1)	m15(1)	
3S		m13(1)1C m15(1) m16(1) m21(1)	#3(1)1T #4(1)1r #5(1) #6(4)1r1T2R m10(1)1B1T m11(1)1C m16(5) m17(2)1B m18(2)1R >19(1)1B >20(3)1[3.5-]1Bu1C x25(1)1C	#3(2) #4(2)L1T2C1Bu1R #5(2)1Bu #6(3)1B1Bu+(1)L x7(1)1L1T1C m9(3)1B m10(1)1L1C m13(1) >20(2)2B >21(1)1Bu x22(2)[6+]1B	m10(1) m14(1)	x7(2)1B m12(2)[5+]1T m15(1)[2-] m16(2)1B1R m18(1)1T
4S			#1(1) #5(1)[3.5]1Bu x7(2)1B1T m8(1)1r1Bu1C m9(2)1L2T1Bu1C m13(1)1B m15(1)	#3(1)1Bu #4(3)1C #5(4)1Bu1C x7(2)2Bu+1L1T1C m8(1)1C m9(2)1[3.5+] m10(1) m12(1) m13(2) m14(1) m17(5) >19(2) >20(1)1r	#2(1) #3(1)1L #4(4) #5(1)1T #6(1)1r1T x7(4)1r1L1C m11(1)1B m12(1) m15(1) >19(1)1T >20(1) >21(2)	#1(1) #4(3)1B1T1C
5S					#2(1)1B m10(1)1r	#3(2)1B x7(1)1r m11(1)1B m13(1)1B
6S						#1(1)1R #6(1) x7(1)1L[6+] 1T1Bu
7S						

Metapodial

Grid	A	B	C	D	E	F
3N		#2(1) #4(1)1B #6(1)[2] x7(1)1B	#3(3)1B #4(1)			
2N		#2(1)[3.5-]1R #4(1)1B #5(2)1T #6(1)1B m8(5) m10(1) m13(1)	#2(2)1B #3(3)1B #4(4) #5(2)1B1T1Bu1C #6(1) x7(1)1B m12(1)[6+]1C			
1N 1N		#2(1)1B1Bu #3(5)2B #4(1) #6(2)1Bu m10(1)1Bu m12(1)1Bu	#2(6)4B #4(3)3B #5(2)1B #6(1)[6+]1B m8(1) m10(2)[6+] m11(1)[6+] m14(1) m16(1)1B e28(1)1T	#1(1) #2(2)1B #3(2) #5(1)[6+]1B	#6(1)1B	
1S	m12(1)	#4(1)1B #5(1) #6(2) x7(1) m12(1) m20(1)	#3(4)1B #5(6)2C #6(3)[3.5-]1B m10(1)1B m11(1) m13(3)1[3.5-]1bu1C m14(2)1[3.5-]	#1(3)2B1Bu #2(3)2B #3(1) #4(4)2B #6(3)1B m8(1)1C m11(1)	#2(1)1B #3(1)1T #4(1)[3.5-] #5(1) #6(1) m8(2)[3.5-]1B 1T1Bu	

			m16(2)1T1C m17(1)1B m20(1)1B	m21(1)1B e30(8)8B	m9(1)1B	
2S	#5(1) m12(1)1B	#4(1)1B m10(1) m11(2) m12(3)2B1Bu1T 1C m13(1)1B	#2(1) #3(3)[6+] #4(3)1B #5(5)1B1R m9(2) m10(1)1B m11(1)1B m13(2)1Bu m14(4)1[3.5] 1[6+]1Bu1C	#1&2(12)4B1Bu 2C #3(2)2B #4(1) #5(2)1[6+]2B #6(2)1[3.5+] x7(1) m8(2)1B m9(1)1B m10(1) m11(1)1B m16(1)1B	#4(2)1R #5(2)1B #6(8)5B x7(2)1B m8(1) m9(1) m11(1) m14(3)1[6+] m16(2)2B m18(1)1B m20(1)1B m26(1)1B	x7(1) m8(1) m9(1)[3.5-]1Bu m12(2)1B1C
3S	m11(1)	#3(1)1B #6(1)[3.5-]1B m8(3)2Bu1C m9(1) m15(1)[3.5+] m17(2)2B1Bu m19(3)2B m22(1)1B m32(1)1T	#5(4)2B1Bu1C #6(1)1B x7(1) m9(1)1T1R m10(1)1B m11(1) m12(3)2B1T m13(1)1B m14(1)1B1T m15(1)1B1C m16(2)1R m17(4)1[6+]3T3Bu 1R1C m18(2)1T >20(1) >21(3)1[3.5+]	#3(4)1[2-] #4(6)[3.5-]1B #5(4)1[3.5-] #6(4)[3.5-]3B x7(2) m10(3)1B m11(3)2B m13(1) m15(2) m16(1) m18(1) >19(3)1B1C x25(1) x35(1)1B	#3(1) #5(1) #6(5) x7(2)1B m8(4)2B m14(2) >20(1)1B	m8(3)[3.5-]1B1C1T m10(1) m11(2)1T m13(1) m15(2) m16(2) m17(3)1[6+]1[3.5-] m18(2)1B
4S			#5(3)[3.5-]1B #6(2)2Bu1C m8(2)[6+] m9(4)[3.5+]1B m10(1)1B m11(6)[6+]2B m12(1) m14(1)[6+] m15(1)[6+] m17(1)1B m18(1) >19(3)1B >20(2)1T1Bu x22(1) x24(1)	#4(1) #5(3)[3.5-] #6(3) x7(1)1B m8(4)1B m10(7)3B m11(2)[3.5-] m15(2)1C m18(7)2B >20(1) >21(4)1B1C x25(1)	#3(5)1B #4(5)1B #5(2)[3.5-] #6(1) x7(1)1T m8(1) m10(1) m11(2) m12(3)1T m14(2)1B m15(1)[6+]1B m17(1)1C >21(1) x22(1)[3.5-]	#2(1) #3(3)1[5+]1B1Bu #5(3)[6+]1B
5S					#5(1) #6(2)1B1Bu x7(1) m8(1)1B m9(1)1C m14(1) m15(1)	#2(1)[5]1B #5(2) #6(2)2B m8(1)1B m12(2) m13(2)2B m14(1) m17(1)[3.5]
6S 6S					#4(1) #5(1)	#6(1)[6-]
7S						#6A(1)1R m8(1) m10(1)1B

Lateral malleolus = [lm] & patella = [p]

Grid	A	B	C	D	E	F
3N						
2N						
1N						
1S				#2(1)L1B [lm]	#6(1) [lm]	
2S		#3(1)1B [lm] m14(1)1B [p]				m12(1) [p]
3S	m12(1) [lm]		m16(1) [lm]	#6(1)L [lm]	m10(1)L [p]	m16(1)[lm]

