PALEOETHNOBOTANY OF INSCRIPTION HOUSE, ARIZONA: SUBSISTENCE IN NITSIN CANYON

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ABSTRACT

This report describes the results of an analysis of macrobotanical material and pollen from an eroded portion of a midden at Inscription House, an 80-room cliff dwelling in the Kayenta region of northeastern Arizona in Navajo National Monument. Navajo National Monument salvaged the recently eroded portion of the midden before the material washed away from the site and contracted the archaeological investigation of the material to Anthropology Laboratories at Northern Arizona University through the Colorado Plateau Cooperative Ecosystem Studies Unit (CPCESU). The contract from Navajo National Monument requested that the Anthropology Laboratories analyze the pollen and macrobotanical material from the salvaged portions of the midden. I conducted the analysis of the botanical material and examined the paleoethnobotanical data to determine the reasons for a migration from the area around A.D. 1300.

Archaeologists continue to debate the reasons behind the Ancestral Puebloan migrations on the Colorado Plateau. Most of the previous research focuses on the broad environmental changes that occurred during the 13th century. Previous research, however, failed to account for the variation of environmental changes in local ecologies. My study examines the capacities of the local ecologies during prolonged or erratic periods of aridity to support the Inscription House community during the Pueblo III Period (A.D. 1150-1300).

The Inscription House community may have implemented risk management strategies to mitigate the effects of environmental deterioration. Risk management strategies consist of dietary changes. Certain changes in diet reveal evidence for a migration due to a drought. A community, for example, sometimes consumes a greater diversity of plant species if a more arid climate reduced the productivity of favored local plant populations.

Analysis of the botanical material from the Inscription House midden, in comparison to previous research in the area, reveals no evidence for the use of a risk management strategy. A lack of risk management strategies suggests that the Ancestral Puebloans migrated from the cliff dwelling for alternative reasons. Through the analysis of diet at Inscription House, the research will add to the development of local cultural trajectories for the migrations that occurred on the Colorado Plateau and add to the understanding of the occupation of Inscription House.

ACKNOWLEDGEMENTS

A special gratitude goes to the National Park Service. Without the opportunities provided by Navajo National Monument, I would have never completed the research. The funding, access to materials, and support provided by the national monument made the entire project possible.

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Chapter 1.

Introduction

This report documents research on paleoethnobotanical data from recently salvaged midden deposits at Inscription House (NAVA 6) on Navajo National Monument lands in northeastern Arizona (Figures 1-3). The project took place under National Park Service Cooperative Agreement Number H1200040002 and took place under the title "Inscription House Midden Recovery and Research Project."

Inscription House is an Ancestral Puebloan cliff dwelling occupied from the Basketmaker III (A.D. 500-700) Period to the end of the Pueblo III Period (A.D. 1150-1300), when the Inscription House inhabitants migrated from area. During the summer of 2008, National Park Service personnel reported a significant detachment and slump of material from the in situ Inscription House midden. The slumped material had fallen down the slickrock in front of the site and the threat of imminent total destruction of the material by monsoonal rains resulted in the National Park Services's decision to salvage the material. Accordingly, the material was mapped and removed by provenience unit blocks from the slick rock and conveyed to Navajo National Monument.

The National Park Service contracted with Anthropology Laboratories at Northern Arizona University for the paleoethnobotanical analysis of the midden deposits. Consultations with affiliated tribes determined that only paleoethnobotanical research and radiocarbon dating should be conducted on the materials and that no artifactual materials should be analyzed. Accordingly, this report presents the paleoethnobotanical analysis and the radiocarbon dating results. Because of the timing of the migration from Inscription House during the grand regional Ancestral Puebloan migrations and aggregations, the paleoethnobotanical research focuses on potential dietary changes that might inform us about the causes or nature of the migration or pre-migration life at the pueblo.

I examined the diet of the Inscription House community during a period of heightened aridity and increased population size to try to detect dietary changes that might indicate the implementation of risk managment strategies. The implemenetation of risk managment strategies might suggest that the Inscription House community experienced dietary stress as a result of a deteriortating environment caused by the effects of increased population pressure and heightened aridity. Dietary stress could explain the migration from Inscription House by A.D. 1300.

Populations under nutritional stress should implement risk management strategies. Risk management strategies consist of an increase in the range of plant foods consumed and an increase in the consumption of starvation foods. I looked for evidence of risk management strategies by analyzing the plant material from the recently slumped portion of the midden that was located directly in front of the main structures of NAVA 6.

Inscription House, an 80-room cliff dwelling, lies deep in the Navajo and Nitsin Canyon systems southeast of the Colorado River. The prehistoric inhabitants of Inscription House appear to have migrated from the area during the same period as the Ancestral Puebloan migrations that substantially depopulated the Kayenta region from A.D. 1275-1300. This research (Inscription House Midden Project) examines the paleoethnobotanical data to explore the causes behind the Inscription House migration. The following chapter introduces the Inscription House Midden Project and background of the site.

The Study and Research Questions

The Ancestral Puebloans permanently occupied Inscription House (Figure 4) during the Pueblo II-III Periods (A.D. 1050-1300). The Inscription House community migrated from the region by A.D. 1300, after a period of regional population dispersion and aggregation. Archaeologists continue to debate the reasons for migration (Ambler 1985). The cited reasons range from social and cultural factors (Axtel et al. 2002) to environmental deterioration resulting from population pressure and a drought (Dean 1988). Increased population pressure and increased aridity likely affected the production of agricultural plants and altered the local plant communities. Changes in the availability of plants possibly caused changes in the diet. I examined changes in the diet of the Inscription House community to look for support for theories of the causes that led to the migration from the region by A.D. 1300.

If the environment was no longer capable of supporting the Inscription House population in the Nitsin and Navajo Canyon systems, I hypothesized that the archaeological record will demonstrate risk management strategies. Risk management strategies might consist of the use of a greater diversity of wild plants as well as an intensive use of less desirable flora that served the population as starvation foods (Minnis 1996; Colson 1980; and Spielmann and Angstadt-Leto 1996). Changes in diet might signify the degree to which local environmental changes and population pressures affected the migration from the area.

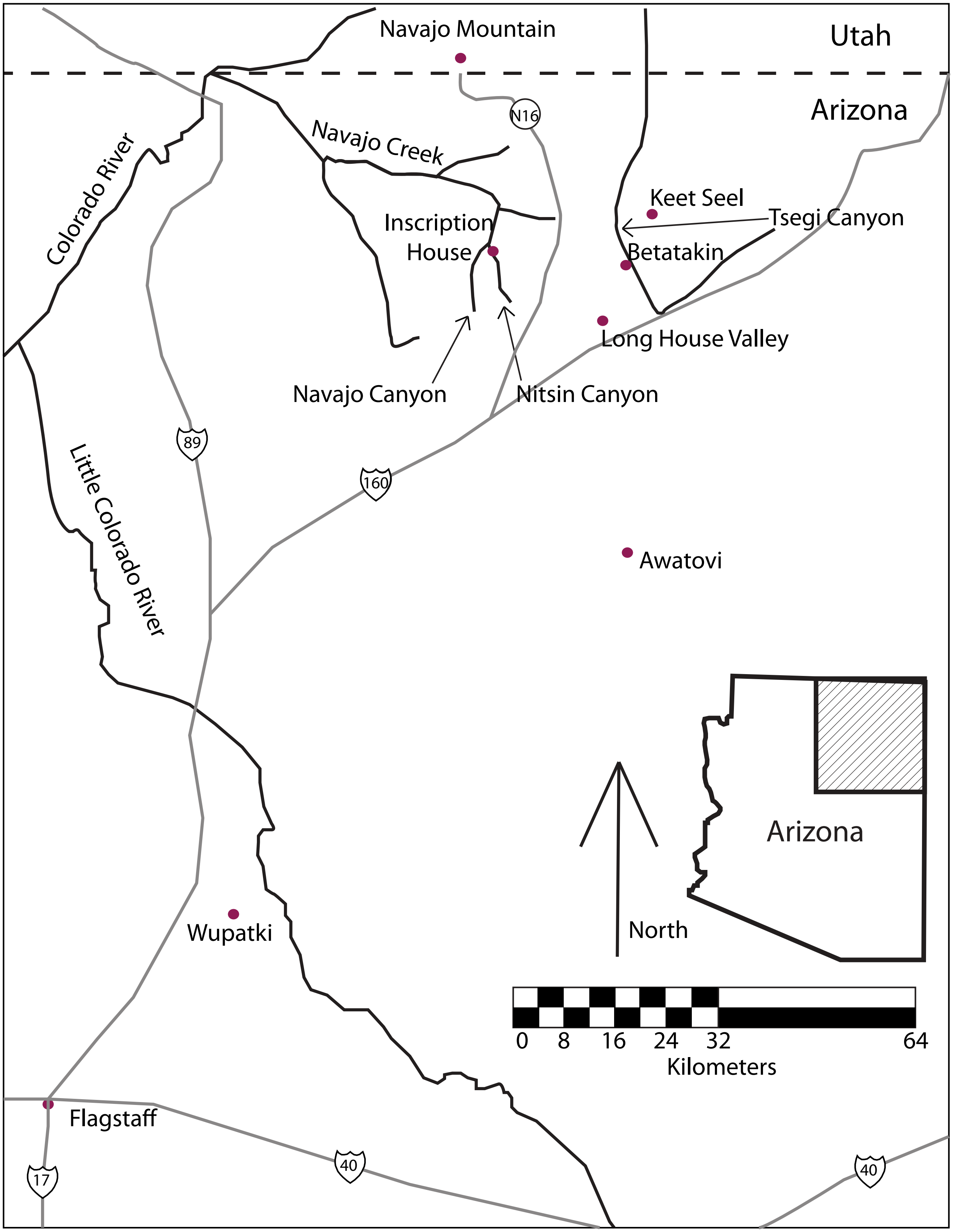


Figure 1. Map of northeastern Arizona.

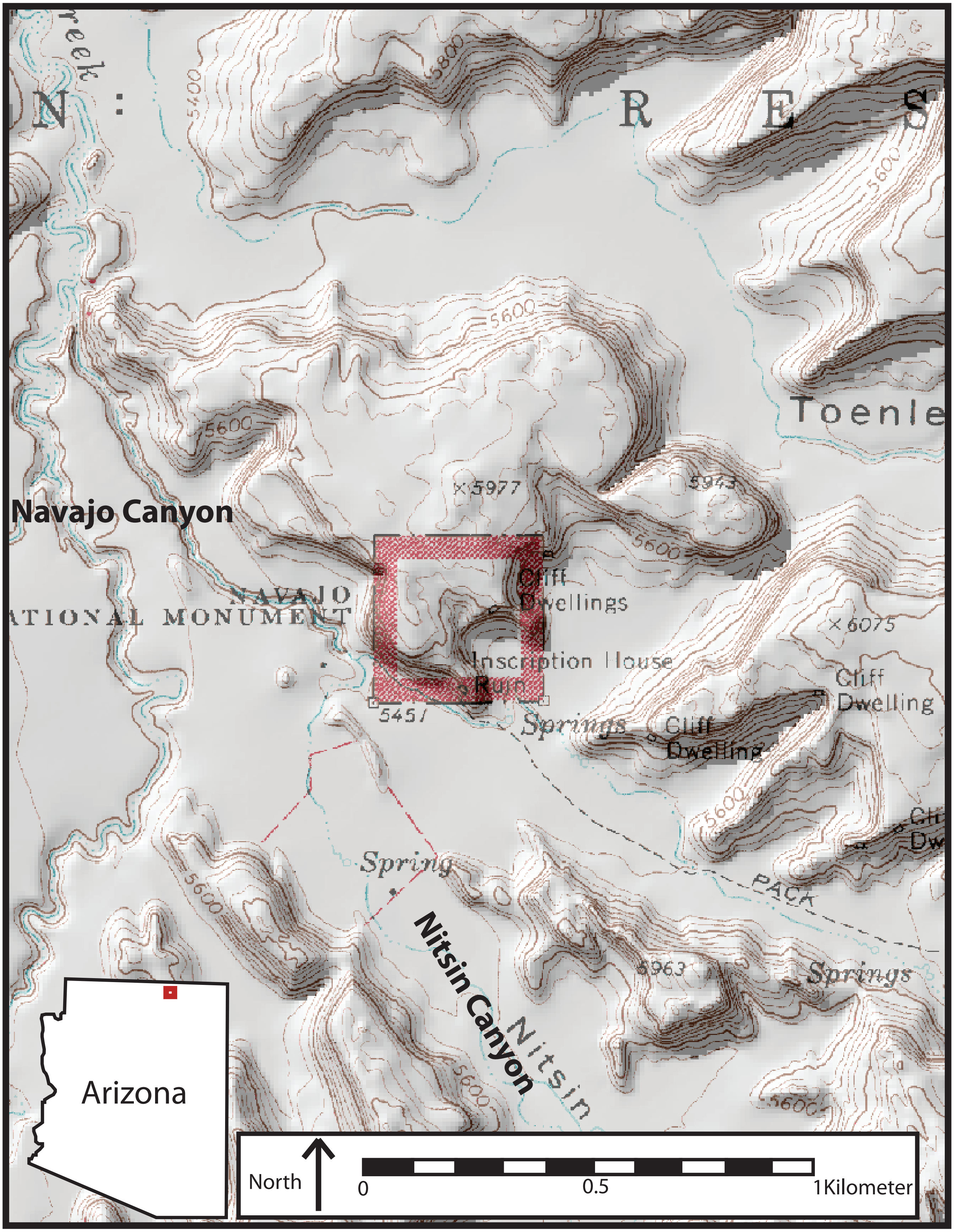


Figure 2. Topographic map showing the location of Inscription House in red (after U.S. Geological Survey 1970).

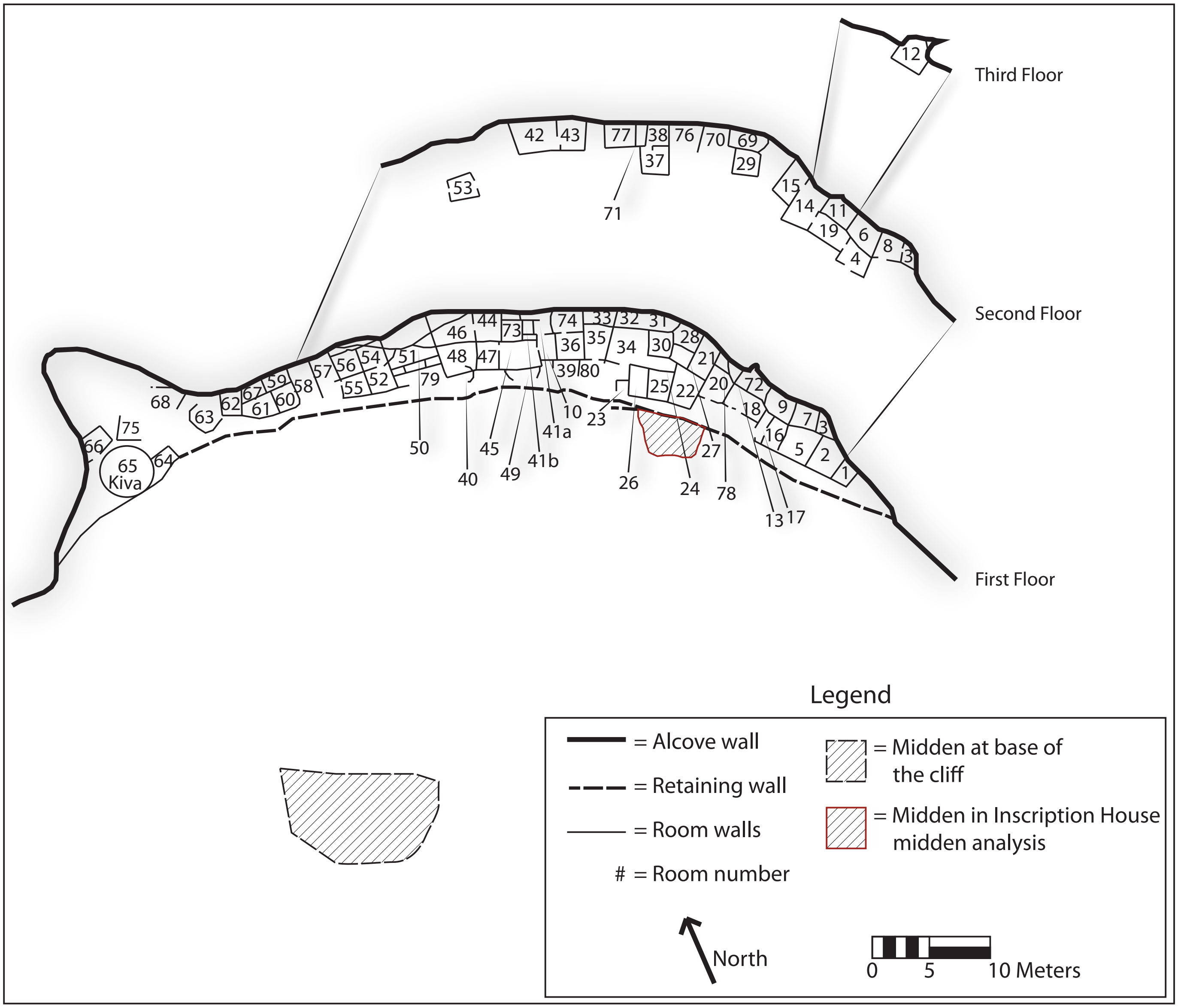


Figure 3. Planview of Inscription House (after Ward 1975:25).

Figure 4. Photograph of the main architectural complex of Inscription House.

I examined the diet by analyzing paleoethnobotanical evidence from a portion of a midden (Figure 5) at Inscription House that recently eroded from a ledge directly in front of the site. The midden consists of room and hearth trash deposited over a period of 300 years, approximately A.D. 1040-1300, by the original inhabitants of the site. The trash deposits reveal important information on the prehistoric life ways of Ancestral Puebloans. The National Park Service made several recovery trips to collect the portions of the midden under immediate threat of destruction by erosion in 2008 and contracted Northern Arizona University to study and recover the botanical data from the midden. I conducted the analysis of the botanical material from the midden.

The midden also contained low frequencies of ceramics, lithics, textiles, and other artifacts. The lithic and ceramic data appear in Appendix F and focused the report on the botanical materials. Navajo National Monument requested that Anthropology Laboratories not examine textiles and certain artifacts as a result of the consultation process. Accordingly, only counts of tribal materials appear in Appendix G.

The National Park Service project provided funding for macrobotanical analysis and limited pollen analysis. The midden matrix, however, was open to the elements before analysis began. The exposure of the midden resulted in the accumulation of relatively high counts of modern pollen in the samples. Modern pollen rain skews the data causing an inaccurate interpretation of the prehistoric pollen record. I determined that the modern pollen rain compromised the data. While I added the pollen data to the report for the contract, I focused the analysis of the botanical data from the midden on the macrobotanical data.

This research investigates the dietary information obtained from the midden in comparison with previous macrobotancial and pollen analyses from the site and similar sites in the region. A comparison of previous research with the Inscription House midden data suggested that no drastic changes occurred in the Inscription House diet during the Pueblo II-III Periods. Changes in diet may signify the degree to which local environmental changes and population pressures caused the migrations that occurred in the region. The analysis of plant use in the Inscription House community adds to the knowledge of the poorly understood Pueblo III Period (A.D. 1150-1300).

Inscription House: Location, History, and Archaeology
Inscription House sits in the south facing wall of Nitsin Canyon, a drainage south of Navajo Mountain, in Navajo National Monument. The Inscription House land is detached from the main monument area that consists of Betatakin and Kiet Siel. The detached parcel encompasses a plot of land on the northern side of Nitsin Canyon, approximately half a mile southeast from Navajo Canyon.

Geography, Environment, and Ecology
The Navajo and Nitsin Canyon systems provide a varied geological and ecological environment. The local ecology changes depending on the slope, the availability of water, and the elevation of the area. The elevation ranges on the canyon floors from 5,451 to about 6,000 feet above sea level. The canyon walls reveal exposed layers of Navajo, Kayenta, and Wingate Formations that date to the early Jurassic period. The oldest geological layer of the three previously mentioned formations consists of Wingate Sandstone.

Wingate Sandstone is red, cross-bedded sandstone formed from eolian, or windblown sand. Sand and silt deposits from rivers later covered the Wingate Sandstone to eventually form the Kayenta Formation. The Kayenta Formation consists of layers of red to brown sandstone and siltstone. A third red sandstone formation, called Navajo Sandstone, overlies the Kayenta Formation. Navajo Sandstone formed from a second period of eolian sand deposition. The eolian sand developed into a second geological layer of red cross-bedded sandstone. The geologic formations later uplifted as a result of tectonic movements approximately five million years ago. The uplift caused streams to cut deeply into the geological formations. Erosion of the Navajo, Kayenta, and Wingate Formations eventually created the Navajo and Nitsin Canyon systems.

The Nitsin and Navajo Canyons generally receive greater annual precipitation and have lower temperatures than environments below 4,500 feet. Brotherson et al. (1978:19) document in an analysis of shrub species at Navajo National Monument that the Monument ranges in temperature from 38 degrees Celsius to -23 degrees Celsius. Further, the Monument receives about 17 to 48 cm of annual precipitation. The range of annual precipitation and temperature fosters growth of a diversity of flora and fauna. Brotherson et al. (1978:20) describe the Inscription House area as an environment consisting of five ecological zones: a streamside (Figure 6), slickrock-scattered shrub (Figure 7), atriplex-grass (Figure 8), talus slope (Figure 9), and pinyon-juniper-mixed shrub habitats (Figure 10).

The canyon top and talus slopes support scattered

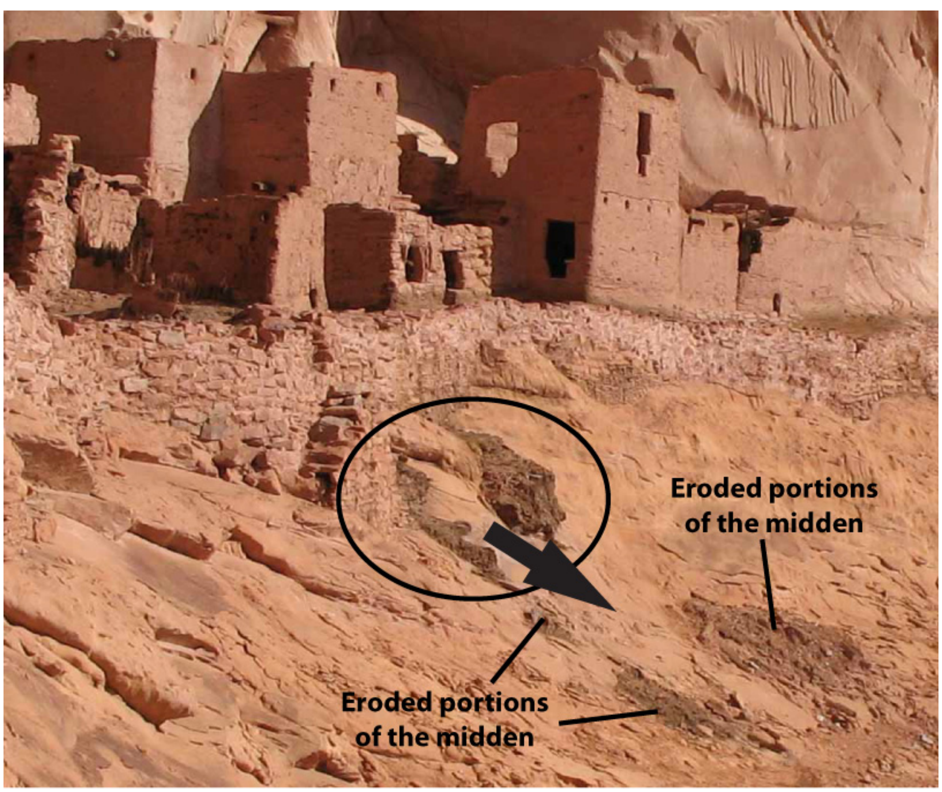


Figure 5. Photograph of Inscription House with the current in situ remnants of the midden circled in black and an arrow showing how the eroded portions of the midden moved from the original position.