						(1)r [p]
4S			x7(1) [lm] m9(1) [lm]	#3(1)[lm]		
5S						#5(1) [p]
6S						
7S						

Longbone

Grid	A	B	C	D	E	F
3N		#1(4)2B #2(51)18B1Bu #3(50)17B #4(48)21B #5(16)7B #6(15)12B x7(12)3B m8(7)3B m9(24)14B m10(13)8B1T1Bu 1R1C m11(6)3B m12(12)5B m13(11)7B m14(1)1B	#2(18)1T #3(51)25B1BuT #4(36)20B #5(4)3B #6(3)1B			
2N		#1(3) #2(30)10B1T1R #3(71)26B1Bu #4(79)26B #5(54)21B1T1Bu #6(70)17B1T x7(62)23B2T1Bu m8(70)14B m9(31)9B2Bu1C m10(43)13B4T2Bu m11(3)8B m12(21)6B2T1Bu m13(8)4B m14(6)1B1R m16(3)2B1Bu m17(1) m18(1)	#1(12)6B #2(69)18B1T2Bu #3(226)93B4T3Bu 1C #4(170)74B1T1Bu #5(47)13B1T #6(26)6B2T1Bu1C x7(49)13B m8(22)6B1T1Bu m9(55)23B m10(13)7B1Bu m11(34)14B m12(20)11B m13(9)3B1Bu m14(3)2B m15(7)2B1Bu m16(3)2B m17(8)5B	#3(6)2B1T #4(29)13B #5(23)9B #6(13)7B x7(18)9B1T m8(12)6B1T		
1N	#1(7)4B	#1(18)1Bu1C #2(19)3B #3(69)27B2T #4(148)50B2T1Bu 1C #5(43)20B1Bu1C #6(54)21B1T x7(43)12B1T m8(55)16B m9(192)116B1C m10(47)17B m11(38)10B3T1Bu m12(30)11B m13(7)2B1T m14(7) m15(16)8B1Bu m16(7)1B2T m17(5)2B m18(9)3B m20(1)1B m21(1) m22(1)1B m23(1)1B m25(2)2B m26(4)1B e27(4)4B	#1(34)15B #2(260)86B4T5Bu #3(176)83B4T1Bu 2C #4(63)20B2T #5(48)11B3T1Bu1C #6(46)21B2T x7(84)35B1T1C m8(112)45B1T1Bu m9(116)53B2T3Bu m10(82)38B2T2Bu 1C m11(69)28B1T2Bu 1R1C m12(51)27B2Bu1C m13(29)13B1T m14(22)9B1T1Bu m15(9)6B1T1Bu1C m16(8)4Bu m17(7)2B m18(18)6B2C2R m19(18)9B1Bu1C m20(10)5B1Bu m21(5)2B m22(4)2B m25(1) m26&27(13)6B e28(6)2B1T	#1(9)5B #2(147)45B2Bu #3(94)48B1T3Bu 1C #4(51)19B #5(65)29B #6(69)32B1Bu x7(41)14B1Bu m8(19)8B m9(15)6B m10(5) m11(1)1B m12(4)1B m13(10)4B m14(3)2B m15(3) m16(3)1B1T1Bu m17(3)1B m18(3)1B e27(1)1T e28(1) x29(1)	#5(7)3B1T1Bu #6(20)7B1B1Bu	#5(7)3B1T1Bu #6(20)7B1B1Bu

1S	#2(2)1B #3(3)1B1T #4(6)4B #5(3)3B #6(6)3B x7(10)7B m8(8)5B1T1C m9(15)10B2T1Bu m10(14)8B2T1C m11(12)7B m12(20)9B m13(10)2B1T m14(13)4B2T1C m15(5)2B	#1&2(22)10B2T 1C 1R #3(133)51B3T2Bu 2C #4(59)21B #5(120)41B1T #6(102)45B1T x7(57)26B1T1Bu1R m8&9(73)28B1T2C m10(65)25B2T m11(66)30B1Bu m12(96)49B2Bu1C m13(3)1B2T1C m14(104)45B2T 4Bu m15(66)18B3T2Bu m16(28)10B1C m17(5)1T m18(1) m19(11)5B1C m20(8)5B m21(3)1B1T m22(1)1B e27(2)1B e27A(1)1B e28(5)1B e30(1)1T x31(2)	#1(96)27B #2(1)1B #3(265)96B2Bu #4(135)55B #5(123)45B #6(123)51B1T x7(80)29B1Bu1R m8(59)17B m9(22) m10(191)75B1C m11(80)43B1T1Bu 2C m12(93)40B2T1Bu m13(100)53B1T 2Bu1C m14(104)42B m15(108)36B1T m16((73)35B2Bu m17(41)14B m18(79)34B1T1Bu m19(46)18B3T1Bu 1C m20(41)19B m21(21)7B m22(22)9B2T2Bu m23(22)13B m25(1) m26(5)3B e27(6)1B e28(5)3B e29(7)1B e30(11)1B1C e31(6)1B1T e32(19)11B1T e34(9) e35(2)1T e36(2)1T	#1(223)68B2B 1C #2(324)116B1T2Bu 1C #3(118)59B #4(80)30B1Bu #5(102)44B #6(75)32B1T1Bu x7(54)21B m8(48)11B3Bu m9(41)14B m10(28)12C1C m11(7)3B1T m12(64)38B m13(13)10B1T1Bu m14(19)5B m15(31)14B1T m16(25)8B1C m17(25)10B1Bu m18(19)9B1T1Bu m19(9)6B m20(9)1B m21(21)7B m22(16)4B1T1Bu m23(8)2B1T m24(16)4B1T1C m25(15)5B m26(4)1B e27(5)3B1Bu e28(3)1B e29(9)1B	#1(25)6B #2(122)35B2T1C #3(106)29B2T #4(91)34B1Bu1C #5(82)26B3T2Bu 1C #6(106)30B3T4Bu x7(68)25B1T3Bu m8(56)20B1T2Bu m9(58)20B	
2S	#2(1) #3(2)1B1T #4(4)3B #5(21)9B #6(22)15B1T x7(22)10B1T m8(14)6B1T m9(21)4B2T1Bu1C m10(21)5B m11(26)7B3T1Bu m12(43)14B m13(34)15B1T m14(15)9B1C m15(18)7B m16(14)3B1T1R m17(6)2B m18(4)1B m19(2)	#1(10)1B #2(18)7B #3(94)30B1T1Bu #4(209)89B2T7Bu #5(103)44B2T2Bu 1C #6(100)41B3T1C x7(67)32B m8(65)28B1Bu m9(115)45B2T m10(88)39B1T1Bu m11(172)69B2T3C m12(121)50Bu1T2C m13(81)34B2T1C 3R m14(49)25B m15(73)27B2T2Bu m16(69)35B1T1Bu 1C m17(48)26B1T1Bu m21(1) m22(33)15B m23(8)2B m24(21)12B1C m25(6)2B m26(11)4B m27(5)2B m28(2) m30(1) m31(2) m32(21)10B x33(5)1B1T x34(4)2B	#1(87)31B1C #2(179)56B1T1Bu 2C #3(182)67B1T7Bu #4(123)56B1T #5(138)54B1T6Bu #6(97)42B1T1Bu x7(61)12B1T m8(31)7B1T m9(87)21B3T2C m10(110)56B1Bu m11(99)36B1T1Bu m12(83)38B2T3Bu m13(96)40B1R m14(3)2B2T2C m15(74)26B1T2Bu m16(64)25B1T1Bu m17(60)22B m18(49)23B1Bu1R m19(29)16B m20(22)13B1C m21(17)9B m22(12)5B m23(2)2B m24(7)2B m25(2)1B m26(2)1B e27(4)2B e28(4)1Bu1T e29(2)1B e30(17)4B2Bu e31(24)12B1T4Bu 1C	#1&2(332)140B1T 6Bu1C #3(160)67B3Bu #4(4)1T1Bu2C #5(261)89B5Bu2C #6(134)54B2T1Bu x7(119)51B2Bu m8(112)40B m9(63)27B1Bu1C m10(85)36B m11(57)21B1T1Bu m12(51)17B m13(8)3B m14(17)7B m15(46)20B2C m16(46)15B1T2Bu m17(57)22B1C m18(15)6B m19(11)5B2T m20(4)1B1Bu	#1(13) #2(79)33B #3(149)46B1T1Bu #4(183)86B2T #5(189)74B4T4Bu 1C #6(194)76B1C x7(138)50B2T3Bu 1C m8(109)39B1T2Bu m9(133)50B1T3Bu 2R m10(98)40B2T1C m11(72)46B m12(57)29B1Bu1T m13(67)29B1Bu m14(77)27B2Bu m15(26)7B m16(13)9B m17(35)12B m18(40)11B2T3Bu m19(12)4B m20(17)9B m21(26)14B m22(5)2B m23(5)3B m24(5)1B m25(5)2B1Bu m26(3) m27(1) m28(3)1B m30(5)1B m31(1)1B	#2(12)3B #3(4)2B #4(11)2B1Bu #5(25)12B #6(34)12B2T1C x7(28)6B1Bu m8(37)14B m9(54)23B2T m10(42)19B4Bu 4T m11(5)1B m12(17)9B m13(41)13B1T 1Bu1C1R

		x35(3)3B	e32(9)4B e33(6)3B e34(3)1B e35(3)2B e37(1)1B			
3S	#1(1) #2(1) #3(9)2B #4(3)1B #5(8)3B #6(21)6B1Bu1C x7(5)2B m8(23)10B1C m9(16)8B2T1Bu m10(21)5B1Bu1C1R m11(31)10B1T m12(31)10B m13(1)	#1&2(25)14B1T #3(41)20B1C #4(83)38B1T1C #5(135)65B1Bu1C #6(150)68B2Bu x7(107)46B1T1Bu1C m8(123)49B1T1Bu m9(116)50B1C m10(97)44B3Bu1R m11(98)44B1T2Bu m12(80)41B1T1Bu m13(71)24B m14(93)45B1T m15(133)64B2T2Bu1R m16(111)61B1Bu2C m17(119)47B2Bu1C m18(38)15B1T m19(63)25B1T1C m20(22)14B m21(23)6B1T m22(49)27B1T m23(29)13B m24(21)9B m25(17)10B m26(6)3B m27(10)7B m28(5)3B m29(1) m30(1)1B m31(5) m33(6)2B m34(3)3B e35(1) e36(7)6B	#1(4) #3(124)48B1T2Bu #4(44)11B #5(186)69B4T #6(140)46B1T1C x7(19)4B1T2Bu m8(34)3B m9(190)60B1T1Bu3C m10(89)32B1T m11(80)25B2T m12(123)62B3T2Bu m13(30)10B2T1Bu2C m14(21)6B2T m15(123)44B2T m16(207)81B1T4Bu3C m17(27)5B1T m18(36)11B5Bu4T >19(92)42B1Bu >20(70)38B >21(57)31B1T x22(45)12B x23(18)3B x24(15)5B1T x25(15)7B x26(9)5B x27(2)1B x28(3) x29(7)1B e30A(1)1B e30(2)1B e31(3)2B e32(5)2B e33(22)12B1T1Bu e34(12)4B e35(17)7B e36(12)5B1T e37(4)1B e38(5)4B e39(3)3B e41(1)	#1(5)1B #2(27)5B2Bu #3(101)23B1T1Bu1R #4(120)33B2T2Bu #5(96)31B2T #6(302)89B3T3Bu x7(203)62B5Bu3C m8(143)58B1T4Bu m9(108)47B2T1Bu1C m10(116)50B3Bu1T m11(145)60B1T1Bu1C m12(126)47B1T1Bu m13(117)44B1T1Bu m14(93)30B1Bu3C1R m15(91)42B2Bu1R m16(117)40B1T2Bu1C m17(100)41B1T m18(80)30B2T3Bu1C >19(98)32B4Bu >20(46)20B >21(31)14B1R x22(38)21B x23(20)7B x24(22)6B x25(16)7B x26(13)6B1Bu x27(6)3B x28(10)2B x29(2)1B x30(2) x32(15)10B1Bu x33(15)13B e34(25)16B1T2Bu e35(27)20B2R e36(13)9B e37(4)3B e38(1) e39(4)1B1R e40(3)2B e41(3)2B	#1(18)3B1T #2(88)21B3Bu #3(275)126B2T1Bu #4(298)126B1T4Bu4C #5(170)71B2T2Bu1C #6(212)110B4T3Bu x7(97)58B2T3Bu m8(63)19B m9(118)56B1T2C m10(70)32B2T1Bu m11(78)35B2T m12(72)38B1Bu m13(89)53B1Bu m14(82)40B m15(65)35b3Bu m16(53)26B1Bu m17(40)17B1Bu m18(20)10B1T1C >19(19)6B1C x22(1) x23(9)4B	#1(2)1B #2(25)5B #3(40)14B #4(22)4B1T #5(50)9B1Bu1R #6(41)11B1T1Bu x7(42)11B1R m8(75)23B1T1Bu1R m9(40)14B1C m10(78)20B3T m12(118)55B3T1Bu1C2R m13(1) m14(147)67B2T m15(133)59B4T1Bu6R m16(107)34B2T2Bu2C m17(73)28)1T1Bu1C m18(27)7B1Bu
4S			#1(2)1B #2(9)2B #3(21)7B #4(49)19B1T #5(97)33B2T #6(156)55B1T1Bu1C x7(140)54B3T7Bu m8(107)27B3T3Bu m9(137)44B4T2Bu m10(105)47B1Bu m11(105)53B2T3Bu1C m12(139)68B3Bu4C m13(121)50B2Bu1R m14(146)66B5T7Bu1C1R m15(136)45B1T2Bu	#1&2(25)7B #3(187)76B1T4Bu2C2R #4(141)47B1T2Bu #5(237)70B5Bu #6(159)45B3Bu1R x7(189)54B1T4Bu3C m8(160)53B1T1Bu m9(143)50B1T3Bu m10(246)86B3T1Bu1C1R m11(72)20B1T1Bu m12(93)38B m13(115)37B2Bu1C m14(108)52B4Bu3C1R m15(77)29B1Bu	#2(75)22B1Bu #3(129)31B4Bu #4(297)161B1T6Bu1C #5(212)67B2T3Bu #6(138)38B6T1Bu x7(143)46B1T2Bu m8(76)26B3Bu m9(105)33B3T1Bu m10(47)20B1T2Bu m11(119)39B4Bu m12(127)53B2T4Bu1R m13(83)32B1Bu1C m14(76)32B2Bu1R m15(6)3B m16(76)24B1Bu m17(62)14B2T2C	#1(55)15B #2(15)3B3T1Bu #3(40)8B1Bu #4(74)26B1R #5(76)12B

			m16(86)36B4T1Bu 2C m17(124)53B1T8Bu 1C m18(21)5B4T1Bu >19(33)13B2T1C >20(113)55B5T4Bu 1C >21(80)33B x22(35)11B1C1T x23(41)17B2Bu1C x24(17)6B x26(42)17B1T1Bu x27(15)6B2T2Bu1R x28(9)4B x29(6)1B x30(10)3B x31(6)2B x32(6)3B x33(3)1B x34(1) x35(1) x36(3)2B1Bu e37(1)1B e38(2)1B e39(6)2B1T1Bu e40(5)3B1T	m16(83)36B1Bu m17(112)37B2C m18(141(62B4T 4Bu1R >19(80)45B1Bu1R >20(70)22B2Bu11C >21(90)35B1Bu x22(31)11B1Bu1T x23(16)2B1Bu x24(23)5B1Bu x25(25)8B1Bu x26(37)12B x27(11)5B x28(14)2B1Bu x29(6)3B x30(5)1B x31(1)1B x35(1) x36(1) e37(11)8B e38(5)4B1R e39(4)1B e40(3)3B e41(2) e42(2)	m18(51)20B1T1Bu 1R >19(54)26B1T1Bu 2C >20(47)19B2T2Bu 2C >21(50)21B x22(56)23B1Bu1C	
5S				#3(9)2B1Bu	#2(7)3B1Bu #3(19)8B #4(25)8B #5(44)13B1T #6(32)9B x7(27)8B1T1Bu m8(59)18B1Bu m9(41)13B m10(36)7B1T1Bu 1C m11(40)10B m12(60)20B1T1Bu 1C m13(39)14B1Bu m14(57)19B1Bu1T m15(52)11B1Bu	#1(4)1T #2(29)3B2T1Bu #3(14)1Bu1C #4(54)18B2Bu #5(9)1Bu1C #6(96)17B2Bu x7(51)12B11C m8(47)15B1T2Bu m9(66)25B2T1Bu m10(7)3B1T1Bu m11(40)12B3T3Bu m12(37)13B1T1Bu m13(60)23B2T1R m14(51)17B2R m15(24)6B m16(23)12B m17(33)13B1Bu
6S			#3&4&5(20)10B 1Bu		#1(9)4B #2(37)16B1Bu #3(2)1T #4(80)32B1Bu #5(29)11B #6(1) x7(20)6B m8(24)11B	#1(36)15B #2(5) #3(20)4B1Bu[3.5-] #4(45)15B #5(3)3B #6(56)20B1Bu x7(16)5B1Bu m8(50)13B1T1Bu
7S					#1(1)1B #3(3)1B #4(9)2B #5(11)7B #6(7)3B	#2(1)1T #4(5)2B #5(3)1B #6(3)1B 6A(7)3B x7(4) m8(8)3B m9(9)2B m10(7)2B

Vestigial metacarpal

Grid	A	B	C	D	E	F
3N						
2N			#3(1)1B m12(1)1B			
1N			#5(1)	#4(1) #6(1)		
1S	m8(1)1B	#6(1)	#3(1)	#1(2)	#2(1)1B	