Figure 6. Photograph of the streamside habitat in Nitsin Canyon that consists of cottonwood trees, willow, shrubs, and grasses.

Figure 7. Photograph of the slickrock-scattered shrub plant community above Nitsin Canyon. The plant community consists of saltbush, mormon tea, and yucca.

Figure 8. Photograph of atriplex-grass habitat in Nitsin Canyon. The habitat contains fourwing saltbush, Indian ricegrass, and blue grama.

Figure 9 Photograph of a talus slope ecological zone in Nitsin Canyon. The talus slope habitat consists of juniper trees, pinyon trees, grasses, and shrubs.

Figure 10. Photograph of a pinyon and juniper habitat above Nitsin Canyon. The habitat also consists of grasses and shrubs, such as apache plume and grama.

pinyon pine and juniper trees with interspersed sage and blackbrush (Ward 1975). Cacti, grasses, and a variety of shrubs blanket the canyon floor. Pinyon and juniper trees occasionally grow along the canyon floor as well. The stream banks at the base of the canyon contain stands of cottonwood and willow.

The vegetation growing in the canyon system exemplifies an Upper Sonoran Life Zone. The vegetation currently growing in the Monument probably consists of a similar group of plants that grew during the Pueblo III Period. The wild plants provided food, firewood, and construction material for the Inscription House community.

The Ancestral Puebloans also took advantage of the deep fertile soils that developed on the canyon floors for agriculture. The deep soils on the canyons floors accumulate from the erosion of soils from the tops of the canyons. The erosion results from precipitation during summer monsoons and the melting of winter snow. The precipitation also erodes the bedrock of the canyon walls.

Bedrock erosion caused by precipitation created the alcoves and caves seen in the Nitsin and Navajo Canyons. The alcoves and caves provide a relatively dry and cool place to live during the summer. During the winter, the alcoves stay relatively warm. The dry alcove setting also allows perishable prehistoric artifacts to survive in the archaeological record. The artifacts at Inscription House preserve well as a result of the site's sheltered setting.

Inscription House sits in an alcove and cave cut high into the canyon wall. The cave sits in the western edge of the alcove and reaches 14 m into the bedrock (Ward 1975:23). Sandstone comprises the canyon walls and creates a smooth and malleable surface that prehistoric inhabitants altered to make grinding slicks, steps to climb the bedrock, and petroglyphs.

The high ceiling of the alcove provides protection from rain washing down from the canyon top. Runoff from major storms, however, falls upon the outer retaining wall of the ruins. Runoff has eroded the soil from directly in front of the site. The slick rock slopes are almost devoid of vegetation. A few scattered junipers, yucca, grasses, and shrubs grow at the base of the cliff along a stream bank.

The wide canyon floors in the Nitsin and Navajo Canyons contain two streams (Figure 11). The streams currently cut deeply into the soils along the base of the Inscription House cliff. The erosion along the cliff face has made recent visitations to the site difficult. The erosion has also exposed deep strata of alluvial deposits in Nitsin and Navajo Canyons. The deposits of alluvial soil once provided the potential to support a relatively large

Figure 11. Photograph of the streams directly in front of Inscription House.

prehistoric horticultural community. The large stands of cottonwoods and willow, as well as the dense shrub and grass communities growing on the canyon floor reveal the fertility of the deposits and the moisture still present in the soil today.

Arroyo cutting and overgrazing have caused the deep stream channels currently in the Navajo and Nitsin Canyon systems (Ward 1975:23). The deep stream channels probably did not exist during the main period of occupation at Inscription House. Ward argues that "only in the twentieth century has arroyo-cutting of the alluvium-filled valley reached a depth necessary to expose the level of the present emergence of groundwater" (Ward 1975:23). Prehistoric groundwater levels would have prevented the rate of erosion that occurs today.

Periods of erosion, however, occur naturally in the canyon systems of northeastern Arizona. Hack (1945) and Karlstrom (1988) analyzed the geology of canyon systems in northeastern Arizona and identified a cyclical trend of erosion followed by periods of alluviation. The cyclical trends characterize and define the environment in the canyon bottoms.

The soils on the floors of the canyons support a lower population of plants during a warmer and drier climatic period. The lower plant populations and increased aridity cause the development of sand dunes. The sand dunes consist of loose and unstable soils that erode heavily as annual precipitation increases. Increases in precipitation cause arroyo cutting in the canyons. Slope wash and streams eventually deposit new fertile soils on the canyon floors. The accumulation of fertile soils on the canyon floors allows for the re-growth of vegetation as the local environment stabilizes during a cooler and wetter climatic period.

A warm and dry trend near the beginning of the Pueblo III Period (A.D. 1130-1180) may have resulted in the loss of agricultural soil and a decrease in the amount of available water for prehistoric communities in the Navajo and Nitsin Canyons. Dean (1970) analyzed Ancestral Puebloan communities in the neighboring Tsegi Canyon system and suggests that a second drier trend from A.D. 1200-1250 resulted in an Ancestral Puebloan migration from the northern Arizona canyon systems. Under Dean's (1970) model, Ancestral Puebloans did not experience the extreme aridity before A.D. 1200s. Further, a thirty year break from the arid conditions probably did not provide the Ancestral Puebloan communities with enough time to recoup from the first period of increased aridity. The second period of aridity placed increased pressure on already struggling communities living in northern Arizona during the Pueblo III Period.

Prehistory of the Site

Artifact assemblages and the structural characteristics of Inscription House reveal an occupation of the cliff area from the Basketmaker III (A.D. 450-700) through Pueblo III Periods (A.D. 1150-1300). The prehistory (Figure 12) of Inscription House is poorly understood despite several surveys by dendrochronologists, archaeologists, and Park Service employees. Early investigations by Cummings of Inscription House consisted of excavations in 70 of the 80 rooms at the site (Ward 1975). Albert Ward (1975) wrote two research reports documenting archaeological work performed on Inscription House and argues that a fire at Cumming's home destroyed the majority of the field notes and artifacts from the initial excavations. The loss of data from the early excavations creates a considerable problem in interpreting the prehistory of Inscription House. Interpretations of the prehistory rely on the data gathered from later excavations. The later excavations revealed information on the different periods of occupation at Inscription House.

The earliest known habitation of the Inscription House cliff area dates to approximately A.D. 600 during the Basketmaker III period. Early inhabitants used the alcove as a temporary shelter until A.D. 1050, the beginning of the Pueblo II Period. From A.D. 1050-1150, the alcove contained the first permanent settlement during a period of population aggregation occurring throughout the northern Arizona canyon systems. The population continued to grow at Inscription House after A.D. 1150. A ceramic analysis, however, of a midden at the base of the site indicates a possible migration from the cliff dwelling around A.D. 1200.

Archaeologists identify evidence for the migration in a lack of ceramics that date from A.D. 1200 to A.D. 1250, the middle Pueblo III Period (Ambler 1985). The lack of evidence for ceramics during the middle Pueblo III Period indicates a hiatus in the occupation of the cliff dwelling. The ceramic assemblage also suggests that the greatest occupation of Inscription House occurred during the Tsegi Phase (A.D. 1250-1300) of the Pueblo III Period (Ambler 1985; Ward 1975:28).

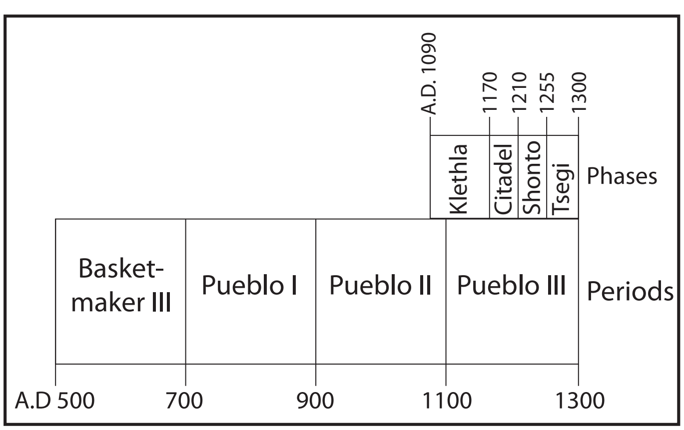


Figure 12. Timeline with period and cultural phase designations.

The inhabitants of Inscription House during the Tsegi Phase constructed the main architectural complex currently standing. The site consists of adobe and masonry structures ranging in height from one to three stories along the ledge of a shallow alcove. Sixty-one rooms sit on the ground surface supporting an additional 18 rooms on the second story, and a single room on the third story. The rooms form a variety of shapes, but generally consist of quadrilateral rooms. Further, the rooms form irregular rows that line the canyon wall.

A small cave (Figure 13) on the western extent of the cliff contains a single room behind the only identified kiva, or ceremonial structure, at Inscription House. The kiva consists of a circular enclosure at the opening of the cave with loom holes ground into the bedrock surface. A second, possible kiva lies in the main structure. Evidence for the second kiva consists of a bench that wraps around the room and significant smoke blackening along the walls. The walls, however, form a rectangular shape instead of the prehistorically more traditional, circular shape of a kiva (Ward 1975). The different shape of the room suggests that the possible kiva served an alternative function. The room likely functioned as a community room for the Inscription House occupants.

The occupants of the pueblo constructed rooms as needed. Several room blocks initially housed nuclear families (Ward 1975). As the internal population increased and new groups immigrated into the pueblo, the community added new room blocks onto the structure. The inhabitants of Inscription House also remodeled rooms throughout the occupation of the cliff dwelling (Ward 1975). Ward (1975:35) argues that the Inscription House community tore down and reused material from rooms 40, 48, 68, and 10. The remodeling and expansion of the room block reveals information on the population size of the community during different periods of occupation.

The alcove dwelling supported approximately 75 individuals during the greatest period of occupation (Ward 1975:50). As the population began to decline and migration from the area began, rooms served as refuse areas. Rooms originally served four primary functions for the Inscription House community: living areas, storage

Figure 13. Photograph of the cave at the western extent of the cliff dwelling.

rooms, areas serving both as living and storage rooms, and as granaries (Ward 1975). The exceptions to the four functions consist of the kivas and a single mealing room.

Pueblo III Period Phases

The Pueblo III Period, A.D. 1150-1300, occupation of Navajo and Nitsin Canyons consists of four cultural phases: the Klethla (A.D. 1090-1170), Citadel (A.D. 1170-1210), Shonto (A.D. 1210-1255), and Tsegi Phases (A.D. 1255-1300). The Klethla Phase reveals the transition from the dispersed communities in the Pueblo II Period to the aggregative communities in the later Pueblo III period. Major cultural changes occurred during the Klethla Phase that results in community restructuring and intensive agricultural production.

Near the end of the Klethla Phase, the Ancestral Puebloan communities experienced a period of increased aridity. The increased aridity caused a period of alluvial erosion in the canyon systems of northeastern Arizona. Alluvial erosion resulted in the loss of agricultural soils. Ambler (1985) investigated the prehistory of Navajo National Monument and argues that the loss of agricultural land forced groups in larger communities to migrate. The migrations from areas in the Kayenta region mark the end of the Klethla Phase and the beginning of the Citadel Phase.

Ancestral Puebloans from the Kayenta region during the Citadel Phase increased trade with cultural groups further to the south, mainly the Wupatki area. The northern Kayenta communities during the Citadel Phase also began to produce more local ceramics than in previous phases. In addition, Citadel Phase population sizes increased in the canyon systems of northeastern Arizona. Population increases probably occurred into the next period of occupation, the Shonto Phase. Ambler (1985) argues that Shonto Phase communities established a pattern of social and cultural organization that continued into the Tsegi Phase.

The Kayenta settlements during the Tsegi Phase coalesced into large pueblos and cliff dwellings from previously dispersed, smaller communities. Ambler describes the Tsegi Phase as a period of increased cultural heterogeneity and argues that "the sizes and numbers of sites indicate a population growth rate higher than can be accounted for by in situ growth" (1985:53). The evidence for cultural heterogeneity comes from the increase in architectural variation of structures in Navajo National Monument. Differences in construction styles of pueblos reveal social and cultural differences between groups that lived in the canyon systems of Navajo National Monument. The heterogeneity of the populations may have caused tensions between different groups in the communities.

Despite possible tensions between communities, the influx of different groups into the area resulted in heightened production of local ceramics and the development of new stylistic traditions. Alexander Lindsay (1969) researched and identified the characteristics of Tsegi Phase material culture, which consists of the use of local materials and the use of simple designs and patterns. The simple designs and patterns of the Tsegi Phase artifacts also appear to imitate styles from earlier periods. The production of the Tsegi Phase material culture occurs for approximately fifty years, or until the end of the Kayenta branch of Ancestral Puebloan occupation of northeastern Arizona.

The Tsegi Phase as well as the Kayenta Tradition ends by around A.D. 1300. Ward contends the occupation of the largest Pueblo III Period communities lasted only 50 years with the "highland communities" migrating from the Pueblos as "early as A.D. 1275" (1975:22). The occupants of the larger cliff dwellings, including Inscription House, were some of the last to migrate from the Tsegi and Navajo Canyon systems, around A.D. 1300.

History of the Name

Ward indicates that Byron Cummings, who performed the first archaeological research on Inscription House in 1909, wrote the name of the site initially in a notebook as "Adobe House," but in later published works called the site "Inscription House" (1975:6). The name "Inscription House" derives from an inscription in a sheltered area of the alcove. Cummings believed originally that the inscription read "Ano Domi 1616" and was carved by a Spaniard exploring the canyon system (Ward 1975:8; Miller 1968). Since the inscription was not deeply carved, Ward (1975) questioned the interpretation of the inscription. Ward (1975) argues that a second set of inscriptions on a rock formation further down in Navajo Canyon contained a similar writing style to the one at Inscription House. The second set of inscriptions, however, reads "W. C. Stewert 1861" and "W. E. Mitchell 1861" instead of "Ano Domi 1616" (Ward 1975:8-10).

Later research by Ward (1975:11-15) revealed that in 1861 Navajos, who had recently escaped a United States Army raid, confronted a Mormon party from Utah in Navajo Canyon. The Navajos killed George A. Smith Jr., a member of the Mormon party. A second Mormon party under the leadership of Jacob Hamblin attempted to retrieve Smith's body a few months later (Ward 1975). The recovery party consisted of both Stewert and Mitchell, who inscribed their names on a boulder further along the canyon floor. Ward (1975:16) compared the second set of inscriptions with the inscription at Inscription House and determined that the date truly read 1861, originating from the Mormon recovery party.

Previous Work Performed at Inscription House

Archaeologists from the National Park Service, from regional universities, and from regional museums have conducted research at Inscription House over a period of more than a century. The earliest work by Cummings took place in the early Twentieth Century. Unfortunately, a fire in Cummings' garage, according to Ward (1975:26) destroyed the majority of the research notes, maps, and other records. Cummings worked at Inscription House sporadically from 1909 to 1930. Cummings' field crews excavated 70 of the 80 rooms in the site.

Later investigations by the Museum of Northern Arizona (1966) and the University of Colorado (1977) analyzed material from five of the ten unexcavated rooms as well as material from a midden at the base of the cliff. Archaeologists conducted several studies on the excavated material during the 1966 fieldwork. The research consists of pollen, coprolite, faunal, textile, paleoethnobotanical, and tree ring studies. The pollen, coprolite, faunal, and tree ring research provide only limited information on the diet of the Inscription House community and the environment of the Pueblo III Period.

The First Archaeological Investigations of Inscription House

Archaeologists have given Inscription House four site numbers consisting of NA 2160 (Museum of Northern Arizona), Echo Cliffs 8:1 (Gila Pueblo), NAVA 06 (National Park Service), and Ariz. D:5:10 (Arizona State Museum). Byron Cummings (1910, 1920, and 1926), in association with Gila Pueblo Archaeological Foundation and the University of Utah, performed the first archaeological investigations of the site. The initial investigations occurred sporadically over a period of about twenty years.

Cummings first documented Inscription House in 1909 with the help of John Wetherill, Louisa Wetherill, and Stuart M. Young. Cummings recorded only a few notes and took only a few photographs as part of an initial reconnaissance trip to Nitsin Canyon (Ward 1975). The reconnaissance trip provided Cummings with the location of prehistoric sites for later archaeological investigations. From 1914-1916 and in 1930, Cummings returned to Inscription House excavating a large portion of the ruins (Ward 1975). He published none of the results of the excavations and presumably the garage fire at Cumming's home destroyed nearly all of the fieldwork and artifacts (Ward 1975:26). A few diary entries from students, a few surviving pages of field notes, and a sketch map are all that survived of the early excavations. Ward (1975) contends that only ten rooms were untested after 1930 with five of the rooms excavated in the 1966 work by the Museum of Northern Arizona.

Stabilization Work

The National Park Service performed stabilization work on the site in 1939 under the guidance of Steen (1940). Steen (1940) rebuilt a retaining wall in front of the cliff dwelling. Stabilization of the retaining wall prevented the erosion of cultural fill and additional structural elements of the cliff dwelling. Steen (1940) used back dirt from Cummings' excavations as fill for the stabilization work on the retaining wall. The stabilization work later posed threats to the integrity of a midden directly in front of the wall. The threats stem from a drainage area constructed in the wall during the 1939 fieldwork. The drainage hole allowed water to flow directly into the middle portion of the midden. The midden slumped in 2008 providing the material for the current analysis.

The 1939 National Park Service stabilization work also consisted of a backfilling project for several rooms throughout the site. The backfill stabilized the walls of the rooms excavated by Cummings. Examination of the walls also revealed different rates of deterioration requiring various degrees of work. As a result of the stabilization activities in 1939, the condition of the site stayed relatively stable for about two decades. The site, however, required stabilization again in 1958.

Richert (1958), a National Park Service employee, oversaw the new stabilization work in 1958. The 1958 stabilization work consisted of recapping the retaining wall and minor repairs in 20 rooms. Ward (1975:26) notes that half of the 20 rooms were described as repaired earlier by Steen (1940). Richert also collected several sherds including Historic Yellow Ware from a refuse midden for analysis. I briefly discuss the results of the analysis for the Yellow Ware sherds in a later section.

A third stabilization episode occurred in 1977 as part of a project contracted out to the University of Colorado. Breternitz, an archaeologist with the University of Colorado, directed the completion of minor stabilization work on 15 rooms as well as the retaining wall. After 1977, the National Park Service personnel infrequently returned to the site to stabilize eroding elements of the architecture.

The 1966 and 1977 Excavations

The National Park Service contracted the Museum of Northern Arizona in 1966 to excavate a portion of a refuse midden located below Inscription House. The midden was located in close proximity to an encroaching stream. The stream would have washed archaeological contexts down the canyon if not for the salvage efforts by the Museum of Northern Arizona. The Museum of Northern Arizona, under the direction of Gumerman, excavated the threatened portion of the midden (Ward 1975). Gumerman and the field crew also conducted excavations in ten of the rooms, cut a trench in the cave, and completed a detailed structural analysis of the cliff dwelling. Ward (1975) wrote the final two reports on the findings of the 1966 field work.

The Museum of Northern Arizona identified and excavated samples from three classifications of middens associated with Inscription House. The types of refuse areas consisted of deposits at the base of the canyon wall, refuse in the rooms, and deposits in front of the retaining wall along the slopes (Ward 1975). The refuse midden at the base of the cliff accumulated through Pre-Tsegi and Tsegi Phase trash deposition on the slopes of the bedrock. The trash that accumulated at the base of the cliff consists of the bulk of refuse at the site.

The midden at the base of the cliff contained mixed deposits from different periods of occupation. The mixed deposits possibly resulted from the activity of Pueblo III Period occupants. Ward (1975:28) suggests that Inscription House occupants cleared room fill from previous occupations and deposited the material in a mixed context on top of the midden. Evidence for Ward's hypothesis comes from a lack of archaeological contexts in some of the rooms that date before the Tsegi Phase. Pre-Tsegi Phase material appears primarily in the midden at the base of cliff. Ceramics from the midden date from the Basketmaker III Period to the end of the Pueblo III Period. Most of the midden material, however, consisted of ceramics and lithics indicative of Tsegi Phase occupation. A paucity of Basketmaker III Period and Pueblo I Period (A.D. 700-900) material provides evidence for a temporary use of the alcove during the early periods of occupation (Ward 1975:28).

The excavation of the cliff base midden also revealed 32 Tsegi Phase human burials, a dog burial, and evidence of a ceremonial cache (Ward 1975:29). Deposits of the midden unassociated with the burials contained ceramics, animal bone, charred corncobs, and stone tools. Ward (1975) used the frequencies of ceramics to develop a scheme, discussed earlier in the chapter, for the different periods of occupation at Inscription House. The frequency of ceramics from the Pueblo II and III Periods reveal a permanent occupation of the cliff dwelling by a relatively large population. Migration from the Inscription House area occurs simultaneously with Betatakin and Kiet Siel around A.D. 1300. Ceramic evidence, however, shows that Puebloans visited the site in later periods. Ward (1975) suggests that two Awatovi Yellow Ware sherds indicate the last known use of Inscription House by Hopi, sometime between the Fourteenth and mid-Nineteenth Centuries. Vivian (Navajo National Monument correspondence 1959), however, argues in an earlier analysis of Yellow Ware sherds from Inscription House that the Yellow Ware probably originate from Zuni and that the vessel or vessels were traded to Navajo or stolen by Navajo during the 1800s.

By around A.D. 1300, Ward (1975) hypothesizes occupants of Inscription House, as well as other communities living in Nitsin and Navajo Canyon systems, migrated south. The Inscription House occupants may have migrated to join other groups at the Puebloan settlement of Awatovi. Awatovi and Inscription House inhabitants used a similar construction technique to build structures. Ward (1975:50) suggests that the use of molded adobe bricks for construction material in both areas provides evidence of a link between the two communities.

The information gathered from the 1966 excavation provided the first detailed understanding of the Inscription House occupation. The 1966 project consisted of studies on textiles, human remains, faunal remains, botanical material, and tree-rings. The pertinent studies to the current analysis consist of an initial examination of coprolites by Fry and Hall (1973), a secondary coprolite analysis by Kelso (1972; 1976), an investigation of human remains by Harris et al. (1973), and a report on the tree-ring record by Dean (1975).

The four mentioned reports document a more complete analysis of the archaeological material. Ward (1975) attached the tree-ring study to the appendix of the 1975 report. Prior to the completion of the 1975 report, Fry and Hall (1973) wrote a report on an initial investigation of coprolites excavated from the rooms in the cliff dwelling. A secondary investigation of coprolites by Kelso (1972) adds to the findings of the first report. Kelso (1972) later adapted the report into a section of his doctoral dissertation. I discuss in more detail the findings of Kelso's (1972; 1976), Fry and Hall's (1973), and Dean's (1975) reports in Chapters 5 and 6.