				#6(1)1B	#3(2) #4(1)	
2S			#5(1) e34(1)1B	#1&2(1) #5(1)1B	#2(1)1B #3(1)1B #5(2)2B m24(1) m25(1)1B	m13(1)
3S	m11(1)	x7(2) m9(1) m12(1)	m9(1) m12(1)1B e30A(1)1B	#3(1) m11(1) m13(1) m18(1)	#4(1)1B #6(2) x7(1)1C m12(1)	#6(1) m14(1) m18(1)
4S			#6(1)1B x7(1) m10(1)	#4(1) m10(1)1B m14(2) >21(1) x29(1)	#5(1)	
5S						#3(1)1B #5(1)
6S						
7S						

Innominate, Pelvis, Sacrum

Grid	A	B	C	D	E	F
3N						
2N		#6(1)1B	#3(1) #4(1)1B #5(2) m13(1)			
1N		#4(5)	#4(5) m9(1)Bu			
1S			m11(2) m13(2)	#3(1)1R	x7(3)	
2S		m9(1)	m11(1) m13(1)1T1Bu m15(1)	m9(1)	m24(1)	m12(1)
3S		m10(1) e33(1)	#6(2) m12(1) m15(1) m17(1) m18(1)1Bu	#4(1)1B x7(1) m8(1) x26(1)1R	#3(1) #5(1)	m10(1)1B
4S			#6(7) m9(1) m11(2) m14(1) >19(1)	#3(1)1B #5(2) m10(2) m14(2)	#5(1) m14(2)	#4(3) #5(1)
5S						#4(1)
6S						#3(1) #6(1)
7S						m10(1)

Carpals

Grid	A	B	C	D	E	F
3N		#3(1) #4(1) #6(1)				
2N		m9(1)	#3(3)3B #4(1)1B			
1N		#4(1) #5(1) m11(1) m12(1)	#2(1) #3(3)3B m9(1)1B			
1S	#2(1)	#4(4)2B #5(1) #6(1)1B m11(1) m16(1)	#3(3) #5(1)1B x7(1) m9(1) m10(1)	#2(5)1B #5(1)1B x7(1)	#1(1) #4(1) #5(1) x7(1)	
2S	#4(1) m11(1)	#2(1)1B #3(1) m8(1) m13(1)1B	#3(2) #4(1)1B x7(1) m10(1)	#1&2(2)1B #3(1)1B #4(1)1B #5(3)	#3(1)1B #4(1) #5(3) #6(1)	x7(1) m8(1) m13(1)1B

		m23(1)	m16(1)	m10(2) m12(1)1B m13(1)1B	m11(1)1B m13(1)1B m20(1)	
3S		#5(2) #6(1) m11(1) m14(2)1B m15(1)	#3(2)1Bu #4(1)1B #5(6)2B #6(2) m8(2)2B m13(1) m14(1) m15(1)	#3(1) #5(2)1B #6(1)1B x7(5)5B m9(1) m11(1) m13(1) m14(1) m16(1)	#3(2) #2(1) #4(4) #6(2) x7(1) m9(1) m12(2)1B m17(1)	m9(1) m10(1)1B m12(1) m14(1) m18(2)
4S			#5(1) #6(1) x7(2) m8(1)	#3(2)2B #4(2) #5(1)1B #6(1) m8(1) m9(2) m11(1)1B >19(1)	#4(3) #5(2) #6(1) x7(2) m8(1) m9(1) m12(1) m13(1)	
5S					#5(1) x7(1)1B m8(1)	#5(1) m11(1)
6S						
7S					#1(1)	#3(1)

Tarsals

Grid	A	B	C	D	E	F
3N		m12(1)				
2N		#6(1)1B m9(1)		m8(1)		
1N		#4(2) #6(1) x7(1)	#2(1)1B #6(1) x7(3) m10(1)	#2(3)3B #3(1)		
1S		#3(1)1B #4(1)1B #6(2)1C[6-] m13(1)	#3(1)1B #4(1) x7(1)1Bu m8(1)1C m10(1) m17(1)	#2(2)1B #6(1) m21(1)1B	#2(3) #3(1) #6(1)	
2S	m15(1)	#5(1) m9(1)1B m10(1) m12(1) m14(1)	#2(1) #3(2) m11(2) e32(2)1R	#3(1) #4(1) #5(3)3B m11(1) m15(1)1B	#4(2)2B #5(1) #6(3)1B m8(1) m9(1) m11(2)1B	m13(1)
3S 3S Tarsal	m9(1) m10(1) m12(1)1B	#6(1) m13(1)1C m16(2)1B m19(1)1B	#5(1) #6(2) m8(1) m11(1) m13(1)	#3(2) #6(5)[6-] x7(3)1[6-]1[6+] m15(1) m17(1) x30(1) e40(1)	#3(2) m13(1)1B	x7(1)1B m9(1) m10(2)1[1.5-] m11(2) m13(1) m14(1) m16(1) m17(1)
4S			x7(1) m8(1) m9(2) m13(1)[5.5+] m17(1) >19(1) >20(1) x22(1) x26(1) x30(3)	#1&2(6) #3(1) #6(1)1B x7(1) m8(2)1B m9(1)[3.5-] m10(2) m14(2) m18(1) >19(3)3T[6+] >20(2)	#2(1) #4(1) #5(1)[6+] m15(1)1B m16(1) m18(1)1B >19(1)1B	#2(1) #4(1)
5S						#2(1)1B #5(1) m8(1) m16(1)[3.5-]

6S						#6(1)1B m8(1)1B
7S						m10(1)1B

Sesamoid

Grid	A	B	C	D	E	F
3N		#2(1)1C #3(1)				
2N		x7(1) m8(3)	#3(1)1B #4(1)1B			
1N		#2(1)1B #4(1) #5(1)1B m12(1)	#5(1) m14(1)1B m20(1)	#2(1)1B		
1S	#4(1)	#1&2(1)1B #3(1)1B	#4(1)1B m13(1) m15(1)	#1(1) m11(1) m21(1)	#4(1) #5(2) #6(1)	
2S		m10(1) m12(1)1B m13(1)	#6(2) m9(1) m12(1) m16(1)	m17(1)	#4(1)1B #5(1) m25(1)	
3S		#5(1)1B x7(1)1B m11(1)1B m15(1)	#4(1)1B x7(1) m13(1)1B >19(1)1B	#4(2) x7(1) m11(1) m12(1) m13(1) m16(1) x31(1)	#3(1)1B #4(1) m8(1)	#5(1) m9(2)
4S			m9(1) m13(1)1B	#4(1) x7(1) m16(1)	#3(1) #5(1)1B m13(2) x22(1)1B	
5S					x7(1) m8(1) m15(1)	m10(1)
6S						
7S						

Undifferentiated phalanx

Grid	A	B	C	D	E	F
3N		#5(2)	#4(1)			
2N		#3(1)1B #4(1) #5(1) m8(1)1B	#2(1)1B #3(1)1B #4(2)2B #5(1)1B #6(4)3B	#3(1) #4(1)		
1N		#3(1)1B #4(1) #6(1)1B m13(1) m14(1)	#2(5)3B #4(1)1B #5(2) m8(1)1B m10(1)1B m12(2)1B	#2(6)3B #5(2)1B		
1S		#3(3) #4(1) m8&9(1)1B m12(1) m15(1)	#3(2) #5(1) m10(1) m15(1)1B1T1Bu m18(1)1B m20(1)1B e29(1)	#1(11) #2(6)4B #3(1) #6(2)1B m9(1) m17(1)1B	#3(1) #5(2)1B x7(1)1B m8(1)	
2S	#4(1)	#4(2) #6(1) m10(1) m11(1)1B m12(1)1B m15(1) m16(3)1B	#2(1) #3(4) #5(1)1B x7(3)1B m8(1)1B m18(1)1B m19(1) e31(1)1B	#1&2(16)1B #3(2) #4(1) #5(1)1B #6(1)1B x7(3)1B m8(1)1B m9(6)2B1Bu m15(1)	#3(1) #4(5)5B #5(2) #6(6)4B m13(1) m14(1) m18(1)	#6(1) x7(1) m13(1)
3S	x7(1)1B	#3(1)1B #5(1)1B	#5(8)1B x7(2)	#3(4)1B #4(2)	#2(1) #3(2)	#6(1) m8(2)