Chapters 5 and 6 also contain a discussion of the data from the Harris et al. (1973) report. The Harris et al. (1973) report supplements a preliminary examination of human remains by Reed (1967). The osteological data revealed the health of the Inscription House community during the Pueblo III Period. In addition to the reports mentioned above, the 1966 archaeological investigations consisted of an analysis of textiles by Kent and Loehr (1973). The data from the textile and other reports from the 1966 investigations provided comprehensive information on the occupation of Inscription House. Since 1966, archaeologists have completed one other excavation, which has added to the previous findings.

The University of Colorado completed the most recent excavations at Inscription House in 1977. Gordon Tucker Jr. supervised the fieldwork and Breternitz (1977) wrote the final report of the 1977 archaeological investigation. The 1977 investigation examined unexcavated soil from the midden at the base of the cliff by excavating four, 2 meter by 1 meter test pits. The excavated midden material consisted of ceramics, lithics, animal bones, and botanical material similar to the material uncovered during the 1966 excavations. Breternitz (1977:13) indicates that the ceramic data added little information to the previous findings of the 1966 project. The University of Colorado, however, expanded on the previous research on the site by analyzing pollen from 11 soil samples.

Scott (1978) analyzed 11 pollen samples collected from strata in the test pits. Only one sample from a cultural context, however, contained enough pollen grains for a proper ubiquity test. Pearsall (2000) wrote a manual for examining plant material in archaeological contexts and contends that palynologists require a 200 pollen grain count per sample to attain a practical count for a statistical analysis. A pollen grain count less than 200 grains may not reveal an accurate record of the vegetation in the area. Since only one pollen sample from the 1977 excavation yielded 200 pollen grains, the pollen data provided a limited understanding of the local environment during the Tsegi Phase.

The pollen analysis showed evidence of a low pollen count of juniper and pine during the Tsegi Phase. Scott (1978:41) suggests the low arboreal pollen count reveals that the Inscription House community cleared the mesa top for agricultural fields. A high amaranth count in the same pollen sample may signify the use of a garden economy or the promotion of wild, pioneer plants for consumption. The limited information provided by the pollen analysis makes evident a need for additional pollen studies of cultural deposits.

Despite the limited information provided by the pollen analysis, the coprolite studies during the 1970s contain relatively detailed and significant information about paleoethnobotanical data. The pollen and macrobotanical data from the coprolites show changes in the consumption of plants and changes in the local ecology between different periods of occupation. I describe the data from the two analyses in greater detail in later chapters.

Material Culture from the Latest Excavations

Archaeologists from the last two excavations identified the excellent preservation of artifacts from Inscription House as the result of the relatively dry microclimate of the alcove setting. The perishable artifacts excavated during the last two excavations consisted of objects made from human hair, feathers, bone, leather, fur, and plant material. The artifacts from the 1966 and 1977 excavations added to the understanding of Ancestral Puebloan material culture in Nitsin and Navajo Canyons.

Excavators from the Museum of Northern Arizona discovered relatively intact cordage, baskets, and other textiles. Ward (1975:44) argues that the textiles analyzed during the 1966 project clarified and expanded greatly on the knowledge of the Tsegi Phase textile industry. The textiles were made from yucca, cotton, and feathers.

Food remains found in the site consisted of beans, cotton seeds, parts of corn, and parts of squash. The cotton likely originated from fields lower in the Navajo Canyon system instead of from a local agricultural field (Ward 1975:45). The report by Ward (1975) also consisted of a brief description of animal bones excavated from Inscription House. The analysis of animal bones revealed the presence of dogs and turkeys during the occupation of the site. Ward (1975) also suggests that the Inscription House occupants traded for macaws and macaw feathers. Evidence for the trade comes from a feather in Tsegi Phase contexts.

The Tsegi Phase occupants of Inscription House also traded for shell from the Gulf of California as well. The shell artifacts at the site consisted of two disk beads, an abalone pendant (*Haliotis fulgens*), a reworked bracelet fragment (*Glycimeris gigantea*), and a tinkler fragment (*Conus* sp.) (Ward 1975:46). The shell and macaw artifacts indicate a long distance trade route that ran through the traditional Hohokam and Singaua territories.

Locally produced material excavated during the 1966 project partially consists of lithic artifacts. Lithic artifacts excavated from the refuse midden at Inscription House consisted of tools and debitage. The tool assemblage was comprised of mainly manos and metates, with a relatively low count of hunting related implements. The tool assemblage revealed that the Inscription House community probably supplemented a mainly vegetal based diet with meat (Ward 1975:46).

The interpretation of the lithic data, however, relies on a relatively low count of identified tools from the 1966 excavation. Ward cautions that the low frequency of lithic tools result from "(1) the portable nature of these tools, (2) the lack of local resource material, and (3) the possibility that wood projectile points were utilized" (1975:46). The low tool counts provide an inaccurate record of the tools used by the Inscription House community. The community probably constructed more projectile points than the points identified in the midden.

Biases also occurred in the tree-ring analysis of the 1966 archaeological investigations. Dean (1975) reanalyzed tree-ring samples, 16 total, collected during the early to middle 1900s. The reanalysis of the tree-ring samples provided limited information on the dates of construction of Inscription House. Dean argues that "Inscription House was a disappointment in that so few dates were derived from a site which contains so many well preserved beams" (1975:54). The prehistoric construction beams consisted primarily of species of trees that dendrochronologists consider unsuitable for dating. Juniper (*Juniperus* spp.), for example, consists of erratic ring structures that differ drastically from specimen to specimen.

Only two specimens from the tree-ring analysis provided accurate dates. The first sample showed a cutting date of A.D. 1271 and the second analyzed sample revealed a date of A.D. 1222. The second analyzed sample, however, contained an incomplete final ring that resulted in an unverifiable date. Dean (1975:54) suggests that the second sample probably dates to an early part of the Pueblo III Period despite the lack of a complete outer ring. The two dated specimens show that the Inscription House community constructed rooms from around A.D. 1220 to A.D. 1271.

The tree-ring research also revealed the Pueblo III Period community's preferences for construction timbers. The timbers at Inscription House consisted of species of cottonwood (*Populus* sp.), boxelder (*Acer negundo*), juniper, pinyon pine (*Pinus edulis* Englem.), Douglas fir (*Pseudotsuga menziesi*), and ponderos pine (*Pinus ponderosa*). The majority of the identified timber specimens consisted of juniper. The frequency of species of construction timber shows that the Inscription House community preferred to use juniper as timber, but used other available and suitable wood species for construction timbers.

The construction timbers revealed information on timber wood preference, but the timbers provided poor material for tree-ring dating. The tree-ring study developed only a broad understanding of the final period of construction. As a result, the 1966 and 1977 research relied on the ceramic assemblages to determine the different periods of occupation at Inscription House.

The ceramics from the excavations consisted of Tusayan Grayware, Tusayan Whiteware, and Tsegi Orangeware dating to the Pueblo II-III Periods. A low frequency of the ceramic assemblages consisted of ware types from outside the Kayenta region. The Inscription House community traded for the ceramics from outside the Kayenta region, with the exception of two Awatovi Yellowware sherds. The Awatovi Yellowware sherds originated from a later period and reveal a Hopi visitation to the area (Ward 1975).

The 1977 field crew also discovered worked sherds and a ceramic effigy doll. The field crew found the ceramic effigy doll, as well as a second artifact, while stabilizing a room in the cliff dwelling. The second artifact consisted of a piece of wood wrapped with a cornhusk and other botanical material. Breternitz (1977:22) failed to determine how the prehistoric community at Inscription House used the artifact, but labeled the artifact as a “doll.”

Despite lingering research questions in the 1966 and 1977 research, the artifact studies contributed to the understanding of the Ancestral Puebloan occupation of Inscription House. Additional research will expand the data and develop a more detailed record of the occupation. This research, specifically, adds to the dietary information of the previous archaeological investigations of Inscription House.

Current Research

The Inscription House Midden Project examines midden material from Inscription House and constitutes the first investigations at Inscription House since the 1970s. The analyzed midden material eroded from a cliff in front of a retaining wall. The National Park Service rescued the displaced midden before continued erosion caused the destruction or loss of artifacts. National Park Service employees led recovery trips to the site to collect the soil for analysis. The National Park Service personnel established provenience units for the fractured chunks of midden and carried the soil out of the canyon system to the National Park Service’s offices. Roberts (2008) mapped and digitized the provenience units of the soil samples for later use during the analysis.

The National Park Service then contracted with Anthropology Laboratories at Northern Arizona University. The contract requested, in particular, the examination of botanical data. This report discusses the implementation and conclusions from the project in the following chapters.

Chapter 2.

Theoretical Framework

This chapter examines the range of archaeological explanations of the migrations during the end of the Pueblo III Period as well as the application of risk management theory. My aim is to develop working hypotheses to help in the interpretation of the paleoethnobotanical data from the Inscription House Midden Project. The midden project requires an understanding of regional migration theories that consider environmental as well as social and cultural factors to search for possible causes of the Inscription House migration. The research also requires knowledge of risk management strategies to help identify possible changes in the diet as a result of stress caused by climate changes or population pressure. Evidence of risk management strategies in the Inscription House midden may or may not support explanations of the migration of the Inscription House community during the late Pueblo III Period.

Late Pueblo III Period Migrations

Archaeologists posit several explanations for the late Pueblo III Period migrations. The explanations range from social and cultural causes to environmentally deterministic causes. Explanations for the migration consist of drought, population pressure, conflict, traditional migrations, and a multiple cause approach. The hypothesized causes resulted not only in regional depopulation, but in the Inscription House migration as well.

Population Pressure and Drought during the Pueblo III Period

Proponents of a population pressure explanation behind the late Pueblo III Period migrations suggest that the demands placed by the increasing populations living in northeastern Arizona during the A.D. 1100s-1200s put stress on marginal environments. The population reached a point beyond the carrying capacity of the local environment. Dean (2002) analyzed sites in the neighboring Tsegi Canyon system and argued that the increasingly intensive use of land for agriculture resulted in a depletion of nutrients in the soil. The loss of nutrients in the soil affected the growth of agricultural crops and, as a result, the food stores of the Pueblo III Period communities.

In addition, Dean (2002) suggests that the collection of firewood and construction timbers during the Pueblo III Period resulted in the denuding of forests in the Tsegi Canyon system. The fuel and construction requirements of the Tsegi Canyon communities overshadowed the capacity of the local environment to replenish the resources. Under Dean's (2002) model, the effects of population pressure on the local environment forced prehistoric communities to migrate to new areas.

Population pressure exacerbated problems in local ecologies already stressed by climatic deterioration. Hack (1945) and Karlstrom (1988) argue that the environment of northeastern Arizona consists of a cyclical trend of warm and dry periods followed by cool and wet periods. Warm, dry periods in canyon systems result in the loss of vegetation and the development of loose soils that form sand dunes. Runoff from precipitation in the canyon causes erosion of the loose soils.

Soil accumulation occurs again during cool and wet periods when vegetation re-grows in barren areas. The new vegetation holds the sediment deposits in place and helps to prevent heavy erosion of the new soils. The soils begin to erode again after a climatic shift to another period of increased aridity. The cyclical trends of erosion and deposition characterize the ecologies of northern Arizona and, in particular, the ecology of Navajo and Nitsin Canyons.

The northern Arizona environment had two periods of warmer and drier weather during the main period of occupation of Inscription House. The first period of warmer, drier weather occurred in the late Pueblo II and early Pueblo III Periods, A.D. 1130-1180, followed by a second, more intense period of aridity from about A.D. 1200-1250. Dean (2006) argues that the tree ring evidence from Tsegi Canyon reveals lower annual precipitation and groundwater levels during the Pueblo III Period than previously experienced in the American Southwest. The lower precipitation and groundwater levels resulted from a breakdown in the long-term climatic pattern of northern Arizona (Dean 2006). The irregular increase in aridity intensified the erosion and deterioration occurring already in the local ecologies.

The increased erosion and deterioration likely altered the plant communities and reduced the agricultural productivity of the land. Local ecologies may not have provided enough sources of food or water to support the large Pueblo III Period populations that occupied the canyon systems of northeastern Arizona. Smaller populations living during the earlier Pueblo Periods probably experienced similar breakdowns in the climatic pattern. The earlier, smaller populations, however, required less from the environment than the populations during the Pueblo III Period.

Early Pueblo II Period communities in the Kayenta region of the Colorado Plateau inhabited simple, dispersed settlements. Inhabitants of the area near the end of the Pueblo II and Pueblo III Period began to form larger, aggregated settlements. Dean (2002:157), in an analysis of dendroclimatic data, attributes the cultural changes during the transition from the Pueblo II to III Periods to the environmental degradation occurring on the Colorado Plateau.

Arroyo cutting, population pressures, and increases in aridity caused communities to aggregate along available, cultivable tracts of land. The communities primarily settled in canyon systems, such as Navajo and Nitsin Canyons, during the Pueblo III Period. The Pueblo III Period communities used several risk management strategies to cope with the environmental deterioration. Dean (1970) suggests the aggregated communities developed a more hierarchical settlement system out of a need to control the allocation of resources. Familial groups or clans inhabiting the area first received more rights to land, food reserves, and water than later groups that joined the pueblos. The inhabitants also increased agricultural production to increase food stores and develop a reliable source of food. Agriculture allowed the Ancestral Puebloans to grow more food than locally available in the wild.

Cultures, however, developed additional risk management strategies such as using wild plant resources to supplement the diet to combat poorer climatic conditions. Ford (1972), Plog and Powell (1984) suggest, in analyses of the Pueblo Periods, that the intensely variable environments of the American Southwest required prehistoric communities to practice a diversity of adaptive strategies. The diversity of strategies ensures, as Plog and Powell argue, "at least some individuals in the population" will already practice a "strategy appropriate to the new conditions" (1984:52).

Despite the employment of risk management strategies in Kayenta communities, by about A.D. 1300 the Ancestral Puebloans migrated from the northern canyon systems of the Colorado Plateau. Dean (1970) suggests the migrations resulted from the same population pressures, environmental degradation, and arroyo cutting that resulted in the initial aggregation of the Ancestral Puebloan communities. Salzer (2000) also argues that volcanic activity from several volcanoes around the world may have caused cooler temperatures and lower annual precipitation during the cooler, wetter periods. The cooler temperatures and lower annual precipitation during the cooler and wetter periods aggravated the already deteriorating local conditions. The prolonged aridity under Dean's (1970) and Salzer's (2000) models during the Pueblo III Period did not occur during previous Pueblo Periods in northern Arizona. The combination of two relatively extreme warmer and drier trends in a 30-year interval and a drop in the annual precipitation during cooler trends created a scenario that the local populations probably could not cope with.

In addition to the heightened aridity, populations grew to sizes previously unseen in the canyon systems. Deteriorating local environments, under Dean's (1970) model, did not produce enough renewable resources to sustain growing populations. Dean (2002) suggests that the populations overtaxed local resources already greatly reduced by environmental deterioration. The reduced capacity of the land forced the populations to migrate to more mesic areas further south. The northern Arizona populations combined with other Ancestral Puebloan groups to form the Hopi culture. Ancestral Puebloans likely migrated as a result of environmental deterioration. Environmental changes and population pressure provide a plausible explanation for the migrations.

Recent research, however, reveals that environmental changes and population pressure actually had little impact on local ecologies of certain areas in the Southwest. Clay-Poole (1989), for example, examined arboreal tree pollen in comparison to the dendroclimatic data from Dean's (1970) research. The pollen analysis revealed more annual precipitation and cooler temperatures in Tsegi Canyon than determined through tree ring studies. Clay-Poole (1989) does not dispute that two periods of increased aridity occurred during the Pueblo II and III Periods, but argues that the arboreal pollen data show a relatively cooler and wetter climate than the tree-ring evidence. Evidence of a cooler and wetter climate suggests that less environmental deterioration occurred in Tsegi Canyon than previously hypothesized. If a lower rate of environmental deterioration occurred than previously hypothesized, the local environment could have continued to provide enough resources to sustain the Ancestral Puebloan communities.

A second study, that examines faunal data from Casas Malpais in eastern Arizona, supports the hypothesis that local ecologies continued to support populations during the late Pueblo III Period. Moreno (1995) studied artidactyl (deer and antelope) remains from the Pueblo III site of Casas Malpais to determine if changes in climate and population pressure stressed the local ecology. The Casas Malpais study by Moreno (1995) reveals that a relatively large local deer population lived in the area during the Pueblo III Period compared to around contemporaneous sites in the region. The deer populations continued to provide a reliable source of food for the Casas Malpais community despite a possible deterioration of deer habitat and a possible increase in pressure by the occupants of the pueblo. Moreno (1995) attributes the survival of relatively high numbers of deer to the risk management strategies of the Casas Malpais community.

The Casas Malpais community recognized the increased demand on the finite artidactyl populations and developed a strategy to use more of the individual animals than previously. The occupants of the pueblo consumed more of the animal than in previous periods. More efficient use of previously undesirable parts of the animal allowed the Casas Malpais community to reduce hunting of local deer populations. The local deer populations continued to thrive in relatively high numbers compared to areas around contemporaneous sites despite an increased population pressure by the Casas Malpais community. The community established a risk management strategy that mitigated the effects of a large population in a deteriorating environment.

While the faunal data reveal the successful employment of a risk management strategy, the stability of the Pueblo III Period deer populations could also be attributed to a lower rate of local environmental deterioration compared to other areas on the Colorado Plateau. The local environment around Casas Malpais continued to support a relatively large deer population despite increases in aridity. A low rate of local environmental deterioration and the employment of risk management strategies allowed a relatively stable population of deer to survive in the Casas Malpais area. Evidence of a relatively stable deer population suggests that certain communities were capable of living in areas on the Colorado Plateau beyond the Pueblo III Period.

Ancestral Puebloan communities likely migrated for alternative reasons if data from Pueblo III Period sites reveal no evidence of environmental stress. A study on prehistoric Black Mesa communities by Deschambre (1983), for example, provides evidence that Ancestral Puebloans migrated in periods of increased aridity and during periods of increased moisture. Deschambre (1983) argues that the research revealed an abandonment of Black Mesa by Ancestral Puebloans during the height of a more mesic climate around A.D. 1100.

Ancestral Puebloans in Black Mesa likely migrated from the area due to the effects of population pressure on the local environment. Population pressure could have caused stress on the local resources requiring the communities to migrate. Deschambre (1983), however, suggests that Black Mesa communities migrated as a result of social or cultural conditions. The inhabitants of Black Mesa established settlements relatively close to previous settlements. If the occupants needed to migrate to avoid the effects of population pressure, the community would have migrated to an unaffected area. The data from Deschambre's (1983) research suggest that non-environmental factors influenced the migrations in Black Mesa. Non-environmental factors, such as social conditions, could also explain Ancestral Puebloan migrations outside Black mesa.

The environmental deterioration and population pressure hypotheses provide probable causes for the migrations occurring around A.D. 1300. The inhabitants of the Kayenta region, however, implemented risk management strategies to cope with deteriorating environmental conditions that occurred in the late Pueblo II and early Pueblo III Periods. Researchers need to examine the evidence from individual sites to determine the causes of migration for an Ancestral Pueblaon community.

Social and Cultural Explanations

Archaeologists posit a range of social and cultural explanations and argue that the effects of environmental change and population pressure alone did not force the Pueblo III Period inhabitants of northeastern Arizona to migrate. The social and cultural explanations identify conflict, cohesion, and other cultural changes as the reasons for migration. Evidence for migrations caused by non-environmental factors includes the study on migrations on Black Mesa (Deschambre 1983), which occurred during periods of environmental stability as well as environmental deterioration. If environmental conditions were not the primary influence for the Ancestral Puebloan migrations, the communities likely migrated as a result of cultural or social factors.

Oral Tradition. Evidence for social and cultural explanations of the late Pueblo III Period migrations also comes from research on modern Puebloan oral tradition. Bernadini (2005), for example, argues that Hopi oral tradition suggests that Ancestral Puebloan migrations during the late A.D. 1200s comprised a part of a greater pattern of migrations by Ancestral Puebloans during the Pueblo Periods. Bernadini (2005) describes the Ancestral Puebloan migrations that occurred during the Pueblo Periods as a pattern of serial migration that ended with the aggregation of large communities in areas, such as at Hopi or Zuni. The coalescing of groups around areas, such as Hopi and Zuni, developed a draw for Ancestral Puebloan communities. Ancestral Puebloans sought the social and cultural connections of the large, aggregated communities as areas in northern Arizona started to depopulate. The Inscription House community may have also migrated to join the large, aggregated communities near Hopi to stay connected with other groups as the area around Nitsin and

Navajo Canyons started to depopulate in the late A.D. 1200s.

Conflict. Archaeologists also suggest that Ancestral Puebloans migrated and aggregated into larger communities to avoid conflict. Larger communities could have provided protection from raiding or violence in an area. Ambler (1985:52) suggests that communities from Mesa Verde and Numic speaking groups to the west placed increasing pressure on Kayenta communities at the beginning of the Tsegi Phase. Evidence for the increased presence of outside cultural groups comes from the data on the population growth of Pueblo III Period communities. The Tsegi Phase population growth in northeastern Arizona increased more rapidly than possible with the size of pre-Tsegi Phase populations. An introduction of different architectural styles also indicates the increasing presence of new immigrants to the area.

The immigration of groups from outside the Kayenta cultural area likely resulted in tensions between communities. Cultural or social tensions between different cultural groups in the area were probably amplified by the environmental deterioration. The different cultural groups would have competed for resources as the environment deteriorated. Ambler argues that "militaristic or raiding pressures, real or imagined, from Mesa Verdeans to the east or Numic speakers to the west could have precipitated the construction of fortified villages; internal conflicts could equally well be represented" (1985:52). Conflict might have caused the aggregation of Kayenta communities as a form of protection. The large cliff dwellings in the canyon systems reveal the possibility of the construction of defendable structures.

Explanations for the Pueblo III Period migrations that involve conflict suggest that conflict, internal or external, escalated to a point at which the communities needed to migrate to new areas. Dean (1988), however, argues that Ancestral Puebloans adapted the social organization of a community to include outside groups. Reorganization of social organizations likely resolved conflict in a community and enabled different cultural groups to work together. Ambler (1985) also suggests that limited evidence reveals that warfare occurred in northeastern Arizona and that the migrations during the late Pueblo III Period appear too orderly for a community escaping violent conflict. If conflict occurred, the occupants would have evacuated in a relatively quick and chaotic manner to escape the violence. The archaeological evidence, instead, indicates a relatively slow migration from the canyon systems in northeastern Arizona.

The Inscription House community, for example, migrated from the cliff dwelling over a period of 15 years (Ward 1975). The prolonged period of migration suggests that the community left in an organized manner. The evidence from Inscription House provides evidence that the community did not leave the area to evade violent conflict. Communities avoiding nonviolent tensions between different groups, however, likely migrated in a relatively orderly manner, as well. The influx of different cultural groups into Kayenta communities could have resulted in social, cultural, or ideological tensions. The inhabitants recognized that the community no longer functioned as a cohesive group and migrated to avoid the tensions.

Large-scale Community Efforts. Ancestral Puebloans, however, may not have experience conflict or tensions at all during the Pueblo III Period. Communities in northeastern Arizona could have migrated as a result of peaceful social or cultural conditions. Ambler (1985:56) provides an alternative hypothesis that suggests communities in the south required the large populations and social organization of the larger communities in northeastern Arizona for intensive agricultural production. The communities in northeastern Arizona migrated to help southern groups employ large-scale community efforts.

Non-environmental Explanations. The social and cultural hypotheses for migrations posit alternative explanations for the migrations that occurred on the Colorado Plateau. Dean argues in an analysis of behavioral adaptations on the Colorado Plateau that:

> Behavioral (or cultural) variables are commonly viewed as mechanisms of adapting human populations to their physical and social environments; therefore, they are usually seen as being results, rather than causes, of systemic culture change. However, under certain circumstances, purely cultural factors can transform the adaptive situation sufficiently to cause systemic culture change. [1988:34]

Internal developments of a community could have caused the inhabitants of canyon systems in northeastern Arizona to migrate instead of the environmental conditions of the Pueblo III Period.

The environment affected the communities, but the environment did not always determine the cultural evolutionary trajectory of the inhabitants of the Colorado Plateau. The paleoethnobotanical data from Inscription House, for example, reveal no evidence of dietary stress. A lack of dietary stress suggests that social or cultural conditions caused the migration of the Inscription House occupants.

Multivariate Approach

In response to the several explanantions for regional population shifts during the late Pueblo III Period, Axtell et al. (2002) promote a multivariate approach in a multi-agent model for population collapse in Long House Valley, a valley south of Tsegi Canyon. Participants in the Long House Valley Project developed a computer program that analyzed real world data to determine if survival was a possibility for communities in the valley after A.D. 1300. The real world data consisted of demographic and environmental variables on the Long House Valley during the Puebloan periods. Demographic and environmental variables consisted of the requirements of agricultural crop production, the food and water requirements for the populations living in the valley, and annual precipitation during different periods.

The researchers entered the parameters into the program to determine if the computer program revealed a cultural evolutionary trajectory similar to the real world data. Axtell et al. (2002) argue that the program mirrored the real world population growth and population decline in Long House Valley during the Pueblo II-IV Periods with an important exception. The computer model revealed "…that even the degraded environment of the 1270-1450 period could have supported a reduced but substantial population in small settlements dispersed across suitable farming habitats…" (Axtell et al. 2002:7278). The computer model demonstrated that the environment initially caused groups to migrate from the valley. The populations in Long House Valley continued to migrate during the late Pueblo III Period despite the presence of agriculturally viable, although limited, land.

Accordingly, Axtell et al. (2002) argue that Long House Valley populations migrated for social-organization reasons, not simply because of environmental stress. Pueblo communities existed as nodes in a social, ceremonial, and economic network that required cohesion to persist. Once communities began leaving Long House Valley, the cultural network could not survive and the final populations living in the valley had to migrate as well.

In my view, a similar process of migration probably occurred at Inscription House. The Inscription House community migrated slowly from the Navajo and Nitsin canyon systems from A.D. 1275-1300. The populations, under the multi-agent model, decreased slowly overtime as families sought more mesic areas. Populations inhabiting Inscription House during the final years of occupation likely elected to leave the area despite the capability of the land to support the diminished community size.

The Inscription House midden data suggest that multiple causes resulted in the migration of the community. The paleoethnobotanical data show that the community did not suffer from dietary stress. A lack of evidence for dietary stress indicates that the Inscription House community did not migrate because of the environmental conditions. Previous research on Inscription House, however, provides no evidence of drastic social or cultural causes. A lack of direct evidence for an individual factor likely points to a combination of multiple factors that influenced the Inscription House community's decision to migrate.

Risk Management Strategies

To search for the causes of migration, we can profitably examine human responses to drought. Communities typically respond to drought and environmental deterioration with risk management strategies. Evidence of the use of risk management strategies derived from botanical material usually leads to an inference of dietary stress caused by environmental deterioration. Accordingly, the Inscription House Midden Project examined the botanical evidence for risk management strategies as a means of determining whether environmental deterioration might have affected the community.

Stuart (2000) argues in an analysis of the collapse of Ancestral Puebloan communities that Ancestral Puebloans migrated continually during the Puebloan Periods after periods of environmental degradation. The communities migrated to new areas if a local environment failed to support a community, but the communities in Stuart's (2000) analysis also attempted to adapt to the environmental conditions before leaving an area. Minnis (1996), Colson (1980), and Spielmann and Angstadt-Leto (1996) posit several risk management strategies used by prehistoric southwestern communities. The strategies consist of an increased mobility, dietary changes, technological adaptations, and food exchange.

An increase in mobility allows a community to use resources in a larger area instead of concentrating resource collection on the area around a permanent settlement. A community that increases mobility on the landscape occupies temporary or seasonal encampments throughout a region. A larger resource catchment prevents a community from overtaxing the local ecology. The Inscription House inhabitants, however, occupied the cliff area year round and we see no evidence of increased mobility.

A more practical risk management strategy for the

Inscription House community would likely consist of changes to the diet. Dietary changes might consist of a diversification of the diet to include more plant species, the consumption of starvation foods, concentration on a single species, or a reduction in food intake. Since the Pueblo III Period communities already relied on corn and squash, the Inscription House occupants could have consumed a greater volume of domesticates. A higher dietary reliance on domesticates provides a stable source of food for a community mitigating the effects of environmental deterioration. Minnis (1996), however, argues that communities need to broaden the diet to meet nutritional requirements and that a diet concentrated on the consumption of a few species is a poor risk management option.

A plausible risk management strategy for the Inscription House community consists of the altering of a domesticated species so that the plants require a shorter growing season. Prehistoric communities could have select seed specimens of a domesticated species that require less water and time to produce mature fruit. By altering the growth requirements species, prehistoric communities could theoretically have adapt a plant to survive during periods of drought. The macrobotanical data from Inscription House, however, show no evidence of major changes in the corn varieties during the Tsegi Phase.

A counter-strategy to the adaptation of cultigens is increased use of marginal wild foods. Prehistoric communities consume starvation foods during periods of drought. Starvation foods consist of plants that thrive in periods of drought and typically require treatment before providing nutritional benefits. A deteriorating environment could force prehistoric communities to consume previously undesirable foods or consume higher frequencies of drought tolerant species, such as Indian ricegrass. A greater frequency of drought tolerant or undesirable species in the archaeological record would, thus, suggest that a community consumed starvation foods as a risk management strategy.

Another plausible risk management strategy consists of the consumption of a greater range of plant species. Minnis (1996) argues that ethnographic evidence shows that communities frequently respond to food stress by broadening the diet. A broader vegetal diet allows communities to rely on multiple sources of food instead of depleting a limited, stressed resource. Accordingly, I looked for evidence of a broader diet in the Inscription House midden by determining if the number of plant taxa in the diet increased over time.

Inscription House occupants might have adapted to the changing environment through technological innovation as well. Nelson (1996) suggests, in a study of prehistoric technological adaptations in the American Southwest, that communities developed better storage techniques, agricultural tools, or cooking implements during periods of dietary stress. Previous research, however, provides limited information on changes in storage techniques, changes in cooking tools, or changes in agricultural tools at Inscription House during the Pueblo III Period. Although changes in technology likely reveal evidence of a risk management strategy, research on technology lies beyond the current parameters of the Inscription House Midden Project.

Another risk management strategy typically used by prehistoric Southwestern communities is of trade. Spielman et al. (1996) and Minnis (1996) argue that ethnographic research shows that communities engage in positive exchange between neighbors to create a source of food during periods of dietary stress. During periods of dietary stress, people increase social ties with neighboring communities and trade for food.

Communities might also engage in negative social interactions, such as raiding or stealing from one another (Minnis 1996). Raiding and stealing provide a temporary and short-term fix to shortages in food. Overtime, however, neighboring groups would not have supplied enough stores. Accordingly, raiding likely provided a limited source of food for communities during the Pueblo III Period. Despite the plausibility of raiding and stealing, Ambler (1989) argues that the evidence in the archaeological record suggests that no major conflicts occurred in Navajo or Nitsin Canyons.

Prehistoric communities employed risk management strategies to mitigate the effects of environmental deterioration. Evidence of risk management strategies during the Pueblo III Period would show that environmental deterioration affected the Ancestral Puebloans' decision to migrate around A.D. 1300. Migration costs too much in time and energy to provide an efficient initial risk management strategy. Ancestral Puebloans probably implemented one, if not several, alternative strategies before migrating from the area.

Since the Inscription House Midden Project is limited to the examination of paleoethnobotanical data, I looked for evidence of dietary changes in the consumption of plants at Inscription House. The paleoethnobotanical data from the Inscription House midden, however, showed no evidence of drastic dietary changes used as a risk management strategy in response to environmental deterioration during the A.D. 1100-1200s (determined by radiocarbon dating). I find the lack of evidence for the employment of dietary change at Inscription House facsinating. I must tentatively conclude that, although the Inscription House residents could have continued to live in Nitsin Canyon, they decided for cultural reasons, to leave. Accordingly, I doubt that environmental deterioration directly caused the Inscription House community to migrate from the area by A.D. 1300.

Chapter 3.

Methods of Analysis

The research agreement for the Inscription House Midden Project required an analysis of macrobotanical material, an analysis of pollen data, and radiocarbon dating of appropriate specimens. I focused the analysis of the paleoethnobotanical material on the diet of the Inscription House community. While palynology provides insight into the diet of prehistoric communities, the accumulation of modern pollen rain in the eroded midden material from Inscription House can result in an inaccurate interpretation of prehistoric pollen deposits. As a result of biases in the pollen data, I concentrated this research on the macrobotanical data from the midden. Macrobotanical data provide a means for researchers to determine the range of species of plants used for food. Pearsall (2000) provides a framework of sampling strategies and methods of macrobotanical analysis that I used for the Inscription House analysis. The following chapter describes the laboratory methods implemented in the study including sampling strategies, sorting of plant taxa, identification of botanical materials, quantification of data, ethnographic research, and dating techniques.

Using Provenience Unit Designations in an Analysis of Eroded Cultural Soils

A portion of a midden directly in front of the main retaining wall of Inscription House slumped down the slick rock in 2008. Continued erosion of the slumped midden would have led to the loss of archaeological information. National Park Service employees, however, salvaged the eroded sections before the material washed down the canyon. The field crew carried approximately 60 liters of the eroded cultural soil out of the canyons from July 16th to the 14th of August 2008.

The Inscription House Midden Project used the provenience units (Figure 14) identified by the National Park Service as the units of analysis. The National Park Service separated the chunks of cultural deposits and numbered the material with provenience unit designations during the salvage project in 2008. The field crew numbered the chunks of midden from 1 to 9 based on the spatial location of each chunk and visible differences in the soil. The field crew also separated the nine provenience units into subsections. Chunks of midden with subsection designations consist of small midden chunks that broke off from larger provenience units and midden material that the field crew broke apart in order to carry the soil out of the canyons. I analyzed the subsections as separate units of analysis in the lab. The subsections contained deposits from different temporal contexts than the main provenience units and I maintained the integrity of the subsections.

While I obtained macrobotanical data from all the salvaged provenience units, I determined that the macrobotanical research also required a sampling strategy using a standardized volume of analysis. Pearsall argues that:

> …it is important not only that the analyst know how much soil…produced an assemblage of macroremains but also that sample sizes do not fluctuate dramatically among contexts. [2000:75]

A standardized unit of analysis provides a means of comparing different contexts of cultural soils. A large chunk of midden might contain a high count of seeds compared to a smaller chunk, but the differences between the count do not indicate differences in the rates of seed deposition.

Researchers, for example, may identify a high count of squash seeds in 5 liters of soil dating to the Pueblo II Period and a low count of squash seeds in 2 liters of soil dating to the Pueblo III Period. An initial examination of the frequencies suggests that squash consumption decreases during the Pueblo III Period. A second investigation, however, of only 2 liters of soil from both of the samples shows a similar frequency of squash seeds in both the Pueblo II and III Period contexts. Without a comparable sample size from the different contexts, a researcher might inaccurately conclude that the consumption of squash decreases during the Pueblo III Period. The use of standardized sample sizes helps to determine if frequencies of taxa between contexts result from actual changes in the rate of deposition of taxon.

Accordingly, the Inscription House Midden Project used a standard sample size of 1 liter for comparable units of analysis. I left smaller provenience units and extra material from larger provenience units out of the comparative analyses. I also held a small portion of the material out of the analysis in case an associated Native American group wanted to witness the analysis first hand. The unanalyzed units did not affect the analysis.

I compared 12 provenience units in total: 1, 1a, 1c, 2, 3, 4N, 4SE, 4SW, 5.1, 5.3, 5.4, and 5.5. The sampling strategy provided a means of comparison in the analysis that was integral to the study of the Inscription House diet through time. The following sections discuss the methods used during the macrobotanical analysis, pollen analysis,

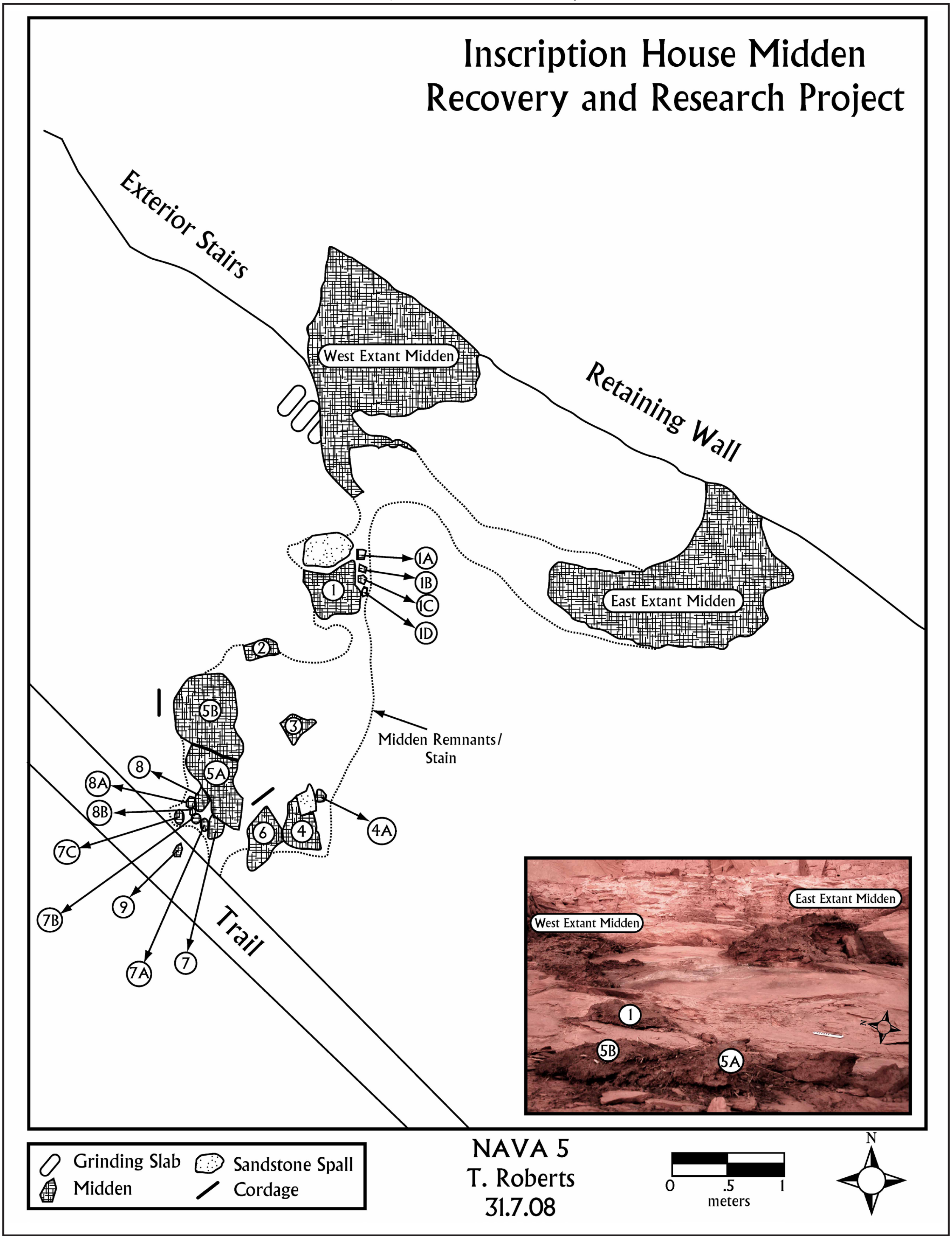


Figure 14. Digitized National Park Service map by Ted Roberts (2008) of the slumped portions of the midden with provenience unit designations.

and dating of midden matrix.

Macrobotanical Analysis of a Midden from Inscription House

Macrobotanical analysis involves the recovery of carbonized and uncarbonized plant material from archaeological matrix. The matrix in this project consists of midden material that slumped from in situ deposits at Inscription House. The midden material consists of fill and trash from the daily activities of the Inscription House residents. The trash contained ceramics, lithics, charred wood, wild seeds, cultigens, and other organics.

The macrobotanical recovery proceeded, in this case, by gently breaking down the clumps of material to free the organics and artifacts. Because flotation, often used in the recovery of botanicals from archaeological matrix, would have moistened and damaged the non-charred botanicals and other organics, I chose not to float. Much of the matrix, once broken down, could be dry-sieved using nested screens.

The first step in dry sieving involves the sifting of individual soil samples through nested geological sieves. The sieves progressively digress in size from 2 mm to 0.5 mm. I analyzed material from the individual sieves (4 in total) separately. A separate analysis of the different sized material allows a researcher to have an organized and simplified method for investigating the samples. Viewing material in a similar size helps an analyst keep track of what was sorted and what was not sorted.

Sorting involves the separation and identification of individual species of plants, as well as other archaeological material, in a sample. The identification of material less than 2mm, in the Inscription House Midden Project, required the use of a low powered microscope. Material greater than 2 mm was analyzed with the naked eye. After sorting the material, I labeled the separated specimens with taxon and provenience unit information. I later counted the specimens of individual taxa.

Identification of the taxon of botanical specimens required the use of modern comparative samples from the Paleoethnobotany Laboratory in the Bilby Research Center at Northern Arizona University. If the botanical collection lacked comparative samples pertinent to the study, I examined botanical books and online resources. The seed guide written by Barkley and Martin (1961) provided comprehensive information on the identification of plant species and was a primary text resource during the identification process.

Supplemental species identification texts used in the study consisted of botanical guides by McDougall (1973), Steinshouer (1985), Sharp (1990), Young and Young (1992), Musil (1980), Delorit (1970), and Hitchcock (1971). The supplemental botanical guides provided information on topics in the characteristics of regional plant taxa, grasses, wood, seed plants, and woody plants. I also used the United States Department of Agriculture Plants Database (2008) to help identify and determine current taxonomical terminology for individual species.

The plant database, texts, and comparative samples revealed the morphological characteristics of seeds and wood of individual species. Researchers use the differences in morphological characteristics to identify seeds and wood to at least the family level. Different species of plants in a family sometimes contain similar morphological features. Archaeological samples also consist of fragments of seeds with no distinguishable features. For the purposes of the analysis, I attempted to identify the plant material in the midden samples to at least the family name.

The matrix of the midden, however, consisted of several unidentifiable species. The species were unidentifiable due to the lack of distinguishable features of some specimens and the fragmentation of other specimens. I noted the unknown species, but left unidentified specimens out of most of the analyses. The unidentified specimens provided no relevant information for the Inscription House midden study.

In addition to the identification and counting of specimens, the Inscription House Midden Project required an analysis of the morphological measurements of corn. The morphological measurements (Figure 15) of corn used in the Inscription House Midden Project consisted of measurements described by Sanchez Gonsalez (1989) in a study on the Mexican races of corn. The measurements consisted of cupule depth, cupule width, rachis segment length, rachis diameter, number of rows, cob length, cob diameter, kernel width, kernel thickness, and kernel length. Sanchez Gonsalez (1989) examined the morphology of corn to determine possible difference in the size of corn over time. The Inscription House Midden Project also examined the morphology of specimens to determine if changes occurred in the size and shape of corn consumed at the site from the Pueblo II to the end of the Pueblo III Period. A change in the morphology of the corn could reveal a shift in the consumption of different varieties of the plant or show evidence of environmental stress.

The macrobotanical data recovered from the Inscription House midden provided important information on the diet

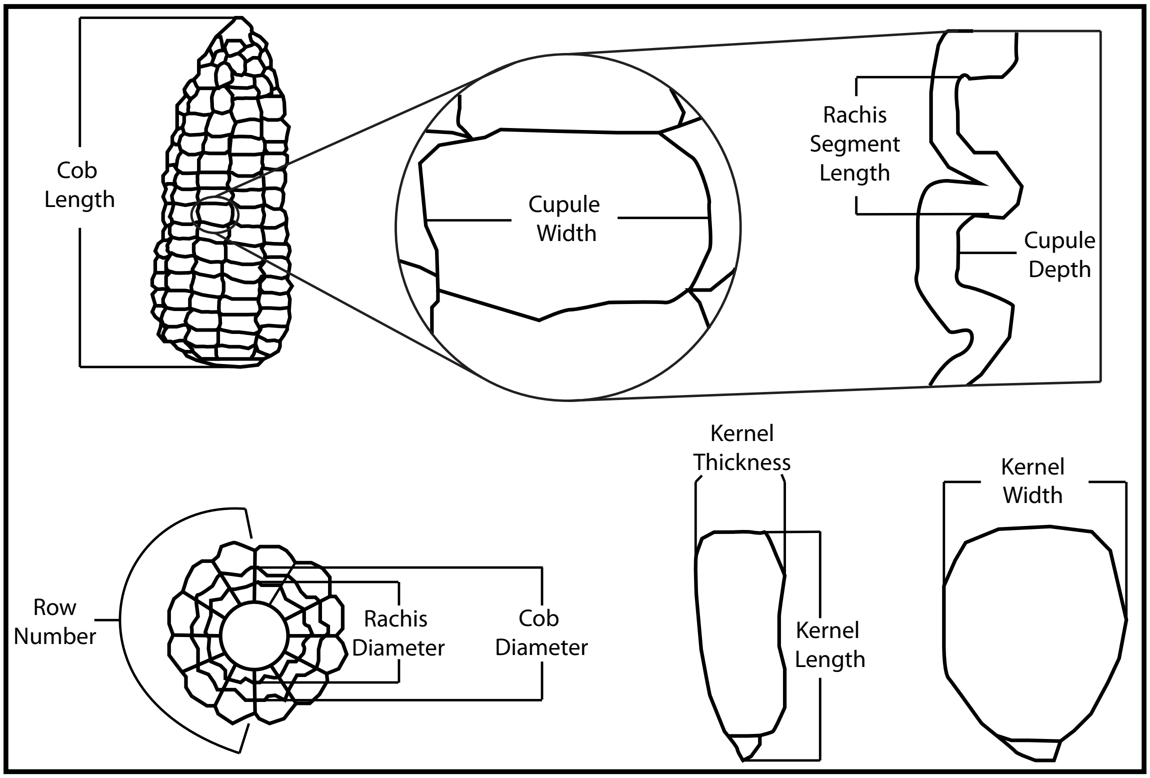


Figure 15. Corn morphology diagram (after Sanchez Gonsalez 1989).

of the occupants of the cliff dwelling during the Pueblo II and III Periods. Information on the diet of the occupants consists of any changes in the preference of species overtime and if the community used a risk management strategy in response to environmental deterioration. The identified plant taxa from the Inscription House midden also showed if the plant communities altered during the Pueblo III Period because of changes in the environment. A dominance of water loving species in an archaeological matrix may indicate a high annual precipitation or high water table in the area. A high frequency of dry habitat plants, however, likely reveals a low water table or a low annual precipitation. The information recovered on the local environment and the Inscription House occupants' diet was integral in determining if environmental deterioration forced the community to migrate from the area by the end of the Pueblo III Period.