		#6(1)1B m9(1) m13(1)1B m14(1)	m8(1) m9(1) m11(2)2B m13(1)1B m17(1)1B >19(1)1B	#5(1)1B #6(1) x7(2) m8(4)3B m9(1) m12(2)1B m14(2)1B m16(6)1B m17(1) >19(2) x22(2) x26(2) e34(1)	#4(6)4B1R #5(1) #6(3)1B x7(2)2B m11(1) m12(1)1B x23(1)	m9(1) m18(2)
4S			#4(1)1B #5(3) #6(1) m8(2)2B m9(2)1B1C m10(1)1B m11(1) m12(1) m13(2)2B m15(3)1B >19(1) >20(1)1B x23(1)1B	#3(2)2B #4(1) #5(3) m10(4)2B m11(4)2B1R m12(1) m14(1) m15(2) >21(1)1B	#3(2) #4(1)1B #5(3) m9(1) m10(1)1B m11(2)2B m12(3) m13(3)2B	#1(1) #3(2)
5S					#3(1)1B #4(2)2B #5(1) m10(2)1B m11(2)2B	#2(1)1B m10(1) m11(2)1B m13(1)1B
6S					#5(1) m8(2)	
7S						m9(1)

First Phalanx

Grid	A	B	C	D	E	F
3N		#2(1) #5(1)1B				
2N			#5(1) x7(1) m9(1) m11(1)	x7(1)		
1N		#4(1)1B x7(1)1B	#1(1)1R #2(3)1B #6(1) m11(1)	x7(1) m9(1)		
1S	x7(2)2B	m11(1)	#6(1) x7(1)1B m10(1)1B m11(1)	#2(4)4B #4(1) m11(1)1B m12(1)1B	x7(2)	
2S		#3(4) #6(1) m9(1)1B m10(4) m14(1) m20(1)1B	#3(3)1B1C #4(2)1B #5(1) m14(1) m15(1) e30(1) e31(1)1Bu1R	#1&2(1)1B1T #3(1)1R #5(1)1B #6(2)1B x7(1) m9(1)1B m18(1)	#1(1) #3(1)1Bu #4(1)1B #6(4) x7(2)1B m8(3) m9(2) m12(1) m18(1) m19(1) m20(1) m21(1) m25(1)	#3(1) m10(1)1B m12(1)
3S	#5(1)	m9(1)1B m19(1) m21(1)	#5(2) #6(1) x7(1) m12(2)1B m15(2)2B	#3(2)1R #4(5)1B #5(1)1B #6(2)1B m9(1) m14(1)	#2(1) #3(3) #4(2)1B #5(1) #6(1) m9(2)1B	#2(1) #4(1) #5(1)1B m8(1) m9(1) m10(1)1B

				m17(1) x30(1)		m14(2)1B m16(2)1B m17(1)
4S			#2(1)1B #5(1) m12(1)1B m16(1) m17(2)1B1C	#1&2(1) #3(2)1T2Bu #4(2) #5(1) #6(1) x7(2)1B1R m8(1)1B m9(2)1B m10(1) m12(1) m13(1) m14(2)1B1C m15(1) m18(1)1B >19(1) >21(2)1T	#3(5)1B #4(1) #5(1) x7(2)1B m9(1) m11(1) m12(1)	#1(1)1B #2(1)1Bu #5(1)1B
5S					m13(1)	#1(1) #6(1)1B m8(1) m14(2)1B m15(1)1B
6S					#1(1) #2(2) #4(1)1B #5(1)	#1(1) m8(1)
7S						m8(1)

Second phalanx

Grid	A	B	C	D	E	F
3N		m12(1)	#3(1) #4(1)			
2N		m8(2)	#1(1) #4(3) #6(1)1B m10(1) m13(1)	x7(1)		
1N		m10(1) m18(1)	#2(1)1C m8(1) m9(1) e26&27(1)	#2(2)2B #3(1)1B #6(1) m11(1)1B		
1S	m11(1)1B	m10(1)1B m12(1) m15(1)	#4(2)1B #6(1) m10(1) m11(1) m21(1) m24(1)1B	#1(2) #2(2)1B #4(1) #6(1) m8(1) m9(1)1B m12(1) m13(1)1B m15(1) m18(1)	m9(1)	
2S	m10(1) m11(1)	#4(1)1B x7(1) m13(1)1B	#3(1) #4(1) #6(1) m9(1)1C m11(2) m13(1) m14(2) e30(3)	#1&2(1)1B #3(1) #5(1) #6(1) m8(2)1B m9(1)	#5(1) #6(1) x7(1) m8(1) m9(3) m11(1)1B	m8(1) m10(1)1B m13(1)
3S		#5(1) m16(2)2B m22(1)1B	m10(1) m11(2)1B m13(1) >21(1)	#3(1) #4(1) #5(2)1B #6(2)1B m8(1)1B m9(1)1B m12(1) m15(1)1B m16(1)1B	#3(2)2B #4(3) #5(2)1B #6(3)2B x7(1)1B m10(1) m11(1) m14(1)	#2(1)1B #4(1)1B m8(1)1B m10(2)1B m15(1) m17(1)1B

4S			m10(1)1T1Bu m17(2) m18(1)1B	#4(1)1B #5(1) #6(1) x7(2)2B m10(2) m12(1) m14(1)1B x24(1)	#1(1)1B #3(1) #4(3)1B #5(2)2B #6(1) m9(1) m14(2) m17(1) >19(1)	#4(1)1B1C #5(2)
5S					#3(2) #6(1)1B m12(2) m15(1)	#1(1) m9(1) m10(1)1B
6S					#4(1)1B	x7(1) m8(1)
7S					#3(1)1B	m8(1) m9(1)1B

Third phalanx

Grid	A	B	C	D	E	F
3N						
2N		m8(1) m11(1)1B m12(1) m14(1)	#3(1)1B #5(1)1B			
1N		m8(2)2B	#2(1)1B	#6(1)1B		
1S		#4(1)1B m13(1) m14(1)1B	#3(2)1B	#2(2)1B x7(1) m13(1)	#2(1)1B #4(1) #5(1) x7(2)	
2S		#3(1)1B #5(1) m8(1)	#3(1) #4(2) #6(1)	#5(2)	#4(1) m17(1)	
3S	#6(1) m11(2)2B	#5(1) m17(2)1T m19(1) m21(1)	#6(1) m8(1)1B m16(1)1B m18(1)1B	#4(1)1B #5(1) #6(2) x7(1)1T m10(1) m11(1) m18(1)	#2(1) #3(2) #4(3)1B #5(1) m15(1)	#2(1) #3(1) x7(1) m15(1)
4S			x7(1) m9(1) m10(1)1B m15(1) >19(1) x23(1)1B	#6(1) x7(3) m14(1)1B	#3(3)2B #4(2)1B #5(1) x7(1) m10(1)	#2(1)
5S						#4(1) m14(1)
6S					#5(1)1B #6(1)	#3(1)
7S						m10(2)

Vestigial phalanx

Grid	A	B	C	D	E	F
3N			#4(1)			
2N		#6(1)	#4(1)			
1N		m8(1)1B	#2(4)1B #3(1) #4(1)1B m11(1)1B			
1S		#4(1)1B	e29(1)1B	#1(2) #4(1) #5(1) m8(1) m22(1)	x7(1)	
2S		m11(1)	#1(1) m17(1)		m8(1) m13(1) m23(1)	
3S			#4(1) m8(1)	#3(`1) #5(1)	#5(1) #6(2)	#3(1)

			e30A(1)	m8(1)1B x22(1)		
4S			x7(1)	#4(1)1B x7(1) m10(1)	#2(1) #5(1)1B	
5S						
6S						
7S						