Identifying Culturally Significant Remains and the Problems Associated with Decay

An analysis of prehistoric diets requires an understanding of biases in the paleoethnobotanical record associated with natural decay and the natural deposition of plant material. Plant material enters the archaeological record through natural deposition as well as through human activity. Plant material that enters the archaeological record through natural deposition reveals limited information on past human activity. An analysis of a prehistoric group's diet necessitates that a researcher determine culturally significant material, or material that a researcher correlates with past human activity. A researcher also needs to understand that plant material decays overtime. The plant material currently in the ground is only a portion of the material originally in the archaeological record.

The dry alcove setting of Inscription House allows the preservation of a relatively high frequency of plant material. A portion of the plant material, however, eroded overtime. In addition, parts of plants decay at different rates. Nuts, for example, survive longer in the archaeological record than roots or tubers. The counts of specimens of taxa in the Inscription House midden may not reveal the original counts of specimens in the midden during the period of primary deposition. Natural decay creates an uncontrollable bias in the study of paleoethnobotanical material.

A researcher, however, may find and correct the biases introduced into the record by natural processes. Paleoethnobotanists attempt to identify differences between plant material naturally deposited in soils and culturally significant plant remains. Pearsall (2000), as well as paleoethnobotanists Hastorf and Popper (1988), argue that the examination of charred seeds or nuts controls for the natural deposition of plant material in the archaeological record. Naturally deposited plant material usually is un-charred in archaeological deposits. Charred plant material provides an indication of culturally deposited material. Although, prehistoric people did not always char plants before consumption and ate certain plants raw. Foods consumed raw or unburned might not survive in archaeological contexts in the Inscription House midden because of natural decay.

The biases in the frequencies of surviving plant material create uncontrollable variables in the Inscription House Midden Project. The project, however, mitigated the process of natural deposition of plant material in the archaeological record. To mitigate natural deposition, I examined only charred plant material to identify culturally significant remains in the soil of the Inscription House midden.

Looking at the Frequencies of Plants in the Inscription House Midden

The Inscription House Midden Project compared the frequencies of plants in different provenience units of the midden to investigate the diet of the Inscription House community. In order to compare and contrast the data from the different provenience units, I created tables with the counts of plant taxa. The counts consisted of fragments as well as whole portions of charred plant material and were used to calculate two forms of statistical results. The two analytical comparisons in the Inscription House research consisted of the proportions of specimens and the ubiquity of specimens, strategies commonly used by paleoethnobotanists. The common usage of proportions of specimens and ubiquity analyses allow comparisons of the data from the Inscription House midden to data from previous studies in the area.

Proportions of specimens involve the division of a quantity of a plant taxon by the quantity of all the plant taxa in a data set. The quantified percentage of taxon shows the percentage of a species in the total artifact assemblage. For example, if a sample contains 43 goosefoot seeds out of 100 seeds, then the sample contains 43% goosefoot seeds.

The second type of analysis consists of ubiquity analyses of plant species. Ubiquity analyses provide the percentage of soil samples that contain a particular plant. An analyst calculates the ubiquity of taxon by dividing the number of samples that contain a particular plant species by the total number of samples. Ubiquity tests provide different information from the proportion of specimens and mitigate for biases that occur in analyses of the proportion of specimens.

Ubiquity tests show how commonly a community uses a plant, while proportions of specimens provide information on the percentage that a particular species comprises of the total assemblage. Proportions of specimens indicate the degree to which a community relies on a plant, but the counts of specimens contain biases that skew the data. Biases derive from the differential production of fruit, seeds, or nuts by different species of plants.

Amaranth, for example, produces more seeds than a currant bush. A higher production of seeds, if a community consumes both plants, would result in a higher count of amaranth compared to currant in a soil sample. If a researcher only examined the proportion of the specimens, the data would show that prehistoric people preferred amaranth to currant. An examination of the ubiquity of the species, however, indicates a higher percentage of the samples consist of currant compared to amaranth. The ubiquity of the taxa, in this example, provides evidence that the prehistoric community relied more heavily on currant than amaranth as a source of food. The higher count of amaranth resulted from a higher rate of seed production for the plant rather than a greater consumption of the plant.

Comparing and contrasting the information from both analyses provides a greater understanding of the diet in a community. An analysis of the Inscription House diet required a similar strategy to deal with possible biases in the data. For the previously mentioned reasons, I calculated the proportion of specimens and ubiquity for the botanical material recovered from the midden and plotted the information on histograms for visual comparison. Comparisons of the data from the Inscription House midden provided significant information about the diet of the Inscription House community during the Pueblo III Period.

Pollen Analysis

The pollen analysis was performed at Bilby Research Center in 40 cc samples. Although modern pollen rain skewed the pollen data, I examined the data primarily for taxa that may correspond with prehistoric activity, namely domesticates, such as corn and squash, that no longer grow in the immediate area and can provide insight into the plants growing in the area during the Pueblo III Period.

Comparing Diets: Investigating Regional Studies on Prehistoric and Modern Communities

The study of dietary changes at Inscription House required an examination of previous archaeological and ethnographic research on diet in the region. The comparative studies consisted of regional and site-specific archaeological research as well as ethnobotanical research conducted on modern Native American groups. The investigation of previous research provides information on the prehistoric use of plants, common dietary staples in Southwestern communities, and the effects that environmental degradation had on prehistoric diets.

Archaeologists have conducted coprolite, pollen, and macrobotanical analyses on sites in northeastern Arizona that show the local variability and regional similarities of Ancestral Puebloan diets. Androy (2003) analyzed, for example, plant material in coprolites and determined the nutritional significance of plants in the diet of early agricultural (circa A.D. 200) communities on the Colorado Plateau. Androy's (2003) research presents evidence for the most desirable wild plants consumed by early agricultural communities in the American Southwest. The prehistorically desirable plants identified in Androy's (2003) research consist of goosefoot, amaranths, juniper, pinyon, yucca, prickly pear, and Indian ricegrass. Androy's (2003) dietary research analyzed data from an earlier period, but the data provide possible evidence of desirable plants in the diets of later Ancestral Puebloan groups.

A second study of diets by Rocek (1995) examined material dating to the Pueblo I Period (A.D. 700-900) and showed similar dietary staples as Androy's (2003) research. Rocek's (1995) research, however, provided evidence that local deviations occurred in the proportion and types of plants consumed by prehistoric communities. Prehistoric communities consumed different frequencies of certain species compared to others in an area. Minnis (1989) argues that the differences in diets of prehistoric communities result from differences in local ecologies. Local ecologies provide certain plants that a community uses. A community may use plants from a different area, but the local plant communities guide the diets of a prehistoric group.

Despite differences in the diets of communities, Rocek (1995) identified species most commonly consumed by Ancestral Puebloans. The commonly consumed species include Indian ricegrass, amaranth, and goosefoot. Minnis (1989) also determined, in an analysis of coprolites from the four corners region, that Ancestral Puebloans consumed the same plants mentioned above in consistent frequencies from the Pueblo I-III Periods. The studies by Rocek (1995) and Minnis (1989) show that an analysis of changes in a community's diet requires an understanding of local differences as well as regional similarities in the consumption of foods.

An analysis of diet also requires an understanding of a plant's use in modern Native American communities. Modern ethnobotanical research on descendants of prehistoric groups provides information on past human activity that an archaeologist can sometimes only infers from archaeological data. The ethnographies consulted in the Inscription House Midden Project consist of an initial study of the Hopi by Hough (1897); a secondary study of the Hopi by Whiting (1978); a compilation of studies by Moerman (1998); an investigation of the Navajo by Hocking (1956); a second examination by Elmore (1943); a handbook of edible plants by Ebeling (1986); and a synopsis of plants used in the four corners by Dunmire and Tierney (1997). The modern ethnographies used in the Inscription House research document historic uses of plants by Southwestern groups. Studies of the historic use of plants in a community may document a similar use of plants by prehistoric groups.

Previous ethnographic and archaeological studies on diets provide information necessary in an analysis of the diet of the Inscription House occupants. The modern ethnobotanical and paleoethnobotanical information helped to identify the dietary staples at Inscription House. A comparison of the Inscription House midden data with previous research also provided evidence of any possible dietary stress. In addition, I could examine if the Inscription House community altered the diet in response to dietary stress before the earliest dated material in the midden by examining previous research. By using the information from ethnobotanical and paleoethnobotanical studies on diet, I was able to develop a greater understanding of the data from the Inscription House midden.

Determining the Periods of Deposition of the Inscription House Midden

The Inscription House Midden Project used radiocarbon dating of plant material and an analysis of ceramic dates to determine the periods of deposition of the midden material. The analysis of ceramic types in the soil samples provided approximate dates of the cultural phases and periods of deposition. A more accurate determination of dates for the deposition of midden material occurred through radiocarbon dating. Radiocarbon dating for the Inscription House Midden Project involved the dating of corn and wild seed samples taken from different provenience units throughout the midden. The radiocarbon dating of botanical material and the dating of ceramics provided a chronology used in identifying changes in the Inscription House diet through time.

Dating Archaeological Material through Ceramic Analysis

An analysis of ceramics helps in the identification of the period of deposition of archaeological material. Ceramic dating requires an understanding of current period and phase designations for the local distribution of prehistoric pottery types. Prehistoric people developed different styles and types of pottery through time. The identification of a pottery type in an archaeological context gives an approximate date range for the deposition of material. Ceramic dates provide a relatively accurate date for archaeological material, but an archaeologist can obtain a more accurate date through radiocarbon dating.

Radiocarbon Dating and the Quality of Dated Samples
Radiocarbon dating provides relatively accurate dates for botanical material. The selection of botanical material for radiocarbon dating requires an understanding of material quality. Material quality refers to the rating of samples on a scale of closeness of sample association with cultural activity. The date obtained for an artifact in radiocarbon dating may not necessarily indicate the date a person used an object. Radiocarbon dating determines the age of botanical material at the time the material stopped living.

An inhabitant of Inscription House, for example, could have collected dead juniper branches from the ground for a fire. A radiocarbon date of the charred juniper wood would indicate how long ago the wood died, but not how long ago the inhabitant of Inscription House used the wood for a fire. The dates could vary from decades to even centuries depending on the initial deposition of the juniper wood.

A more precise correlation between human activity and artifacts involves the use of domesticated or charred wild plant material for radiocarbon dating. Dating of domesticated and charred wild plants provides an age of deposition directly connected with prehistoric use. Corn, for example, relies on humans to reproduce. The inhabitants of Inscription House planted and harvested corn in a growing season. A radiocarbon date on corn gives a direct date for cultural contact. Charred wild plants also give a direct temporal indication of human gathering practices. Prehistoric people collected and burned wild seeds for consumption in a relatively short period. A direct correlation to human activity makes charred wild seed and domesticates high quality samples for radiocarbon analysis.

Dating the Midden Contexts
Radiocarbon dating of Inscription House material consisted of the dating of 17 samples of different charred wild seeds and parts of corn from different provenience units in the midden. I organized the radiocarbon samples sent to Beta Analytic Inc. into three pulses. The first group of samples provided an initial determination of dates that revealed gaps or problems in the dating. I then selected a second group of radiocarbon samples based on the result of the preliminary group. A third group of radiocarbon samples came back with dates on previously undated provenience units to expand on the understanding of the deposition of midden material. The radiocarbon and ceramic dates provided the means for a comparative analysis of dietary data from the Inscription House midden through time.

The Strategies Used in the Inscription House Midden Project
The Inscription House Midden Project used several strategies to examine the diet of the Pueblo III Period community. The strategies consisted of methods of analysis, methods of quantifying the data, and methods of dating the contexts. The methods I established for the project allowed for the investigation of the Inscription House diet during different phases of the Pueblo III Period. The following chapters provide the results of the research.

Chapter 4.

Results of the Macrobotanical and Pollen Analysis for the Inscription House Midden Project

This chapter sets out the results of the macrobotanical and pollen analysis that the National Park Service requested for the Inscription House Midden Project. I separated the macrobotanical discussion into 5 categories consisting of domesticates, wild food species, charred wood, miscellaneous parts, and unidentified specimens. The categories provide a framework for discussing and identifying changes in the consumption and use of species through time. I discuss below the frequencies, biological information, and ethnographic information on the identified plant material in the midden and discuss the results of the radiocarbon dating to provide a basis for an examination of the data in the following chapters.

Radiocarbon Dates and Midden Stratigraphic Integrity

Radiocarbon dating of botanical material provided the dates for comparing the macrobotanical data from the different provenience units. I discuss the radiocarbon dates before the macrobotanical data in order to provide a context for the macrobotanical comparisons. The radiocarbon samples (Table 1, Figure 16, and Figure 17) from the provenience units returned a range of dates from different periods of the Pueblo III Period.

While I also analyzed ceramics for dates, I only recovered three sherds from the midden. The three sherds consisted of two Tusayan Polychrome sherds and a Tusayan Grayware sherd that date to the Pueblo III Period. The radiocarbon samples, examined in detail below, (Table 2, Figure 17, and Figure 18) give more precise measures of time for the deposition of material. The radiocarbon dates clustered around A.D. 1040, A.D. 1170, A.D. 1220, A.D. 1260, and A.D. 1270.

I selected 17 samples for radiocarbon dating. The samples consisted of corn cobs, corn kernels, and wild seeds. I submitted the radiocarbon samples from the Inscription House midden in three pulses.

The first radiocarbon set consisted of five different wild seeds (Samples 3-7). The seeds originated from the middle (Provenience Unit 3) and the extents of the midden in different directions (Provenience Units 2, 1a, 4SW, and 5.1). Sampling a variety of locations gives a better understanding of any horizontal differences in the age of the slumped chunks of midden. Since the chunks of midden had eroded from the original vertically stratified positions, the initial radiocarbon sampling strategy provides evidence of the periods of deposition as well as the original relationship of the chunks of midden.

The first pulse of radiocarbon samples also consisted of two corn (Provenience Units 1 and 5.5) specimens from a northern and a western provenience unit to determine any differences between the dates of wild plant material and domesticate material. The initial radiocarbon dates showed little temporal pattern in the horizontal distribution of the slumped sections of the midden. The sampled provenience units returned dates from cal A.D. 1040 in close proximity to provenience units with a radiocarbon date of cal A.D. 1270. The lack of a temporal pattern in the horizontal distribution of the chunks suggests that the midden chunks tumbled or rolled instead of slumping or collapsing directly from the original context. The proveniences units could also have consisted of material deposited from multiple periods.

No visual evidence indicated differences in the soil of individual provenience units during the initial stages of analysis. As a result, the Inscription House Midden Project examined the individual provenience units as a single temporal unit. The provenience units likely consisted of indistinguishable strata from different periods or the provenience units contained mixed contexts. We can see evidence of mixed contexts in the differences in the age of domesticates and wild taxa revealed during the initial pulse of radiocarbon dates.

I examined the possibility of mixed contexts or multiple periods of deposition in the provenience units by sending a second pulse of radiocarbon samples from similar, previously dated locations in the midden. An exception to the samples from previously dated locations consisted of a sample from Provenience Unit 4N. I used the sample in order to broaden the understanding of the age of the midden. The samples from the second pulse mainly consisted of corn kernels and cobs.

The second pulse of radiocarbon samples returned mixed results. Samples from Provenience Units 1, 4SW, and 2 showed an age of deposition similar to the previous radiocarbon samples from the same provenience units. Radiocarbon samples from Provenience Units 5.1 and 5.5, however, yielded a sizable difference in the age of the material between the first and second pulse of radiocarbon dating. The dates of the radiocarbon samples from Provenience Units 5.1 and 5.5 indicate that the

Table 1. Radiocarbon Samples and the Calibrated Dates.

Radiocarbon Sample	Provenience Unit	Material Type	Intercept Date (cal A.D.)	95 % Confidence Interval (cal A.D.)
1	1	Corn Cob	1170	1040-1240
2	5.5	Corn Cob	1040	1010-1170
3	4SW	Indian Ricegrass Seeds	1210	1050-1090 1130-1140 1140-1260
4	3	Groundcherry Seeds	1240	1170-1280
5	1a	Goosefoot Seeds	1270	1220-1300
6	5.1	Sideoats Grama Seeds	1270	1220-1290
7	2	Beeweed Seeds	1220	1160-1270
8	1	Corn Cob	1220	1160-1270
9	5.5	Corn Cob Fragment	1260	1200-1280
10	4N	Corn Cob Fragment	1260	1200-1280
11	4SW	Corn Kernel	1170	1050-1090 1130-1140 1140-1230
12	5.1	Corn Kernel	1040	1020-1160
13	2	Corn Cob Fragment	1230	1170-1270
14	1c	Squash Rind	1210	1160-1260
15	4SE	Corn Kernel	1170	1040-1220
16	5.3	Corn Kernel Fragment	1260	1210-1280
17	5.4	Corn Kernel	1240	1200-1270

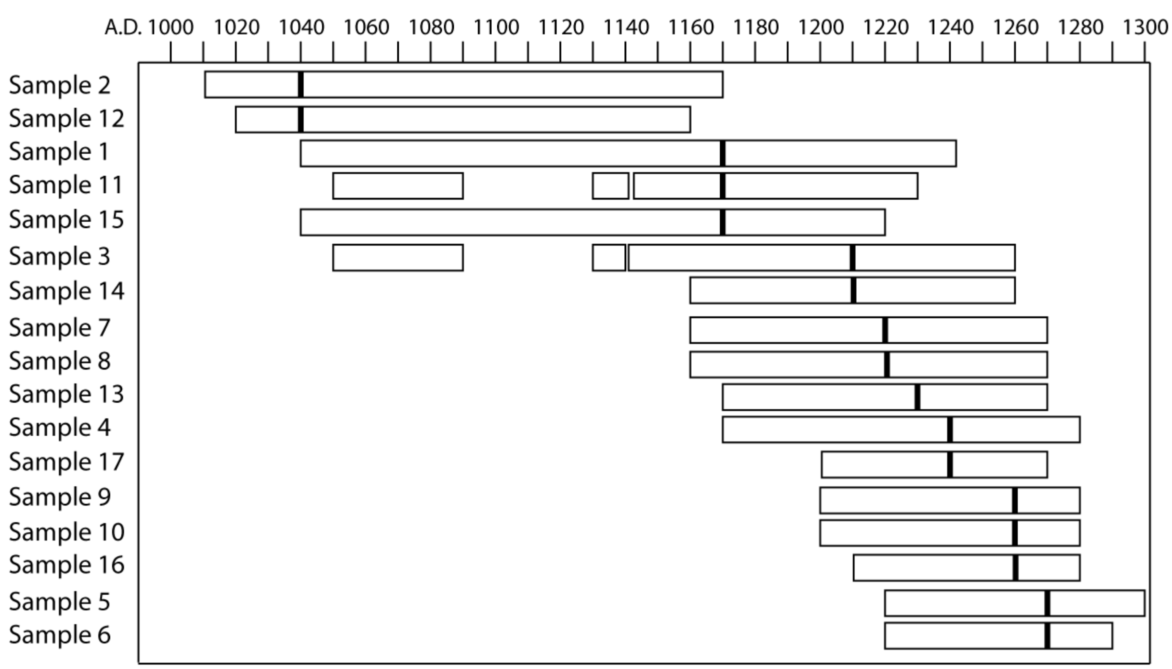


Figure 16. Seriation graph of the calibrated radiocarbon dates with 95 % confidence intervals and intercept dates.

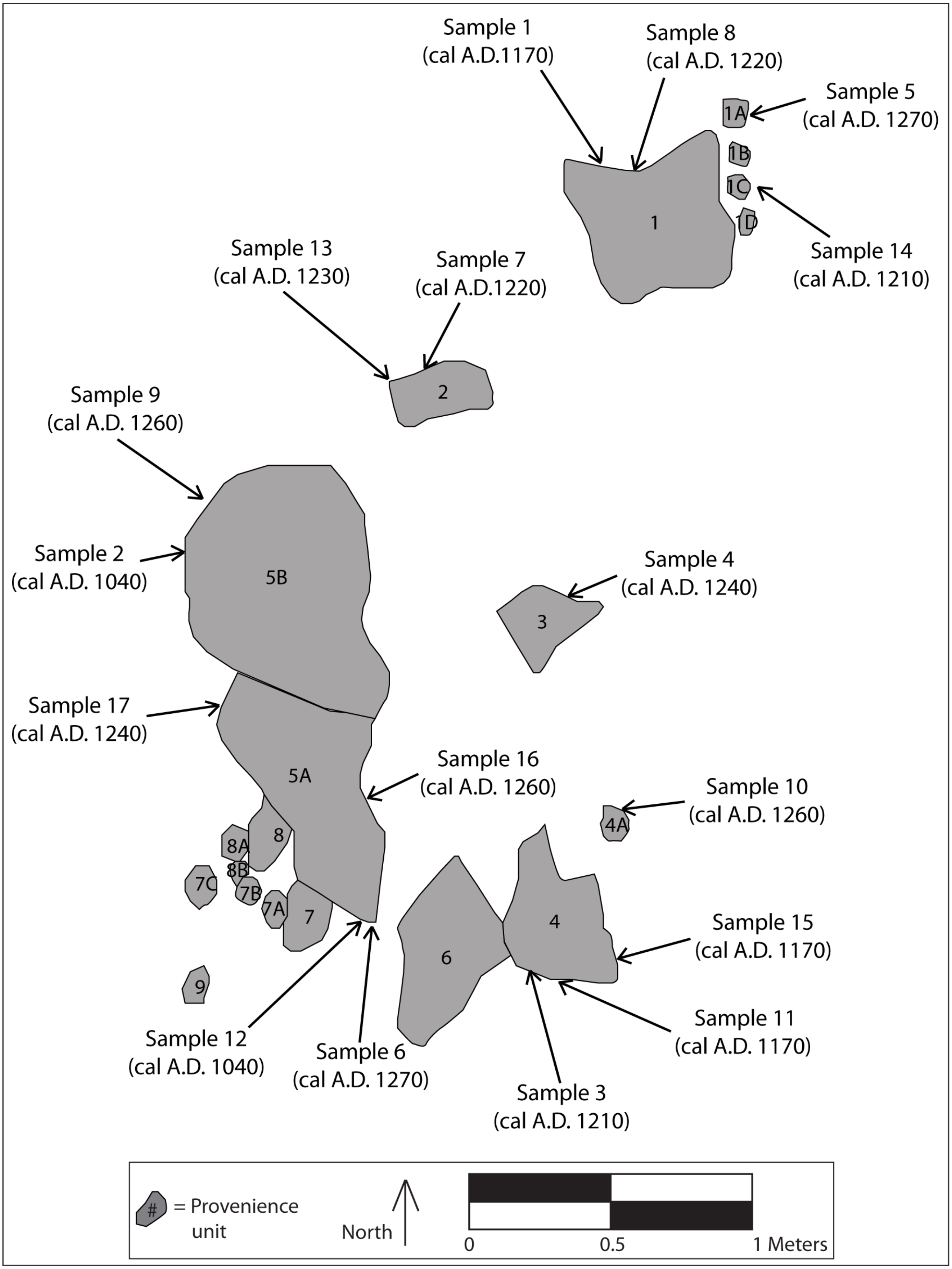


Figure 17. Map showing the location of the radiocarbon samples with calibrated radiocarbon dates.

provenience units consisted of mixed contexts ranging in age from A.D. 1040 to A.D. 1270, a period of over 200 hundred years.