Distribution of Bone Tools
Awls

Grid	A	B	C	D	E	F
3N		m10 DL				
2N		#2 DL m10 DL (4) m12 DL (2)	#2 DL #3 DL (2) #5 Dm #5 DL m13 EL	#4 D metatarsal m8 DL		
1N	#1 R tibia	#3 DL #4 DL (2) #5 D metatarsal #6 DL m9 D ulna m11 DL (3) m16 DL(2)	#2 DL #3 DL (2) #4 DL (2) #5 DL (3) “(1) D metatarsal m8 DL m9 DL m10 DL m11 D radius “ DL m14 DL e28 Dm “ DL	#3 DL e27 DL		
1S	#3 DL m8 DL m8 D femur m10 DL m13 DL m14 DL	#1/2 DL (2) #5 DL #6 DL m8/9 DL m13 DL m14 DL (2) m19 il e30 DL	#6 DL m12 DL (2) m13 il m19 DL m25 D humerus e31 DL e32 DL e35 DL	m11 DL m13 EL “ DL m22 DL m24 DL	#2 D metatarsal #3 DL #5 DL (2) #6 DL (2)	
2S	#3 DL m9 DL (2) m11 DL (3)	#3 DL #4 Dr “ DL (2) #5 DL #6 DL (3) m9 DL m13 DL m15 DL (2) m16 DL	#3 DL #5 DL #6 DL m12 DL m13 D innominate m15 DL “ il m16 DL	#1/2 DL #4 DL #5 D metatarsal #6 DL m11 DL m19 DL	#5 DL (2) #5 D radius m18 DL	m9 DL m13 il “ DL
3S	m9 DL m11 DL	#1/2 DL m8 DL m12 DL m14 DL m15 DL m17 D 3rd Phalanx m18 DL m19 DL “ Fox ulna (2) m27 Dr e32 Dm	#4 Human 3rd metatarsal #4 il (2) #5 Dr #5 DL (2) #6 D metatarsal m9 Dm “ DL m11 D radius “ DL m12 DL “ RL m14 DL (2) m17 il “ Dm (3) m18 DL (2) Dm(1) >21 DL e36 DL	#3 il #4 DL #5 DL #6 DL m8 DL m9 DL m12 D tibia “ DL m13 DL m17 Dr m18 DL(2) e34 DL	#4 il(2) #5 DL #6 DL “ Dr m10 DL m11 DL m17 il	#4 DL m8 DL “ il m10 DL m11 Dm m12 DL m14 DL m15 DL (2) m16 DL (2) m17 Fox L m18 D metatarsal

4S			#4 DL #5 DL m8 DL(2) m9 D metatarsal m11 DL m14 DL (3) Dradius (1) m15 DL m16 DL (4) m17 DL m18 DL (3) >19 DL " RL >20 Dm " DL (5) e39 DL e40 DL	#3 DL #5 il m8 DL m9 DL m10 DL (2) m18 DL (2) >21DL	#5 DL (2) #6 DL (2) m10 DL m12 Dm m18 DL " imL " il >20 DL (2)	#2 DL (2) #3 D vertebra #4 D metatarsal
5S					#5 DL m14 DL	#1 DL #2 DL (2) #3 D tibia #5 D R metacarpal m8 DL m10 DL m11 DL (2)
6S						#1 D radius #3 D antler #5 D humerus m8 D tibia

Beads, L = longbone

Grid	A	B	C	D	E	F
3N						
2N		#3 Rm	#3 Rm #3 Rp	#5 ib		
1N		#3 Ri #5 Rm #6 RL e29 RL	#1 Rm #2 Rm m23 eagle L	#3 D antler tip #4 RL		
1S	#4 RL	#3 RL m14 RL m15 R tibia	#2 RL #3 ibL #4 ibL " Rp m12 Rm m15 Dp e33 ibL	#1 R tibia #2 i bird L #3 ib " R tibia #4 i mb L #5 ib m9 ibL m10 ibL m14 ib	#3 coyote m #4 RL #5 RL (3) m8 DL	
2S		#4 RL m12 R humerus e33 RL	#6 RL m11 RL m15 Rm m17 ib m18 imL m20 RL e30 RL e32Rm e33 Rp	#4 RL " Rm #6 Rm " owl L m8 coyote metatarsal m10 RL	#2 RL (2) #3 RL #4 eagle L " DL #6 i bird L m9 RL	#4/5 Rm m8 Rm
3S	m12 RL	#5 RL	#4 il m8 RL	#5 Rm " RL	#3 RL (2) #4 RL	m8 Rm m11 ib L (2)

			m14 Rm	#6 Rm #6 RL m9 RL m15 Rm e39 RL	#5 DL #6 RL m8 i bird L m9 RL “ i bird L m11 il bird L	m12 Rp
4S			m10 ibL m13 RL >19 Rm	#1/2 RL #4 Ri “ RL #6 RL m8 Rm m10 RL “ JRm m12 RL >19 Rm e40 RL	#3 RL #5 RL m12 RL “ Rm	#3RL (2)
5S					m8 R tibia m10 Rm m12 ib	#1 Dr “ coyote L #6 RL
6S						#1 RL

Generic Tools

Grid	A	B	C	D	E	F
3N						
2N		#5 DL	#1 R tibia #3 DL #4 DL #6 coyote metatarsal “ DL m8 DL	#3 DL		
1N	#1 D tooth	#3 DL	#2 DL (2) #3 DL (2) #4 Dr m9 DL m10 DL m11 Dr m13 DL m15 DL m15 D tibia	#3 E metatarsal “ Rulna rabbit	#5 DL	
1S	m9 DL m14 DL	#3 DL m10 D radius m12 Bison L m13 Rm m15 DL m21 DL	m11 DL m18 DL m19 DL (2) m21 D metatarsal m22 DL e30 RL e33 RL e36 DL	#2 Dr “ il “ D toorh #4 D humerus #5 il #6D femur m23 DL	#2 DL #3 DL #5 DL m8 Dm	
2S	m8 DL m13 DL m16 DL	#5 DL m10 D radius “ DL m12 Dm m13 D tooth e33 DL	#2 DL m8 DL m11 D femur “ DL m12 DL m17 D metatarsal m20 imL e31 DL	#1/2 D 1^{st} p #6 DL m16 DL	#3 DL #5 DL(2) “ D scapula Spine “ Dr #6 Dr “ D scapula m8 DL m9 DL m18 DL	#6 DL (2) m10 DL (3) m12 il m12 Dr m13 Dr
3S	m9 DL	m8 D scapula Spine	#3 DL #5 D femur	#4 D metatarsal	#3 DL #4 DL	#6 DL m10 il

		m11 DL m15 DL m21 DL	#5 DL m11 DL m12 DL m13 DL m14 Dm “ Ri m15 DL m16 D ulna “ DL (2) m17 il m18 DL (2) >20 D toorh e33DL(1)1T	“ DL #5 DL “ ilL #6 DL m11 DL m13 coyote m m16 DL m17 DL	#6 DL (4) “ Dr m10 DL m11 DL m13 D metacarpal “ D skull m17 DL >20 D mandible	m12 D metatarsal m14 DL m15 DL m16 il m17 DL
4S			#5 DL #6 DL “ Dr m8 DL m9 DL (2) m10 EL “ D 2nd P m13 il m14 DL m18 DL >21 il	#4 D scapula “ DL #5 D radius #6 D metacarpal “ Dr m8 D metacarpal m10 DL “ il m11 D incisor “DL m14 D metacarpal m18 DL (2) “ Bison L “ R femur >19 D ulna “ Dr >21 D 1st p “ ilL Fill24 D Scapula spine tool	#4 DL “ D radius #5 D metatarsal “ Dr #6 D metatarsal “ DL (3) “ EL m9 DL (3) m12 DL (2) m18 D femur >19 D metatarsal “ DL	#1 D radius #2 ilr
5S					#5 Dr m10 DL m12 DL (2)	m9 DL “ *Bison* scapula m11 DL m12 DL m13 ilL “ DL (2)
6S					#3 DL	#6 D radius m8 E tibia m8 DL

Scrapers

Grid	A	B	C	D	E	F
3N			#2 DL			
2N		#3 EL #5Dm	#5 D radius			
1N		#6 BL	#2 DL			
1S	m9 DL	m16 EL	#1 BL m13 ilL “ DL m15 DL m16 Dm m22 DL	#1 D scapula #2 DL	#2 D mandible “ DL #3 Dm #6 DL	
2S		#3 D tibia	#4 DL			m9 DL

		m13 DL	m11 Dr			
3S		m22 DL	#4 D humerus #5 DL #6 DL m8 D radius m9 Dhumerus hide scraper m10 D radius m12 DL " Dm m13 DL m16 EL	#3 DL m11 Bm e37 D radius	#2 DL	m8 Dm m10 DL (2) 1 end scraper m12 DL (2)
4S			m9 DL (2) m11 DL m16 D tibia m17 D radius >19 DL	#3 D scapula	#6 DL	
5S						
6S						