The lack of additional samples that date to the Pueblo II Period suggests that the Inscription House community deposited material from mixed contexts in the location of Provenience Units 5.1 and 5.5. Ward (1975) argues that the Inscription House community cleared fill from rooms during different periods of occupation. The deposition of room fill in the midden area likely explains the mixed contexts revealed during the radiocarbon analyses. The occupants probably mixed fill from contemporaneous and previous periods when clearing a room of debris.

The mixed contexts could also result from a low frequency of deposition of material in the midden area during the Pueblo II Period and an increased deposition during the Pueblo III Period. A change in the frequency of use of the midden through time could explain the presence of Pueblo II Period material in only Provenience Units 5.1 and 5.5. I sent a third pulse of radiocarbon samples to see if any additional Pueblo II Period material occurred in the midden as well as to identify additional dates for previously undated contexts.

The results of the final pulse of radiocarbon dating revealed that the last tested provenience units dated to the Pueblo III Period. The three sets of dates show that the midden consists of materials primarily from the Pueblo III Period occupation. The two radiocarbon samples that returned dates from the Pueblo II Period probably suggest that Provenience Units 5.1 and 5.5 consist of mixed contexts. The precise reasons for the mixed contexts are currently unknown. The Inscription House community might have placed the mixed contexts in the midden during the occupation of the site. Individual strata, however, could also comprise the provenience units despite a lack of visual evidence during the initial investigation. Future research should investigate the last in situ portions of the midden using more systematic excavation techniques.

Researchers should excavate the in situ portions of the midden in standardized and incremental levels before any erosion occurs. Dating of material from standardized levels of excavation before the material erodes from the area of primary deposition would show if the midden consists of mixed contexts. Dates from the individual layers might suggest that the midden contexts consist of strata from different periods of deposition.

The Inscription House Midden Project provided a set of dates needed for the analysis of the Inscription House diet. The radiocarbon dates show relatively tight clusters of dates for the midden provenience units. The clusters of dates suggest evidence of distinct periods of deposition during the Pueblo III Period. I used the different dates of deposition for provenience units in the examination of the macrobotanical data through time.

Categories of Specimens Recovered from the Inscription House Midden

I examined and compared data (Table 2 and Figure 18) from 12, 1 liter samples from midden material salvaged by the National Park Service. The samples contained trash from room deposits, hearths, and storage features. Trash deposited along the cliff face consisted of reproductive

Table 2. Proportions and Ubiquity of the Total Charred Material in the Provenience Units.

Charred Material	Counts	Proportion of Specimens (%)	Ubiquity (%)
Domesticates	780	9.2	100
Wild Species	6015	71.1	100
Charred Wood	952	11.2	100
Miscellaneous	687	8.1	100
Unidentified	20	0.2	42
Total	**8454**	**100**	**-**

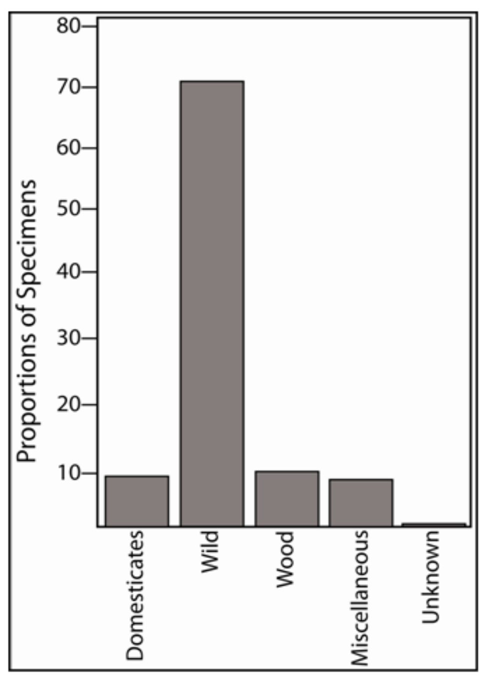


Figure 18. Proportions (%) of the total charred material in the provenience units.dates with 95 % confidence intervals and intercept dates.

parts of wild plants, unidentified seeds, charred wood, parts of domesticates, and miscellaneous parts of plants. I placed a photograph of a specimen from the midden and a plant of the identified species whenever possible in the following sections.

Domesticates Found in the Inscription House Midden

The Inscription House midden contained three domesticates: consisting of *Cucurbita* spp. (gourd), *Zea mays* L. (corn), and *Gossypium* spp. (cotton). The other domesticate grown by Ancestral Puebloans, *Phaseolus vulgaris* L. (beans), did not occur in the midden materials. While no evidence of beans lie in the midden, the Inscription House diet probably consisted of beans similar to diets in contemporaneous Ancestral Puebloan sites in the region. I investigate the absence of beans in the macrobotanical assemblage in a later section. The following subsections describe the biological and ethnographic data on corn, gourds, and cotton in separate subsections.

Zea mays L. *(Corn)*

Domesticated varieties of corn (Zea mays L.) (Figure 19) differ significantly in seed size and number of cobs produced on a single plant compared to wild progenitors. The morphological changes resulted from human intervention. Prehistoric groups selected teosinte (*Zea mays* spp. *parviglumis*) plants that produced larger seeds as well as larger grain spikes. Selection by humans eventually resulted in a plant with a single stalk and non-disarticulating seeds. The new plant differed from wild teosinte, which naturally disperses seeds and grows numerous stalks in a single plant. A side effect of non-disarticulating seeds is a reliance on human intervention for propagation.

Figure 19. Corn cob from Provenience Unit 1.

The domestication of corn from a wild progenitor called *Zea mays* spp. *parviglumis* (teosinte)(Figure 19) occurred in central Mexico. The earliest evidence for a domesticated variety of corn comes from Tehuacán Valley dating to approximately 4,700 B.P. Smith (1998) argues in a study of corn remains from Tehuacán Valley that archaeologists failed to identify any evidence of wild teosinte in the sites. The absence of wild teosinte from sites in Tehuacán Valley possibly indicates that prehistoric people domesticated corn in another area before 4,700 years ago (Smith 1998).

After domestication, humans spread corn to areas outside of Mexico. Archaeologists have identified some of the earliest known evidence of corn in the American Southwest from Las Capas, Arizona (Vierra 2005). The earliest evidence of corn in the American Southwest dates to around 4,000 B.P. Smiley argues in an analysis of early farmers on Black Mesa that "farming appears to have rapidly diffused, or moved by a combination of diffusion and migration, into the northern regions soon after" (2002:41). Based on radiocarbon evidence throughout the southwest, corn dispersed relatively rapidly from Mexico to the northern Ancestral Puebloan territories.

Prehistoric groups on the Colorado Plateau hybridized corn to develop a variety of the plant adapted for dry, high elevation farming. The higher elevations of Arizona have colder temperatures than areas in lower elevations reducing the growing season considerably. The growing season on the Colorado Plateau has around 120 frost free days, a period from late spring to early fall. The Colorado Plateau also has fewer reliable water sources than areas from lower elevations. Because of the less reliable sources of water, prehistoric communities living on the Colorado Plateau relied heavily on annual precipitation patterns for the growth of corn.

Ancestral Puebloans required a variety of corn capable of surviving the lack of a stable water source and the shortened growing season. The corn grown prehistorically and in modern day Puebloan communities is capable of surviving through the use of dry farming techniques. Dry farming relies on summer monsoon rains and winter precipitation. Dry monsoon seasons, however, might result in the immature growth of corn cobs, or the complete failure of a crop. Immature cobs fail to grow to full size and fail to produce complete rows of mature kernels.

The communities living in the Nitsin and Navajo Canyons probably stored water collected from springs or collected precipitation in jars near fields as an additional source of water to prevent crop failure. Ancestral Puebloans, also, recognized the fluctuations of precipitation between growing seasons and stored corn for future use. The storage of food probably sustained a prehistoric community during years of poor crop production.

Prehistoric communities also consumed the cobs during periods of environmental stress. Dunk (2006) suggests that Ancestral Puebloan groups ground up the cobs to use as food as a risk management strategy. The practice of eating ground cobs likely was a last resort for a community in distress.

Modern ethnographic research shows that southwestern communities consume corn in a variety of ways. Puebloan groups parched, boiled, and ground corn as a meal. Whiting (1978) also documents the Hopi preparing corn by soaking the kernels in boiling water with juniper ash to make hominy as well as mixing corn meal with fourwing saltbush (*Atriplex canescens*) to create flour for piki bread. Piki bread is flaky wafer bread made into batter and cooked on top of a heated stone.

Modern ethnographic evidence also suggests that corn serves an important non-dietary purpose in Puebloan culture. Whiting argues, for example, that the Hopi do not consume all varieties of corn grown and that corn "appears in virtually every Hopi ceremony either as corn meal, as an actual ear of corn, or as a symbolic painting" (1978:67). Hopi boil different colors of corn mixed with clay to make body paint for ceremonies and dye for baskets and textiles. Corn husks were even used as rolling paper for ceremonial cigarettes.

Whiting (1978:67) suggests that corn appears frequently in ceremonies throughout the lifespan of a Hopi individual. Hopi use corn as paraphernalia in ceremonies that occur from birth to death. The use of corn as ceremonial paraphernalia reveals the cultural and religious importance of the plant in modern Puebloan groups.

Parts of corn also serve as components of medicinal treatments in modern Native American groups: the Western Keres consume the pollen as a cure all, the Navajo treat sore throats with corn cobs, and the Tewa use corn meal for heart problems (Moerman 1998). The Tewa rub warm corn cobs on children to relieve glandular swelling. In addition, children in modern Puebloan groups use corn as implements in games or as components in toys. Moerman (1998:612) argues that the Zuni attach feathers to cobs to create shuttlecocks or darts. The importance placed on corn in everyday life probably existed in Ancestral Puebloan cultures as well.

Cucurbitaceae *(Cucumber Family)*

The cucumber family (Cucurbitaceae) (Figures 20 and 21) consists of two types of gourds that prehistoric communities used in the American Southwest including *Cucurbita* spp. (squash) and *Lagenaria siceraria* (bottle gourds). Cutler and Whitaker (1961) analyzed gourds in prehistoric sites in the Americas and argue that the identification of varieties of gourd presents difficulties when only the rind of the fruit is present. Rind fragments comprise most of the gourd assemblage in the Inscription House midden and lacked identifiable characteristics for the identification of the specimens to the species level.

While I identified the seeds as squash, the seeds were composed of mostly fragmentary specimens and provided

Figure 20. Fragment of a gourd rind from Provenience Unit 1 at 6.3 x magnification.

Figure 21. Fragment of a squash seed from Provenience Unit 1 at 6.3 x magnification.

an ambiguous morphology that I could not correlate with a specific variety. Squash probably comprises the total assemblage of the gourd genus specimens in the midden, but I investigated the use of several varieties of gourds that occur in archaeological contexts in the Southwest.

Cucurbita spp. *(Squash)*. Prehistoric communities consumed a variety of squash species on the Colorado Plateau. Cutler and Whitaker (1961) and Whiting (1978), document four main southwestern varieties of squash consisting of *C. moschat*a Duchesne (crookneck squash), *C. maxima* Duchesne (winter squash), *C. mixta* Pang. (pumpkin), and *Curcubita pepo* L. (field pumpkin). Whiting (1978) argues that crookneck squash is one of the most common species of squash in modern Hopi communities as well as in archaeological sites near the Hopi mesas. The prehistoric community at Inscription House probably preferred crookneck squash as well.

Domestication of squash occurred in two locations in the Americas. Smith (1997) analyzed the domestication of squash in the New World and argues that the earliest archaeological evidence for a domesticated species of squash comes from a single seed excavated at Guilá Naquítz, a cave in the Oaxaca Valley of southern Mexico. The seed showed significantly larger morphological traits than wild progenitors indicating the domestication of a variety of squash between 8,500 and 10,500 B.P.

The second independent domestication occurred in the eastern United States between 4,300 and 4,500 B.P. Researchers discovered the earliest known examples of the second domestication of squash in Kentucky and Illinois. Both early areas of domestication provided specimens of squash with evidence of morphologically larger seeds than wild varieties. The change in size results from human selection and intentional planting. Over time selection of certain fruit for crop production resulted in the morphological variation from wild progenitors. Smith (1997) argues that seed size initially changed during domestication followed later (4,300 B.P. in the eastern United States and 7,000-7,700 B.P. in Mexico) by changes in the thickness of the rind, an increase in fruit size, and an increase in seed production.

The earliest domesticated species found in archaeological contexts in the American Southwest originated from Mexico. Researchers dated a seed from Bat Cave in the Mogollon Mountains of New Mexico to about 3,000 years ago. Prehistoric groups on the Colorado Plateau probably adopted the domesticated varieties of squash shortly after. Ancestral Puebloans grew squash in combination with previously adopted varieties of corn.

Squash maintains a similar growing season to the dry farming varieties of corn. Ancestral Puebloan groups planted squash seeds in late spring or early summer and harvested the fruits in fall. Modern Puebloan groups boil the meat of harvested squash fruits and roast the seeds for consumption. The Navajo use the squash blossoms in soups. If a modern community does not eat all the fruit during a season, the modern communities store the uneaten fruit for winter. The Hopi, for example, remove the rind from the fruit and tie the meat in bundles for later use (Whiting 1978:93).

Modern Native American communities also use squash for non-dietary purposes. The rind of the fruit provides material for containers or tools and the seeds provide cooking oil that modern Native American communities use on piki stones. In addition, the plant serves as material for ceremonial paraphernalia. The Hopi use the flowers for ceremonial foods and use the rind to create a musical rasp for Katchina dances (Moerman 1998:187-188).

Modern southwestern groups also use squash varieties for medicinal purposes. Moerman (1998) argues the Western Keres use a poultice of crushed roots to treat boils, the Zuni create a poultice of powdered squash seeds to relieve swelling, and the Tewa use the squash roots to create a laxative. Squash comprises an important part of the diet and an important part of the culture of modern Puebloan groups. The ubiquity of squash in the Inscription House midden suggests that the plant was important to the Pueblo III Period community as well. Squash probably served similar functions as in modern Puebloan communities.

Lagenaria siceraria (Bottle Gourds). The cucumber family consists of bottle gourds that occur in similar archaeological contexts as squash remains in northeastern Arizona. Bottle gourds contain a different origin than squash. Since I could not identify individual species of Cucurbitaceae, I included gourds in the discussion of Cucurbitaceae.

Cultivation of bottle gourds originates in Asia approximately 13,000 years ago where the gourd grows naturally. Smith et al. (2005) analyzed the origins of bottle gourds and argue that prehistoric people brought the cultivated version of the gourd from Asia to North America based on radiocarbon and morphological data. The authors, however, also suggest that a natural dispersal of bottle gourds from Asia to the Americas provides a possibility for the introduction of the cultivated gourd in the Americas.

The earliest evidence of bottle gourds in the Americas occurs in central Mexico around 9,000 years ago (Smith 1997). Smith (1997) argues that the earliest evidence of bottle gourds in the American Southwest originates from archaeological contexts in Tularosa Cave, New Mexico that date to approximately 4,000 years ago. The cultivated species of bottle gourd spread to the American Southwest before domesticated varieties of squash.

The meat of the fruit from wild gourds differs from the domesticated species of squash. Squash provides more palatable meat than bottle gourds and probably was preferred over bottle gourds for food. Ethnographies provide evidence for the use of bottle gourd seeds for food, but Ancestral Puebloans probably used the plant more for utilitarian purposes rather than as food.

Non-dietary uses for bottle gourds in modern Native American groups consist of the use of the rind as canteens, bowls, spoons, and ladles. Moerman (1998:294-295) argues that Puebloan groups also create rattles, flutes, or prayer sticks out of the rind of bottle gourds for ceremonial paraphernalia during dances. Hopi use flutes or horns created from bottle gourd rinds as hunting tools to mimic deer calls as well (Whiting 1978:94). In addition, Moerman (1998) describes the use of boiled gourd roots for medicinal purposes. Modern Puebloan groups apply the boiled roots as an aid in curing sores or preventing infections of wounds (Moerman 1998:294). The Inscription House community may have used bottle gourds for similar utilitarian and ceremonial purposes as modern Native American groups.

Prehistoric communities also consumed gourd meat and seeds as a risk management strategy during periods of environmental deterioration. Bottle gourds show a relatively high resistance to the effects of drought and probably provided a source of food for prehistoric communities during periods of heightened aridity. The Inscription House Midden Project, however, was unable to identify species of gourd. A lack of identifiable specimens of bottle gourds in the Inscription House midden shows that the Inscription House community did not need to consume bottle gourds as a risk management strategy.

Cucurbitaceae specimens in the midden consist of squash seeds and an assemblage of unidentifiable rinds. A species with a thinner rind in the Inscription House midden might indicate the presence of bottle gourds in a few of the provenience units, but the identification of individual species based on rinds proves difficult. Squash, based on the seed data, probably forms the majority of the gourds in the Inscription House midden.

Gossypium spp. *(Cotton)*

Cotton produces edible seeds (Figure 22) that prehistoric communities consumed in different frequencies through time. Coprolite evidence suggests a consumption of cotton occurred during the Pueblo III Period in sites in northeastern Arizona (Kelso 1972; Morris1986). The presence of cotton seeds in coprolites shows that cotton was not just an important material for the creation of textiles, but also a source of food for Ancestral Puebloans.

Domesticated cotton found at prehistoric sites in the Southwest originates from southern Mexico. Burbaker and Wendel (1994) analyzed the genetics of early cotton and argue that the first domestication of the plant in the New World occurred along the coast of the Yucatan peninsula. Prehistoric people later developed a second variety of cotton, known as upland cotton, in the Valley of Mexico. Researchers identified the earliest known remains of the upland variety from Zacatenco, Mexico that date to approximately 900 B.C.

The upland variety of cotton eventually spread to the American Southwest. Vorsila Bohrer (1970) suggests in an analysis of botanical material from Snaketown that archaeologists documented cotton production at Hohokam sites in southern Arizona as early as 1,900 years ago. The first known evidence of cotton in northern Arizona only occurs around 1,000 years ago. Despite a slight lag in the adoption of cotton by communities in northern Arizona, prehistoric people used high frequencies of cotton during the Pueblo III and later periods. Puebloan groups continued to use cotton heavily in the historic period. Cotton provided historic communities not only with a source of

Figure 22. Cotton seed from Provenience Unit 4N at 6.3 x magnification.

food, but also with material for non-dietary purposes.

Hopi use cotton to create material for various woven products as well as ceremonial paraphernalia. Whiting, for example, argues "the face of the dead is covered with raw cotton, which signifies its future existence as a cloud" (1978:85). Cotton also provides material for medicinal and technological purposes. Modern Native American groups use cotton fibers as tinder and as a poultice for child baldness. Moerman (1998:251) argues that the Tewa chew the seeds and apply the material to the forehead of children for child baldness.

While modern ethnobotanical research shows a variety of non-dietary uses for cotton, modern Puebloan groups also recognize the nutritional qualities of the seeds. Ethnographic evidence demonstrates that modern Native American groups continue to consume cotton seeds as a food source. Moerman (1998) suggests Native American communities grind the seeds to create a type of cake or eat the seeds raw.

Domesticate Counts in the Inscription House Midden

The domesticate specimens (Table 3; Figures 23-25) from the Inscription House midden consist of corn, squash, and cotton. While no evidence of beans appears in the midden, the Inscription House community probably consumed beans similar to other contemporaneous Ancestral Puebloan groups. Beans supplement a diet heavy in corn and squash, and aid in the reintroduction of nitrogen in agricultural soil.

Research, however, reveals that another domesticate likely replaced beans in the diet during the later Puebloan Periods. Morris argues that "…bean consumption is eclipsed by that of cotton seed, which probably provided many of the proteins and fats the beans would have supplied…" in a study of botanical material from Antelope House in Canyon de Chelly (1986:221). Prehistoric communities probably replaced beans with cotton because the greater range of uses of cotton. Cotton provides an equivalent dietary supplement to beans as well as material for making textiles. The range in uses suggests the plausibility of the replacement hypothesis, but the cotton counts (7 total) are relatively low in the soil samples. The low counts of cotton and the absence of beans in the macrobotanical analysis indicates infrequent consumption or an absence of the plants in the diet.

Previous coprolite studies at the site, however, support a hypothesis that the Inscription House community consumed more cotton than beans (Kelso 1972). The prehistoric community at Inscription House probably relied on the plant during periods of environmental stress. The storability and high drought resistance of upland varieties of cotton likely indicates the importance of the plant as a source of food during periods of increased aridity and environmental degradation.

Cotton, however, occurred in less than half of the midden samples (42%) and in relatively infrequent proportions (around 1%). The low counts of cotton in the macrobotanical assemblage show that the Inscription House community consumed cotton as a supplement to

Table 3. Proportions and Ubiquity of Domesticates for All Provenience Units.

Domesticate	Counts	Proportion of Specimens (%)	Ubiquity (%)
Zea mays L. (Kernels and Cobs)	145	17.2	100
Cucurbitaceae (Seeds and Rinds)	693	82	100
Gossypium spp.	7	0.8	42
Total	**845**	**100**	**-**

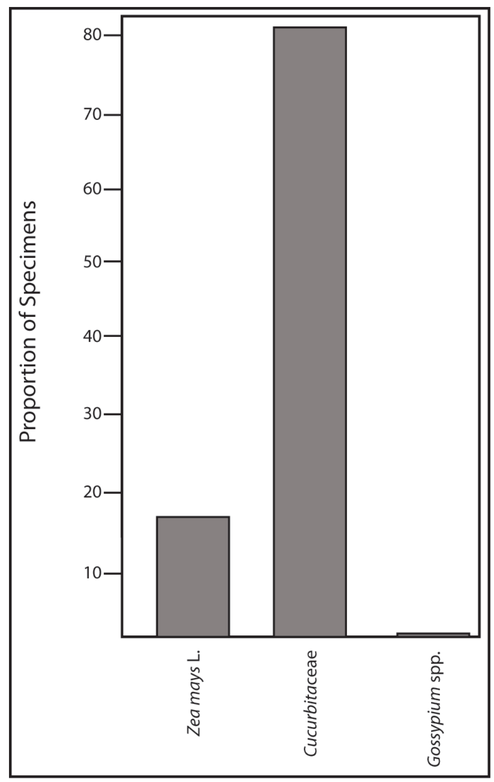


Figure 23. Proportions of domesticates in all provenience units.