Abraders

Grid	A	B	C	D	E	F
3N			#3 DL			
2N						
1N						
1S		m13 DL				
2S			m10 ilL " BL			#2 DL m10 DL
3S		m18 D humerus		#6 DL		m11 Dr
4S						#2 DL
5S						m10 EL
6S						

Smoothers, Gouges, Gravers, Miscellaneous, and Shaped Bone

Grid	A	B	C	D	E	F
3N		Gouge m8 B tibia Gouge m10 D radius				
2N		Gouge #4 D metatarsal Serrated bone #6 DL Grooved bone m9 Dr Gouge m13 D humerus	Serrated bone #3 DL Gouge #5 D metacarpal Gouge #6 DL	Incised tooth #5 D tooth		
1N		Notched saw m13 DL Smoother e28 Dr	Flake m16 il	#3D antler tip Cut bone m16 DL		
1S	Gouge m10 DL	Incised grooved #3 DL Thimble #3 DL Graver	Shaped bone m15 coyote radius Gouge m25 B tibia	Polished bone #6 DL		

		m10 DL Gouge m17 DL				
2S	Burnisher #6 DL	Antler tip #3 D antler	Smoother #3 D metatarsal Smoother #3 Br Shaped bone m13 il Notched m14 Dr	Gouge m19 DL	Incised pendant m14 E tooth	
3S			Eliptical Grooved m10 DL Incised >19 il	Hammer #6 D tibia astragulus calcanium Shaped bone m10 DL Carapace m10 turtle	Cut bone #3 D vertebra Antler tool #4 E antler Carapace m13 Turtle Carapace m17 Turtle Polished bone m17 ilL shaped	Smoother m11 DL Gouge m16 EL
4S			Flesher m9 D metatarsal	Drilled bone #3 D1st phalanx Hammer >19 D astragulus calcaneum		
5S						Gouge m9 DL
6S						Antler tool #4D antler

Decorated bone

Grid	A	B	C	D	E	F
3N						
2N						
1N				m17 il		
1S		#7 il m15 DL		m15 il m16 Dr m18 il porcupine		
2S		m9 DL m17 DL e32/32A Dr		m14 il	m12 DL	
3S			>21 il	m9 DL	m9 DL	
4S			x22 DL x26 DL	m14 il		
5S						
6S						

Symbols used

# = EC =Early Ceramic (EC)	D = deer
m = Middle and Late Archaic (MLA)	R = rabbit
m = metapodial	i = indeterminate
im = indeterminate medium	B = bison
> = Upper Early Archaic (UEA)	L = longbone
e = Lower Early Archaic (LEA)	l = large
p = phalanx	s = small
E = elk	b = bird
s = small	r = rib

Shirley

Site
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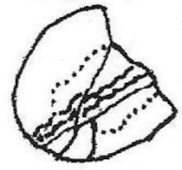
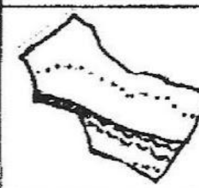
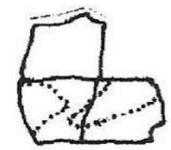
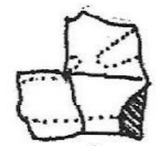
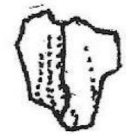
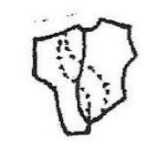
p. 1

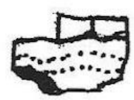
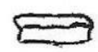
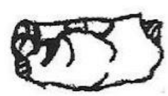
number	Location	length (cm)	width(cm)	thickness (cm)	decoration	Photo/drawing Front	Photo/drawing Back
6808	D2-L14	2.12	1.98	0.21	Punctate designs of dots and wavy lines		
15545	C3-L21	1.25	0.70	0.25	Single line of dots on front		
21436	D1N-L17	~~0.96~~ 1.39	0.75	0.17	Dots on both sides		
17518 & 38196	D1-L16 E2-L3	2.64	1.35	0.29	Wavy pattern and dots on both sides		
17616	D1-L18	1.84	1.73	0.28	Dots and wavy pattern along one edge on both sides and etched image of possible animal on front		
38119 36812 18890	E2-L12 C4-L26 C4-L22	1.13 1.13 0.99	0.94 1.08 0.85	0.17 0.23 0.21	Patterns of dots on both front and back		
27796 27136	D3-L8 B2-L9	1.54 1.52	0.66 0.73	0.22 0.28	Dot patterns on front and back		

Shirley

Site

5JF321

P. 2

number	Location	length (cm)	width(cm)	thickness (cm)	decoration	Photo/drawing Front	Photo/drawing Back
27305	B2-L17	1.61	0.49	0.17	Single line of dots on front and back		
37227	B1-L15	1.68	0.86	0.33	Dot pattern on front and a few scattered dots along broken edge on back		
38195	B1-L7	1.0	.40	.15	Single line of dots on front		
38198	E3-L9	.90	.80	.20	Single line of dots on front and back		
38194 38199	D1-L15 D4-L14	1.0 1.0	.50 .60	.20 .20	Wavy pattern on front and back		
38197	B2-L32	2.0	1.90	.40	Random curving lines and leaf-shaped pattern on front		

Appendix F: Historic Use of Swallow Site

Fred Rathbun and Wilford Couts

Editors' Note. While Swallow is primarily an ancient indigenous site, historic artifacts were collected from the surface and upper levers. Euro-American occupation of the property began around 1859, with cattle ranching operations active from 1885 until 1980 (Johnson and Mobley-Tanaka 1997). Historic use of the rockshelter occurred during this time and seems to have served primarily two purposes, first as a shelter/shade for cattle, and second as a site for target practice. These two activities created the historic deposits at the site. As those layers were removed in the earliest years of excavation, a brief discussion of them was presented by Fred Rathbun in the 1991 interim report.

In his time directing final report efforts, Hammond did not envision a full report of historical materials; however he did enlist fellow CAS member Wilford Couts to count and summarize historical materials collected. Couts's numbers varied from those reported by Rathbun, mainly because excavations were expanded after 1991 and historical materials were recovered in upper levels in units that had not yet been dug by the time of Rathbun's writing. Beyond a more complete count of historical artifacts and a plot map of where they were found on the site, Couts did not complete a narrative to finalize a report chapter or appendix.

While it is appropriate that what is known of historical materials at the site be included in the final site report, the Oversight Committee did not have the resources to complete an analysis of the historical materials from the site, and as those materials were not deemed particularly significant to the understanding of historic occupation of the region, it was decided to reprint Rathbun's original Interim Report, with minor modifications to update the complete numbers of artifacts drawn from Couts's later compilation.

Historic Levels

<u>Animal Dung Layer</u>: The surface of the flat floor area of the shelter is covered by a few cm of compacted and partially decomposed cattle dung. This uppermost layer is mostly restricted to the area inside the modern dripline, is of recent origin, thought to be less than 150 years old. It supports very little plant growth, and contains very few artifacts.

<u>Sand wash Layer</u>: Distributed over the entire site is a 0-20 cm think layer of soft, coarse, red sand derived mainly from the face of the bluff, and to a minor degree from sheet wash from upslope areas to the northwest and southeast. The sand appears to be an incipient A soil horizon, and supports roots and plant growth. It thins toward the interior of the shelter, where it merges with the dung layer. It is considered to be in part older and in part contemporaneous with the dung layer. Where the sand layer underlies the dung layer, it is seen as a hard, packed brown sandy layer.

The contact of the base of the red sand layer with the underlying dark gray prehistoric cultural layer is abrupt and distinct, suggesting an erosional unconformity between the two layers, or at least a drastic change in depositional conditions. A missing time interval above the uppermost prehistoric layer is implied by the contact: that the interval is indeed missing seems to be confirmed by the radiocarbon date of 1370 RCYBP for a firepit some 20 cm below the surface, and about 5 cm below the base of the historic layer. In general, the top of the prehistoric layer exhibits the same slope and configuration as the surface of the sand layer, that is to say, the present ground surface.