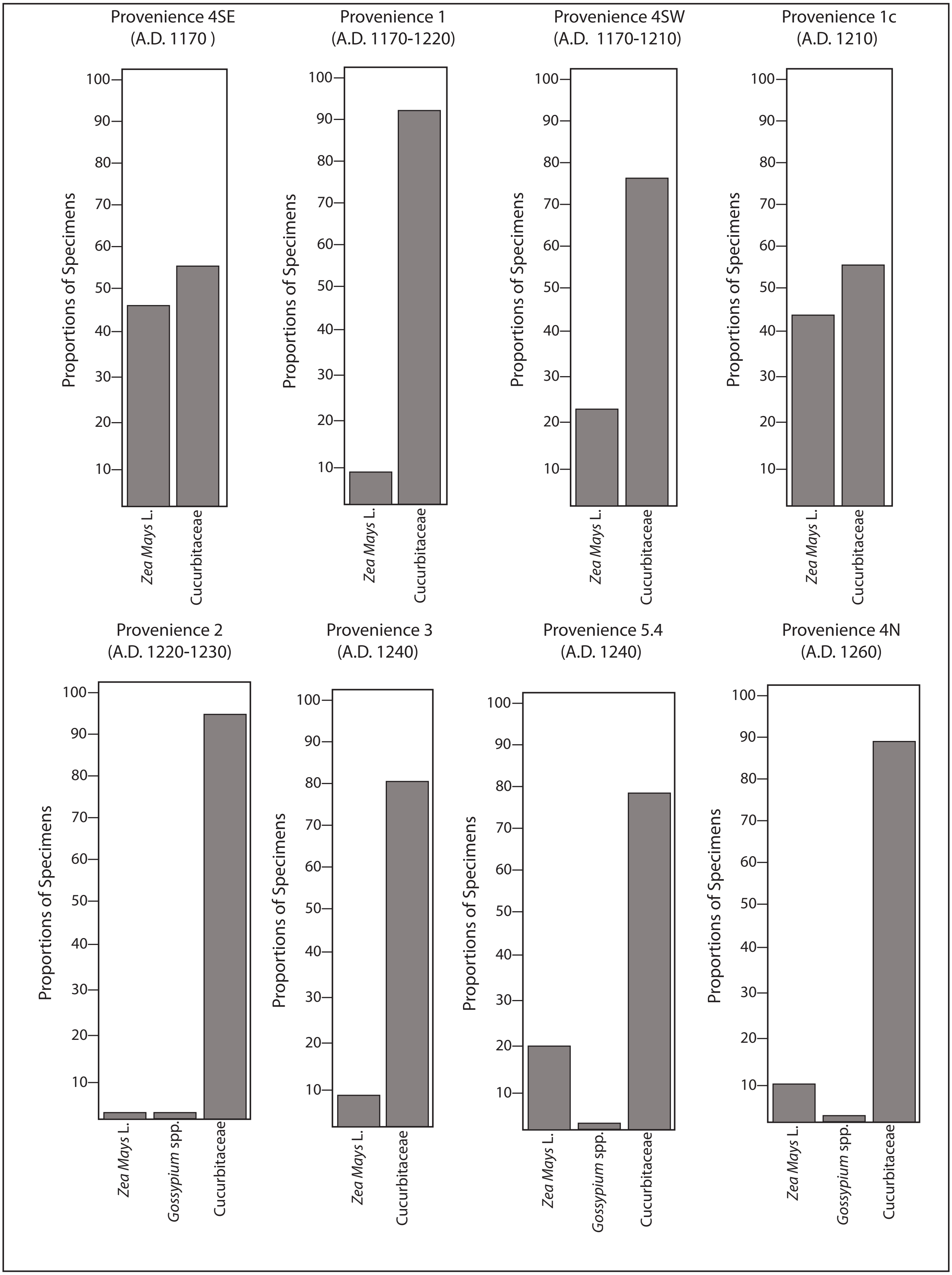


Figure 24. Proportions (%) of domesticates separated by provenience unit and organized by calibrated radiocarbon dates.

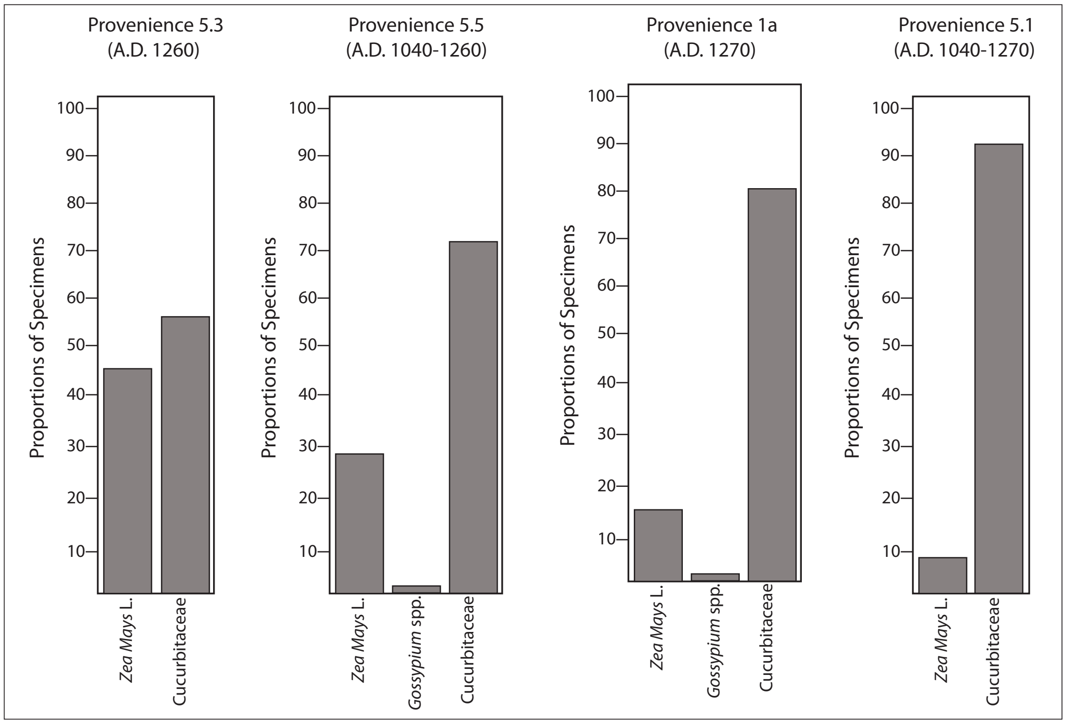


Figure 25. Continued proportions (%) of domesticates separated by provenience unit and organized by calibrated radiocarbon dates.

the diet. The ubiquity and proportions of domesticates suggest that the Inscription House community relied more on corn and squash as sources of food.

Corn and squash occur in 100% of the provenience units. Squash comprises the majority of the identified domesticates with a proportion of 82% of the macrobotanical assemblage in the provenience units. The high frequency of squash compared to corn and cotton possibly results from a bias associated with fruit production and a bias in the deposition of squash in the archaeological record. Squash produces a higher frequency of fruit than corn per plant. In addition, the rinds of the squash fruit fragment easily creating a higher count of individual specimens compared to corn in the archaeological record.

Dunk (2006) argues in an analysis of botanical remains from Shields Pueblo that prehistoric communities also used corn cobs as fuel during periods of wood scarcity. Burning corn cobs might result in the destruction of macrobotanical evidence. The burning of cobs, however, usually increases the frequency of cobs in open air sites. Only a few charred specimens comprise the assemblage of corn in the Inscription House midden. Despite possible biases in the data, corn and squash occurred in high frequencies in the Inscription House diet throughout the Pueblo III Period.

I determined that the specimens from the cucumber family in the midden likely consist of squash rather than bottle gourd based on the seed morphology. The presence of high counts of squash in the midden suggests that the Inscription House community likely did not experience the effects of environmental deterioration, since domesticated squash relies more heavily than bottle gourds on water. Additional evidence of environmental deterioration would appear in the corn morphology.

I examined the morphological measurements of corn specimens for evidence of types of corn and evidence of environmental deterioration. The corn specimens consisted of five whole cobs (without kernels), 61 cob fragments, 24 whole kernels, and 44 kernel fragments. Because the midden yielded few whole cobs and kernels, measurement statistics proved to be of limited use in comparisons of corn morphology through time. The corn cobs were primarily a 10-row variety, possibly related to a 10-16 row flint race, Onaveno.

A single cob fragment suggests the presence of a 6-8 row variety possibly related to a variety called Mais de Ocho. Toll et al. (1985), however, argue in a study of diet at Chaco Canyon that local growing conditions produce varying morphological dimensions of corn. The potential for variability in cob sizes between regions results in difficulties when identifying maize varieties from a site.

Morphologically similar specimens of corn may belong to different varieties.

The cob measurements (whole cobs only) for the 10 row variety in the Inscription House midden consisted of an average cob length of 60 mm, cob diameter of 17 mm, rachis diameter of 11 mm, a cupule width of 5 mm, a rachis segment of 3 mm, and a cupule depth of 3 mm. The 6 row variety (available measurements) consisted of a cob diameter of 15 mm, a rachis diameter of 11 mm, cupule depth of 6 mm, a rachis segment length of 4 mm, and a cupule depth of 3 mm. Average kernel width is 4 mm and average thickness is 2 mm. Average kernel length is 5 mm. The range of measurements for cobs and kernels showed a relative low frequency of changes over time. Variations occurred in similar time ranges, but probably only indicate variations in a crop and different rates of desiccation.

The small sample of corn cobs and kernels provided only a limited understanding of morphological changes in Inscription House maize varieties through time. An analysis of the effects of environmental stress would require a larger sample size. A larger samples size also provides a better comparison to identify specific corn varieties that the community grew during the periods of occupation. For the purposes of the current study, the Inscription House community possibly grew a variety of corn related to Mais de Ocho and Onaveno.

The different varieties of corn and squash comprised dietary staples of the Inscription House diet during the Pueblo II and III Periods. Based on the macrobotanical data, the Inscription House diet shows no evidence of drastic changes during the Pueblo III Period. The counts of domesticates varied in provenience units from the same age, but showed a consistent use of domesticates throughout the main periods of occupation. The counts of domesticate specimens provided no evidence of stress in the Inscription House diet. If the Inscription House diet was stressed by a deteriorating environment, the counts of domesticates would have changed as a result. An increase in the consumption of domesticates could indicate that the community attempted to supplement a diminishing source of wild food with a more reliable source of food. A decrease in the consumption of domesticates suggests that the community was no longer capable of producing the same frequency of crops.

The counts from the Inscription House midden, instead, show that the community consumed the plants in similar frequencies throughout the Pueblo III Period. The botanical data from the midden showed a higher proportion of charred wild specimens (71.1%) compared to domesticates (9.2%) in the Inscription House diet. The frequencies of domesticates and wild taxa appeared in relatively consistent proportions in the different provenience units and provide no evidence of the use of a risk management strategy.

Wild Plants Identified in the Inscription House Midden

The botanical material in the Inscription House midden consists of 21 species of edible wild plants, based on evidence of charring and ethnographic evidence, identified to at least the family level. The following results do not contain unidentified varieties of plants (only eight specimens) or miscellaneous parts of plants. Seeds from weedy plants as well as nuts from pinyon and juniper trees comprise the list of seeds. The most frequent and ubiquitous wild species in the Inscription House midden consist of four weedy taxa: *Chenopodium album* (lambsquarter), *Sporobolus cryptandrus* (sand dropseed), *Achnatherum hymenoides* (Indian ricegrass), and *Physalis heterophylla* Nees (clammy groundcherry). While weedy species tend to produce more seeds than other plant types and often skew the paleoethnobotanical record, the four taxa occur in all the samples. The presence of the four taxa in all the samples shows a consistent reliance on the edible plant varieties from the Pueblo II-Pueblo III Periods. The following sections describe the biological and ethnographic data on the wild edible species recovered from the midden.

Amaranthus L. *(Amaranth)*

Amaranth, (*Amaranthus* L.) (Figure 26), as well as *Chenopodium* spp., occurs in the archaeological

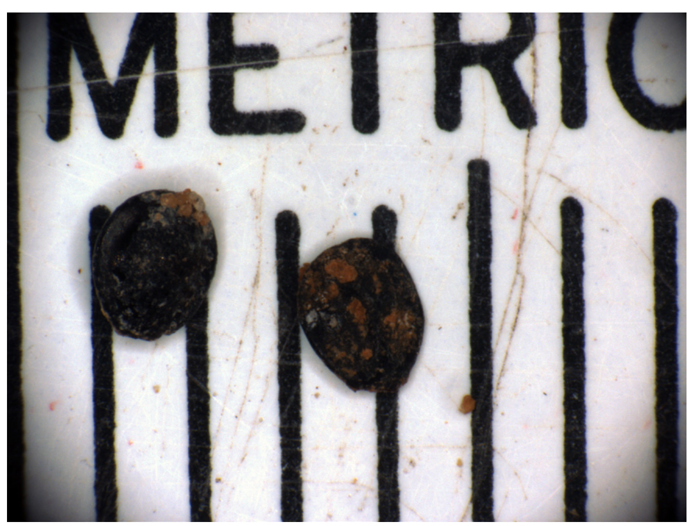


Figure 26. Amaranth seeds from Provenience Unit 2 at 20 x magnification measuring approximately 1 mm in diameter.

record throughout the American continent, showing the importance of the weedy species in prehistoric communities. Prehistoric communities in areas of the New World could have even domesticated varieties of the taxa. Sauer (1967:1993), however, argues in an analysis of amaranth that no definitive evidence occurs in the American Southwest for the domestication of the species. Despite a lack of evidence for the domestication of amaranth, prehistoric communities consumed a relatively high proportion of the species and likely promoted the growth of amaranth in some cases.

Amaranth grows in disturbed soils and often appears in agricultural fields. The species' preference for disturbed, agricultural soils makes the plant an efficient source of food for prehistoric communities. Amaranth requires minimal effort to grow and would have acted as a byproduct of agricultural production. Amaranth probably grew in the fields near Inscription House as well. The local ecology in Nitsin and Navajo Canyons provides enough moisture and frost free days for the plant to thrive in relatively high numbers. Amaranth thrives naturally in the modern canyon ecosystems, possibly indicating a reliable source of nutrition during the Pueblo III Period.

Modern ethnographic studies also document the use and importance of amaranth in modern Native American groups. Native Americans in the American Southwest cook the leaves of amaranth as greens with meat or grind the seeds to create porridge. Hopi also use the seeds of the species *Amaranthus cruentus* L. (Coxcomb or Hopi red dye amaranth) as a dye for piki bread. While the Hopi use the seeds as a dye for piki, the plant provides a poor dye for other materials. Whiting argues that "numerous attempts have been made to use it as a textile dye but without many successful results" (1978:74). Amaranth appears to provide a poor source of material for utilitarian uses as well. Modern groups, however, use the plant more as a source of nutrition.

Amaranth provided a similar source of nutrition for the Inscription House community. Whiting argues that *Acanthochiton wrightii*, a species of amaranth, "is known as the 'ancient Hopi food'" and that "Hopi recount that this plant has warded off famine a number of times" (1978:74). Amaranth grows abundantly in Nitsin and Navajo Canyon with a high tolerance to drought. A reliable growth of the species during periods of drought likely resulted in the increased consumption of the plant as a risk management strategy at Inscription House. The plant probably served as a famine food for the Inscription House community. Amaranth, however, occurs in relatively low frequencies in the midden soils. If dietary stress affected the prehistoric occupants, the inhabitants of the cliff dwelling did not rely on amaranth as a risk management strategy.

Atriplex canescens (Fourwing Saltbush)

The samples consisted of three seeds from an *Atriplex canescens* (fourwing saltbush) plant. Fourwing saltbush (Figures 27 and 28) in modern Puebloan communities is most commonly associated with the making of piki. Modern Puebloans mix the ashes of fourwing saltbush seed pods, which develop on the plant during the summer and fall, with corn meal and water to create flour for thin, flaky bread. If the Inscription House occupants also burned the seed pods to ash to create food similar to piki, then the seeds likely do not occur in an identifiable form in the archaeological record. The absence of identifiable

Figure 27. Photograph of fourwing saltbush.

Figure 28. Saltbush seed from Provenience Unit 5.5 at 25 x magnification measuring approximately 1 mm in diameter.

portions of fourwing saltbush seeds probably results from a bias associated with preparation techniques.

Evidence of alternative preparation techniques of saltbush in ethnographic studies suggests the possibility that a similar bias occurs in the archaeological record as with the making of piki. Whiting (1978), for example, argues that Hopi preferred to eat the young leaves of saltbush compared to the rest of the plant. A preference for young leaves occurs in ethnographic studies on Navajo culture as well (Elmore and Janish 1976). The harvesting of leaves for consumption also likely results in an absence of evidence for the plant in the archaeological record.

Ethnographic studies also suggest that the plant served non-dietary purposes in the Inscription House community. Modern Native Americans in the American Southwest use the wood as fuel for fires and as construction material. Whiting (1978), in particular, mentions the use of saltbush wood for kiva fuel as well as material for the manufacture of prayer sticks. Ethnographic research shows a more commonly religious and utilitarian use for fourwing saltbush rather than as a source of food.

The ethnographic and archaeological data indicate that the Inscription House community at least consumed fourwing saltbush on an infrequent basis. Fourwing saltbush grows in relatively moderate numbers in the modern Navajo and Nitsin Canyon systems and likely provided a stable source of food for the prehistoric community. Saltbush grows in areas up to 8,000 feet above sea level and requires only 20 cm of annual precipitation. A low requirement of precipitation allows the plant to survive most droughts as well as the lower annual precipitation rates for Navajo National Monument. The main deterrent to the growth of saltbush consists of areas with a high water table.

Chenopodium spp. *(Goosefoot)*

An unknown *Chenopodium* sp. (goosefoot) and *Chenopodium album* (lambsquarter) constitute two species of goosefoot (Figures 29 and 30) recovered from the Inscription House midden. Goosefoot species produce seeds from late summer to early fall that prehistoric people ate commonly throughout North and South America. Prehistoric communities promoted the growth of the plant and possibly domesticated species of goosefoot in the Americas. Sauer (1967:1993), however, argues that no definitive evidence occurs in the Southwest for the domestication of goosefoot.

The frequent consumption of goosefoot also occurs in modern Native American communities. Whiting argues that the plant is "boiled and eaten with a number of other foods" (1978:74). The prevalence of the species in the diets of modern and prehistoric communities result not just from the nutritional value provided by goosefoot, but also from the growth rate of the plant. The plant grows in high numbers in disturbed soils providing a reliable and abundant source of food.

Figure 29. Unknown goosefoot species seeds from Provenience Unit 1a at 10 x magnification.

Figure 30. Lambsquarter (*Chenopodium album*) from Provenience Unit 1 at 20 x magnification measuring approximately 1 mm in diameter.

Ethnographic research by Moerman (1998) suggests that modern Native American communities consume the entire plant of goosefoot species. Native American communities probably collect the plants for consumption during late spring to early fall, a period when goosefoot plants produce edible leaves. Goosefoot plants also produce seeds from late summer into late fall that modern Puebloan groups frequently consume as well. Modern Puebloan groups use ground seeds from goosefoot plants to make porridge, stews, and flour for bread (Hocking 1956). Moerman (1998) also notes that Hopi use the leaves as a spice for meat.

Ethnographic studies show evidence of non-dietary uses of goosefoot species as well. Modern Native American groups create medicinal treatments from the plants. The Paiute chew the leaves of certain species as an emetic (Moerman 1998). The Navajo use the stem of the plant to cure snake infections and use the leaves to treat burns (Moerman 1998). The Zuni steam certain species and inhale the vapors as a mild analgesic for headaches (Moerman 1998). Ethnographic research shows versatility and an importance of goosefoot in modern communities. The versatility and importance of goosefoot likely occurred in prehistoric communities as well.

Cleome serrulata (Beeweed)

Beeweed, or *Cleome serrulata*, comprises a low frequency of the macrobotanical assemblage from Inscription House. The Inscription House community probably supplemented the diet with beeweed (Figure 31). Moerman (1998) and Whiting (1978) however, argue that beeweed provides a primary source of food for Native American groups in the American Southwest. Archaeological evidence also indicates that many communities during the Pueblo III Period often consumed a high frequency of beeweed. The low frequency of beeweed seeds in the Inscription House midden suggests a local variation of an Ancestral Puebloan diet. The low frequencies, however, probably also result from biases associated with the preparation of beeweed for consumption.

Figure 31. Beeweed seeds from Provenience Unit 2 at 10 x magnification.

Food preparation of the taxon consists of boiling the whole plant comprised of the pods, stems, and roots for consumption as a vegetable or use the boiled plant as an ingredient in a soup. The consumption of the entire plant before the plant produces seeds may result in an absence or low frequency of seeds in a midden. Modern Native American communities, however, also use the seeds of the plant in meals. Modern Native American communities boil the seeds to create a mush or porridge (Moerman 1998). The consumption of seeds should result in the deposition of evidence in a midden. Despite possible biases in the data, the consumption of beeweed plants provides nutrients that supplemented the diets of modern and Ancestral Puebloan communities.

Native American groups also use the leaves of the plant for medicinal cures and boil the entire plant for a black dye found frequently in the decoration of ceramics (Moerman:1998). The medicinal uses of beeweed consist of cures for problems with voices, relieving problems with eyes, curing stomach disorders, and as a deodorant in modern Native American communities. The Inscription House community likely used beeweed in medicinal cures and as dyes similar to how modern Native American communities use the plant. The midden, however, provides no evidence of non-dietary uses of beeweed at Inscription House. The data suggests, instead, that the Inscription House community consumed the plant as a supplement to the main diet.

The Inscription House occupants probably collected beeweed plants from late spring to early fall. Beeweed produces edible leaves primarily during the summer months and edible seeds in the fall. The species requires a minimum of 13 cm of precipitation annually to grow, a lower annual precipitation than the range documented for Navajo National Monument. The plant also grows in disturbed areas and probably occurred in tilled fields along with goosefoot and amaranth plants. The growth of beeweed in fields probably made the plant an advantageous consequence of agricultural production for the Inscription House community. The Inscription House occupants probably collected beeweed for food as needed.

Corispermum L. *(Genus Bugseed)*

The midden consisted of a low proportion of bugseed (Figure 32), or *Corispermum* L., seeds only identified to the genus. I could not definitively determine how the Inscription House community used bugseed, because of the lack of modern ethnographic evidence for the plant's use. The species, in the Chenopodiaceae family, likely contains of edible parts similar to goosefoot species. Bugseed probably provided the Inscription House community with

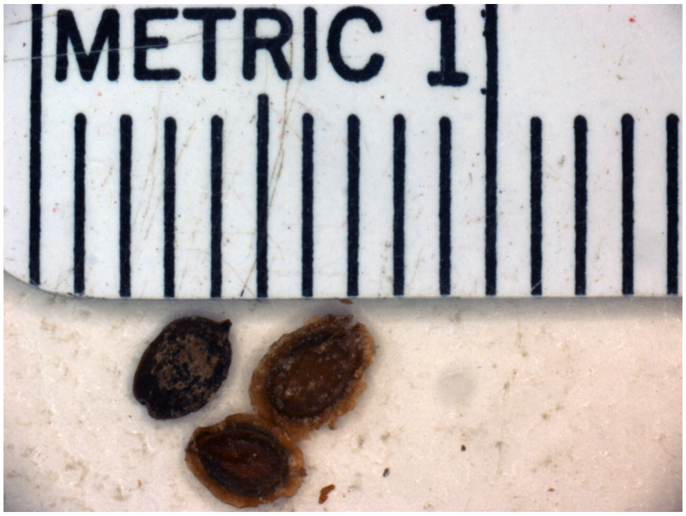


Figure 32. Photograph of bugseed from Provenience Unit 1 at 10 x magnification.

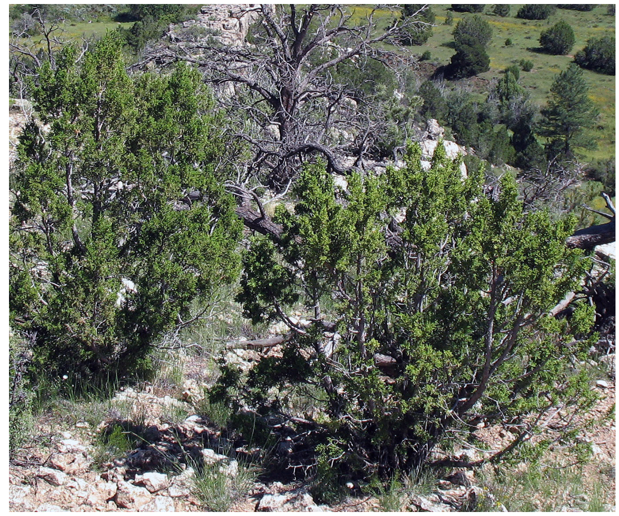


Figure 33. Photograph of oneseed juniper trees.

a similar source of nutrition as goosefoot and amaranth. The plant grew in fields similar to goosefoot species as well.

The plant also prefers xeric habitats and likely provided a source of food during periods of increased aridity. A low frequency of bugseed specimens in the macrobotanical assemblage of the midden at least shows that the Inscription House community supplemented the diet with bugseed. The Inscription House community relied more on goosefoot and amaranth species to provide a source of nutrition during the Pueblo II and III Periods.

Juniperus monosperma (Oneseed Juniper)
The macrobotanical assemblage from the Inscription House midden partially consisted of oneseed juniper nutlets (*Juniperus monosperma*) (Figure 33 and 34). The prehistoric community would have consumed the fruit of juniper trees, produced during the fall, and deposited the nutlets in the archaeological record. The consumption of juniper fruits, however, likely declined during the Pueblo III period because of a possible decrease in the population of juniper in the area. Scott (1978) argues in a pollen report on Inscription House that juniper counts were low around the Pueblo III Period at Inscription House and the counts indicate a clearing of the mesa tops for agriculture. The Inscription House community possibly destroyed a source of food through an increased need for agricultural land. The pollen evidence, however, relies on the information from one sample. The pollen from the sample likely does not accurately depict the environment of Nitsin and Navajo Canyon during the Pueblo III Period.

Figure 34. Juniper nutlet from Provenience Unit 4SE at 10 x magnification.

Pollen from coprolites at Inscription House provide a more accurate indication of juniper populations during the Pueblo III Period. The coprolite evidence analyzed by Kelso (1972) suggests that a relatively larger juniper population grew near Inscription House compared to Scott's (1978) research. The coprolite data show that the juniper populations could have provided a relatively high frequency of juniper berries for the Inscription House community during the Pueblo III Period. The low counts of juniper nutlets in the midden only indicate an infrequent consumption rather than evidence of a declining juniper population. The Inscription House community probably used juniper more as a source of fuel wood or construction timber instead of as a source of nutrition.

While the Inscription House community did not consume juniper berries in high frequencies, ethnographic studies show a frequent consumption of the fruit in modern Native American communities. Puebloans eat juniper berries raw, cooked with meat, or use the berries as a spice. Moerman (1998) argues that oneseed juniper also provides a source of nutrition for modern Native American communities during periods of dietary stress. Modern Puebloan groups rely on the consistent production of juniper berries for food and sometimes eat the bark of the tree during starvation periods. If dietary stress occurred during the Pueblo II and III Periods, the Inscription House community also probably relied on juniper berries and ate the bark of the trees as source of nutrition. As a result of an increased reliance on juniper for food, the frequency of juniper nutlets should increase in the macrobotanical assemblage of the midden. The presence of only two juniper nutlets in the Inscription House midden, however, suggests stability in the Inscription House diet during the Pueblo II and III Periods.

The Inscription House community probably relied more on juniper trees for non-dietary uses during the Pueblo III Period. Ethnographic studies show non-dietary uses of the plant in modern communities. Modern communities use a tea created from the needles to relieve gastrointestinal problems. Further, Tewa use the needles and twigs to aid in gynecological problems and as an analgesic (Moerman 1998:285). Besides medicinal properties, one seed juniper provides firewood and construction material for baskets and houses. I discuss the non-dietary uses of juniper in greater detail in a later section of Chapter 4. For the purposes of this section, the occupants of Inscription House probably consumed juniper berries as an uncommon source of nutrition during the Pueblo III Period.

Opuntia spp. *(Pricklypear Cactus)*

The macrobotanical assemblage of the Inscription House midden contained of pricklypear cactus (*Opuntia* spp.) seeds. I could not identify the specific species because the seeds from the midden resemble seeds from several species of pricklypear (Figures 35 and 36). Brotherson et al. (1978), however, suggest that only two species of prickly pear, Opuntia erinacea Englem. (golden pricklypear) and Opuntia fragilis (Nutt.) Haw. (brittle pricklypear), grow in the current National Monument boundaries. The plant communities during the Pueblo III Period probably consisted of the same species of pricklypear as today.

Despite a low count (19 total) of seeds in the provenience units of the midden, the macrobotanical data show that the Inscription House community consumed pricklypear relatively commonly (75% of the provenience units) from the Pueblo II to Pueblo III Periods. The community probably collected the fruit of the cacti during late summer and fall, when the plant produces ripened fruit. Ethnographic research describes a process of collecting the cactus fruit and preparing the fruit for consumption in modern Native American groups. Whiting argues that “the joints are collected, the larger thorns burned off, the joints boiled and the remaining thorns washed off” (1978:85). Modern Native Americans consume the processed fruit alone or combined with other foods. Moerman (1998) suggests that the Havasupai use the plant to make a drink and create a pulp of dried fruit for cakes. Ethnographic evidence also shows that communities roasted joints and pads of the plant for consumption.

Figure 35. Photograph of a pricklypear cactus.

Figure 36. Pricklypear cactus seeds from Provenience Unit 1 at 10 x magnification.

Pricklypear cacti provide non-dietary uses as well in modern Native American communities. Apache, Hualapai, Jemez, and Navajo boil the roots and fruit for use as a dermatological aid applied to cuts and burns (Moerman 1998:368). In addition, the needles of pricklypear cacti provide tools for modern Native American groups. Native Americans in the Southwest pierce boils and create tattoos with the needles from pricklypear cacti.

Both species of pricklypear that grow in the canyon today require a low rate of annual precipitation and generally survive colder conditions than most taxa in the Cactaceae family. The drought resistance of the species indicates that the plant provided a reliable source of food during periods of increased aridity. Modern ethnographic evidence, however, provides no evidence that modern Puebloan communities rely on the plant as a starvation food. The relatively low number of fruit produced by the plant probably did not provide enough sustenance to a community struggling through a period of major environmental stress. Pricklypear cacti likely only supplement a diet during droughts. Macrobotanical evidence from Inscription House shows that prickly probably supplemented the diet even during less arid conditions. The macrobotanical data also suggest that the Inscription House occupants consumed the fruit in consistent frequencies throughout the Pueblo III Period.

Physalis heterophylla Nees *(Clammy Groundcherry)*
The Inscription House midden material consisted of a relatively high proportion of *Physalis heterophylla* Nees (clammy groundcherry). The Inscription House community used groundcherry (Figure 37) as a staple of the diet. Ethnographic data from the American Southwest provide vague evidence of the modern consumption of ground cherry. Whiting notes in an ethnobotanical study of Hopi that the "fruit (was) said to have been eaten in olden times," but failed to confirm that Hopi actually consumed the plant (1978:90). Despite the lack of modern ethnographic evidence, the frequency of charred ground cherry seeds in the Inscription House midden suggests that the plant provided a primary source of nutrition for the prehistoric community. The plant also appears in high frequencies in coprolites from Inscription House and contemporaneous sites in northeastern Arizona, confirming the prehistoric consumption of groundcherry. Ancestral Puebloans probably harvested mature fruit during the fall. Ancestral Puebloans probably harvested mature fruit during the fall.

Pinus edulis Engelm. *(Twoneedle Pinyon Pine)*
Pinyon pine (*Pinus edulis* Englem.) nuts comprise a portion of the macrobotanical assemblage from Inscription House. Janetski argues in an analysis of the importance of pinyon (Figures 38 and 39) trees for prehistoric people that modern "puebloan peoples would store enough pine nuts to last them two or three years" (1999:250). The storage of pinyon nuts provide modern Native American communities with a consistent source of food. Elmore (1943) argues that modern Native American groups prepare the nuts for consumption by roasting the nuts in pits or crushing the nuts to make a paste. Communities also use ground pinyon nuts as ingredients for soups and cakes (Robbins 1916:323). Pinyon nuts provide important nutritional elements to the diets of prehistoric and modern Puebloan communities.

Protein and fats from the nuts supplement a lack of animal meat in the diet. The low cost of collecting and processing

Figure 37. Clammy groundcherry seeds from Provenience Unit 3 at 10 x magnification.

Figure 38. Photograph of pinyon pine.

Figure 39. Pinyon pine nuts from Provenience Unit 1 at 6.3 x magnification.

the nutritional nuts also make pinyon pine an efficient source of food for communities in the American Southwest. Lanner (1981), however, argues in an investigation of the cultural-historical use of pinyon pine that pinyon nuts provide an erratic source of food with intervals of four to seven years for good pinyon harvests. While pinyon trees produce nuts on a yearly basis, pinyon pines yield a crop only every four to seven years capable of providing a significant dietary component in a community. The long intervals of good production years make the plant an undependable source of food. Although, Minnis (1989) suggests that Ancestral Puebloans prized the nuts during good harvests.

Pinyon nut specimens in the Inscription House midden, however, show consistent counts in individual samples with no indication of different production years. The relatively frequent counts of pinyon nuts in the Inscription House midden show possible evidence of a stable pinyon pine population in Nitsin and Navajo Canyons. A stable pinyon pine population likely indicates that population pressure and environmental degradation had a minimal or minor effect on the local ecology. Pueblo III Period populations in the canyon systems continued to rely on pinyon pines to produce nuts as a supplement to the diet.

The trees also provide non-dietary uses in communities. Modern Native American groups collect sap to waterproof or seal water containers. In addition, the modern communities use the sap as a gum, a candy, material for ceremonial items, a sealant for wounds, and a sealant around artifacts to prevent warping of wood. Prehistoric communities also used the wood as fuel for fires, cradleboards, and as material for tools. The modern non-dietary and dietary uses of pinyon trees probably occurred in the Inscription House community as well.

Poaceae *(Grass Family)*
I recovered five varieties of Poaceae, or the grass family, in the Inscription House midden. The five species of grass consist of *Achnatherum hymenoides* (Indian ricegrass), *Bouteloua curtipendula* (sideoats grama), *Bouteloua* spp. (An unknown species of grama), *Sporobolus cryptandrus* (sand dropseed), an unknown variety of *Festuca* L. (fescue), and an unknown species of grass labeled in the analysis as Poaceae_1 (Figure 40). Grasses provided a valuable and reliable source of food for prehistoric communities.

Figure 40. Unidentified grass species from Provenience Unit 4SW at 25 x magnification measuring 2 mm in diameter.

Ancestral Puebloans could harvest grasses during the early summer when food stores from the winter were low and when many wild plants had not yet produced edible parts. Highland species of grass in the Southwest show a high resistance to drought as well. High elevation grasses produce edible seeds during periods of increased aridity when many plants may suffer from stress. Grass specimens in the Inscription House midden, as well as at comparative sites in the region, occur in high frequencies and ubiquities. The high frequencies and ubiquity of grasses show the importance of the species to Ancestral Puebloan diets.

Achnatherum hymenoides (Indian Ricegrass). Indian ricegrass (*Achnatherum hymenoides*) (Figures 41 and 42) comprises one of the most frequent wild species in the Inscription House midden. The occupants of Inscription House relied on Indian ricegrass as a staple of the diet.

Figure 41. Photograph of Indian ricegrass.

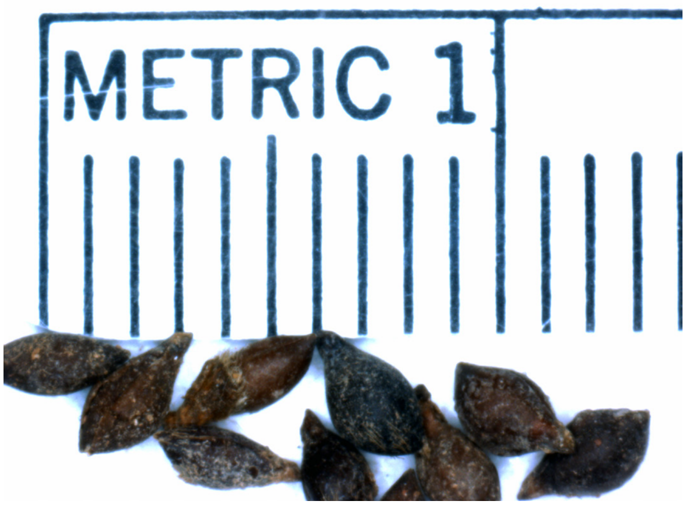


Figure 42. Inidian ricegrass seeds from Provenience Unit 4SW at 10 x magnification.

A similar reliance on the species occurs in comparative prehistoric communities and in modern Native American groups. Whiting describes the plant as having seeds that “fall free from the chaff when ripe, have excellent food value and were collected in quantity, particularly in times of famine” (1978:65). The seeds of Indian ricegrass historically sustained Hopi during famines as well as during periods of dietary stability.

A similar reliance of Indian ricegrass during periods of environmental degradation could have occurred at Inscription House. The macrobotanical data, however, showed a consistent frequency of Indian ricegrass from Pueblo II Period to the end of the Pueblo III Period. A consistent frequency demonstrates the Inscription House community likely did not consume the plant as a risk management strategy. The plant, instead, comprised part of the core of the community’s diet.

The Inscription House community probably collected the plant during the fall. In the fall, Indian ricegrass produces edible seeds. Habitats for the grass species consist of primarily semi-arid regions. The grass requires minimal precipitation, about 15 to 35 cm annually, to survive in an area. Since the Inscription House area receives between 17 and 48 cm annually, the local environment provides a suitable growing area for Indian ricegrass even during periods of increased aridity.

Bouteloua curtipendula (Sideoats Grama). A second species of grass in the midden consists of sideoats grama (Figures 43 and 44). The seeds of the plant were prehistorically used as food, but ethnographic research

Figure 43. Photograph of sideoats grama.

Figure 44. Sideoats grama seeds from Provenience Unit 5.1 at 10 x magnification.

suggests a primarily non-dietary use of the plant. Moerman (1998) argues that modern Native Americans use the stalks of the species as bristles for a hairbrush or for brooms. The information from modern ethnographic research suggests that the infrequent appearance of sideoats grama in the archaeological record results from the uncommon reliance on the plant as a food in Puebloan cultures.

The occupants of Inscription House likely relied on the plant more as a source of material for creating artifacts. No evidence, however, occurs in the midden of non-dietary uses of sideoats grama. The data only show that the inhabitants supplemented the diet with the taxa.

Sideoats grama occurs in semi-arid areas with a moderate annual rainfall, approximately 30 to 50 cm a year. Navajo National Monument's annual precipitation averages around 29 cm and reaches a low of about 17 cm. Since annual precipitation supplies not enough moisture for the grass to survive, the plant provides a poor source of food during periods of heightened aridity A low proportion of sideoats grama in the Inscription House midden would reflect the effects of environmental degradation on the community. The consistent frequency of sideoats grama in the provenience units of the midden, however, shows that the environment continued to support a stable population of the taxon during the Pueblo III Period.

Bouteloua spp. *(Grama).* Two types of grama occur in the Inscription House midden. While I identified one type of grama to the species level, I could not identify the second species (Figure 45), because of the morphological similarities of the seeds to other species in the family. The seeds, however, probably come from blue grama plants (*Bouteloua gracilis*), since blue grama (Figure 46) currently grows in high counts around the site.

Figure 45. Unknown grama species from Provenience Unit 1 at 25 x magnification measuring approximately half a mm in diameter.

Figure 46. Photograph of blue grama.

Ethnographic studies suggest that modern Native American groups consume blue grama seeds. Whiting argues that blue grama, in particular, was an "important forage grass" for Hopi (1978:64). Modern cultural groups in the American Southwest harvest blue grama seeds to create porridge or grind the seeds to produce flour for bread. Blue grama also serves non-dietary purposes in modern Native American communities. Modern Navajo communities use blue grama and Bouteloua simplex (matted grass) for medicinal purposes. Moerman (1998) argues that Navajo chew and blow the roots of the grama species on cuts to heal wounds, consume the plant to cure colds, and eat the plant as a form of postpartum medicine.

The use of grama in the modern Native American communities likely provides evidence for a similar use of the unknown grama species in Ancestral Puebloan groups. Grama possibly provided a medicinal source as well as a source of food for the Inscription House occupants. The midden data show a low frequency of the unknown grama species. The low proportion and ubiquity of the unidentified grama species indicates that the plant provided an uncommon supplement to the Inscription House diet.

Festuca L. *(Fescue).* Fescue (*Festuca* L.) (Figure 47) seeds, unidentifiable to the species level, occur in the soils of the Inscription House midden. The provenience units consisted of 4 seeds, indicating an uncommon and infrequent use of the grass by the Inscription House community. Ethnographic analyses, however, provide no evidence of modern southwestern Native Americans consuming the seeds of fescue plants. The modern

Figure 47. Fescue seeds from Provenience Unit 2 at 10 x magnification.

Figure 48. Sand dropseed seeds from Provenience Unit 1 at 32 x magnification measuring approximately 1.5 mm in diameter.

ethnobotanical evidence shows a mainly non-dietary use of the grass in the American Southwest. The Navajo use the stalks of fescue, tied with string or yucca fibers, to clean metates (Moerman 1998:233). Ethnographic evidence outside the American Southwest, however, indicates a consumption of fescue seeds by Native Americans.

The grass probably provided an uncommon and supplemental source of nutrition for the Inscription House community, since only a few specimens of the plant occur in the midden. If the community consumed the plant, the occupants of the cliff dwelling probably harvested the seeds during the fall. The plant requires minimal moisture to survive and likely supplied a source of nutrition during periods of heightened aridity.

Sporobolus cryptandrus (Sand Dropseed). The second most frequent wild species in the Inscription House midden consists of sand dropseed (Figure 48). Sand dropseed produces edible seeds consumed by modern Native American groups in the Southwest. Whiting argues that Hopi "easily harvested food grain" from dropseed plants (1987:66). After harvesting the grain, modern Native American communities ground the seeds to produce flour for bread or boiled the grains to make porridge (Ebling 1986; Hough 1897). Modern ethnographic comparisons reveal the possible preparation techniques used by the Pueblo II and III Period communities of Inscription House.

Ancestral Puebloans harvested the seeds of sand dropseed from late summer to early fall. Sand dropseed also reseeds frequently following periods of drought. The reliable growth of the species during droughts suggests that the plant served as a famine food for prehistoric communities. An increased consumption of the species during the late Pueblo III period would indicate the use of a risk management strategy. The midden data, however, show no evidence of an increased consumption of dropseed in the Pueblo III Period. A consistent frequency of sand dropseed in the provenience units suggests that sand dropseed was a staple of the Inscription House diet.

Portulaca spp. *(Purslane)*

Purslane (*Portulaca* spp.) (Figure 49), unidentifiable to the species level, comprises a low percentage of the macrobotanical assemblage from the Inscription House midden. The frequent appearance of the plant in the midden, however, shows that the plant provided a standard

Figure 49. Purslane seeds from Provenience Unit 1 at 32 x magnification measuring half a mm in diameter.

source of food in the Inscription House diet. Purslane probably supplemented the dietary staples of the Pueblo II and III Period community. As a source of food, purslane provides edible leaves and seeds that contain vitamins A, C, and B.

The plant also consists of high concentrations of calcium, iron, and protein. Calcium, iron, and protein from purslane supplement nutrients the Inscription House community would have received from domesticates. Modern ethnographic research provides examples of how the prehistoric community possibly ate purslane. Moerman (1998:434) argues that Hopi, Navajo, Tewa, Keres, Apache, and Laguna boil the leaves of the plant to create gravy. Modern Native American groups also eat the leaves similar to spinach and cook the seeds to produce porridge.

Purslane produces edible leaves from spring to summer and seeds from late summer to early fall. The plant provides a source of food for communities primarily during the warmer months. Moerman (1998:434), however, argues that Isleta Pueblo frequently dries and stores the leaves of purslane for a source of food during winter. The Inscription House community possibly stored purslane in a similar method.

Modern ethnographic research also shows evidence of non-dietary uses of purslane. Purslane provides medicinal properties that aid in the treatment of an assortment of afflictions. Modern Native American communities use the plant to treat diarrhea, lock jaw, pain, and as a general cure all. Moerman (1998) suggests that the stem of leaves consist of antiseptic and analgesic properties. The medicinal properties in the leaves provide beneficial effects for a variety of ailments in modern Native American communities. The Inscription House community probably took advantage of the medicinal properties as well as the nutrition offered by purslane.

Rosaceae *(Rose Family)*
The macrobotanical assemblage from the Inscription House midden consisted of a nutlet from the rose family (Figure 50), unidentifiable to the species level. Brotherson et al. (1978), however, identified a single species of Rosaceae during an analysis of the Navajo National Monument plant communities. The modern taxon of Rosaceae growing in the monument consist of *Amelanchier utahensis* Koehne, or Utah Serviceberry (Brotherson et al. 1978). Utah Serviceberry, as well as many species in the family Rosaceae, produces edible berries during late summer and fall. The Navajo, according to Moerman (1998:69), dry and preserve the fruit of Utah Serviceberry bushes for use during winter. While the Inscription House community probably ate the fruit fresh from the bush, the community probably stored the berries similar to Navajo methods as a source of food for the winter.

Figure 50. Nutlet of a species of the rose family from Provenience Unit 1 at 16 x magnification measuring approximately 4 mm in diameter.

Modern ethnobotanical studies also show a non-dietary use of the plant in Native American communities. The Havasupai weave Utah Serviceberry wood to create rims for baskets. In addition, the wood provides useful material for trays, arrow shafts, spindles for fire drills, and cradleboards (Moerman 1998). Besides utilitarian purposes, the Hopi and Navajo use the wood from Utah serviceberry for ceremonial and medicinal functions. Moerman (1998:69-70) argues that Hopi create Pahos, or prayer sticks, and Navajo create "Evilway Hoops" from the stems of Utah serviceberry plants. Navajo also use the plant as an aid in labor to ease the delivery of children.

The Inscription House community probably used Utah serviceberry in similar ways as modern Native American communities. The plant likely grew in relatively high counts in the Nitsin and Navajo Canyons. Utah serviceberry shows a high tolerance to drought and would have survived drops in annual precipitation that occurred during the Pueblo II and III Periods. The Pueblo III Period communities in the Nitsin and Navajo canyons could have relied on the berries to survive periods of environmental stress. The appearance of a single nutlet in the Inscription House midden, however, suggests a limited use of the plant for food.

Rhus L. *(Genus Sumac)*
A single seed from the sumac genus (Figure 51), unidentifiable to the species level, comprised a portion of

Figure 51. Seed of the genus sumac from Provenience Unit 2 at 10 x magnification.

the macrobotanical assemblage of the Inscription House midden. Brotherson et al. (1978) identified skunkbush sumac (*Rhus trilobata*) as the only member of the sumac genus currently growing in the boundary of Navajo National Monument. Sumac species in the southwest produce edible berries eaten by Apache, Navajo, and Puebloan groups. Whiting argues that