There is some mixing of prehistoric and historic artifacts in both the historic sand wash level and in the upper part of the underlying prehistoric level. The few historic artifact which occur in the prehistoric level can likely be attributed to rodent activity. Prehistoric artifacts in the wash layer are more likely to be the result of erosional displacement or human activity. At this time, the sand wash layer is considered to have emplaced in historic time, and the layer directly below is considered to be of prehistoric origin, despite some mixing of cultural materials. By implication, there is at least a 600 year time gap between these two layers.

Historic Artifacts

Figure 1 shows the areal distribution of historic artifacts for the excavated portion of the site, along with depths from surface to the deepest historic item recovered from each square. Total historic recovery is 218 items. One hundred eighty-one of these items, 83% of the total, were recovered from rows A, B, and C, the rows farthest distant from the interior of the shelter.

Historic artifacts recovered include bullets; bullet fragments of lead, copper, and steel; brass cartridge cases; glass; wire; nails; horseshoe nails; plastic; staples; miscellaneous metal fragments; and a steel animal trap.

One hundred fifty-one bullets, bullet fragments, and bullet casings have been recovered, accounting for 69% of the total historic recovery. Most items in this category were battered bits of lead and strips of copper jacketing, probably having been fired from some distance at one of several crudely circular painted red targets, some 60 cm in diameter, on the face of the bluff. One of the more complete fragments was identified by Randy Graubard as being from a bullet current in the 1880s. An intact steel core from an armor-piercing 30-06 military cartridge used in World War II and Korea was identified by Vince Rathbun of the Denver Gunsmithing School. One complete bullet, slightly dented and battered at the tip, was found near the rock wall, evidently its energy was spent before it either hit the rock face or fell short in the dirt. This bullet appears to be the one used in the .30 caliber military carbine of World War II and Korea. Presumably the military cartridges were obtained after World War II as war surplus for target shooting.

Brass cartridge cases make up a small portion of the bullet count, the 8 specimens collected amounting to 5.2% of the ammunition total, and 3.75% of the total historic artifacts. Calibers included .30 and .22, both popular hunting calibers. The shelter and the vertical slabs at the north end of the site could have been used as historic hunting blinds or vantage points overlooking the terrace and waterhole to the west, however the small number of casings compared to the larger number of bullet and bullet fragments suggests that the majority of shooting took place from farther outside of the shelter, and was probably target practice, aimed at the rock face or at bottles set up in front of it.

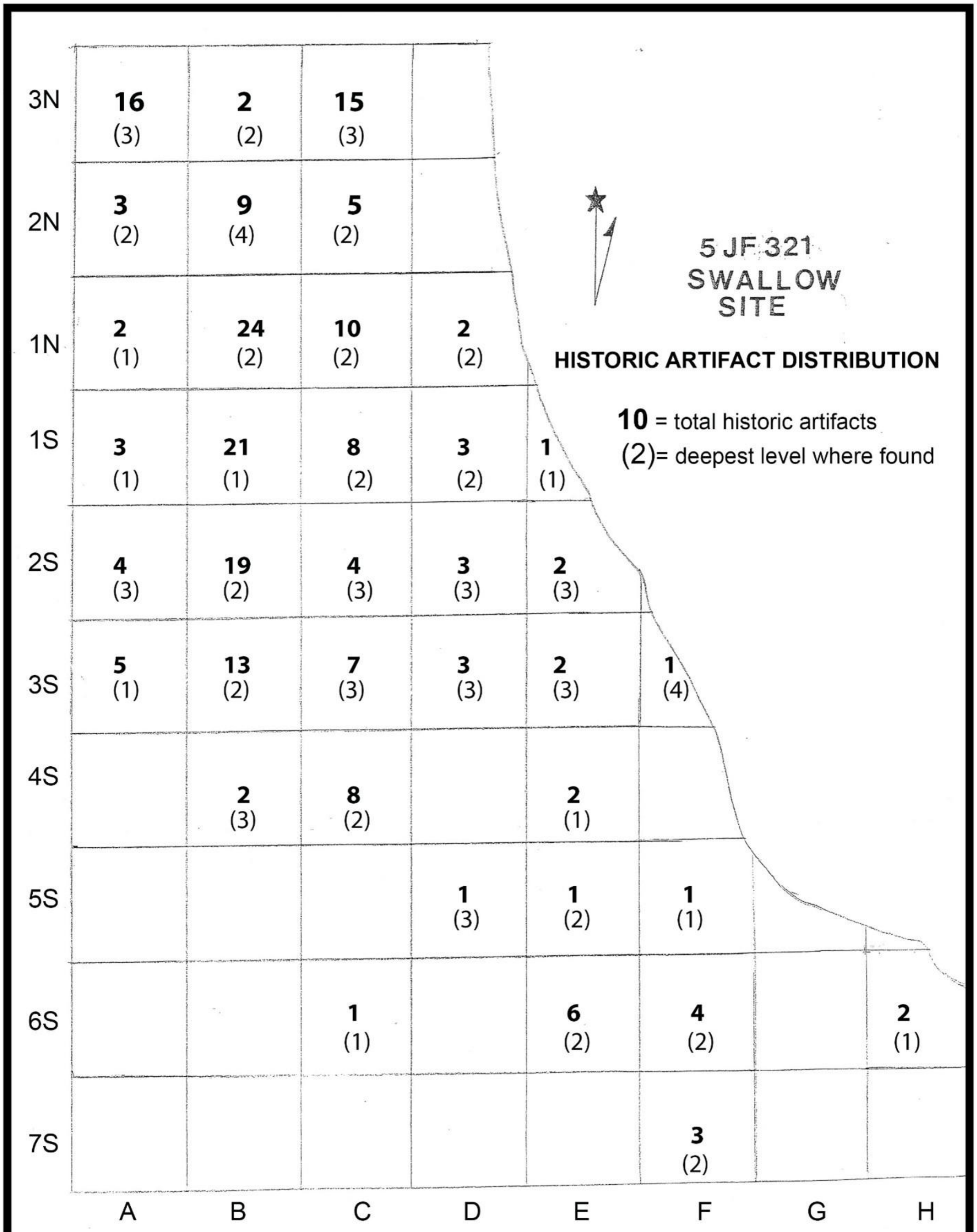


Figure 1. Distribution and maximum depth of historic artifacts at Swallow. The majority of historic artifacts are found in columns B and C rather than close to the shelter wall.

Forty-three glass shards, 19.6% of the total, consist mainly of bottle fragments. At least one shard appears to have been worked as a uniface tool, although cattle trampling could also account for the observed edge "retouch." A more complete analysis might be warranted.

Two bits of plastic, 0.9% of the total, may have been cartridge parts.

The remaining 22 artifacts consist of metal objects, some identifiable and others only fragments.

One horse-shoe nail, 0.4% of the total was found. Other nails, staples, and bits of wire, cumulatively 7.8% of the total, were probably from fence repairing operations. Three metal fragments could not be identified as to form or function.

A completely rusted steel trap, used for the taking of small animals, was recovered from the southwest corner of E3. The trap was about 30cm below the surface, probably having been dragged into a hole by an escaping animal. No animal remains were associated with the trap.

Thus, the record of historic activity, though minimal and superficial, does indicate varied casual uses for the shelter, presumably by ranch hands from the Ken-Caryl cattle ranch. The historical sheltering of cattle at the location altered the surface through the deposit of dung and the churning of materials by hooves, and was likely responsible for substantial mixing of materials in the upper levels of the site.

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1997 The Ken-Caryl Ranch: A Brief History. In *Archaeological Investigations at the Ken-Caryl Ranch, Colorado*, by Ann M. Johnson, J. Frank Adkins, Cecile Beal, Jerry Beal, Florence Irish, Ray D. Lyons, Harry Quinn, Fred Rathbun, Diane Rhodes, Anne Sands, Marcia J. Tate, William H. Tate, and Jeanne Mobley-Tanaka, pp. 1-4. Memoir No. 6. Colorado Archaeological Society, Denver.

Rathbun, Fred C.
1991 *Swallow Site, 5JF321, Hogback Valley, Jefferson County, Colorado: Interim Report,1991*. Report on File, OAHP, History Colorado, Denver.

Appendix G: Blood Residue

Richard Marlar

Double-click the icon to access the blood residue data spreadsheet: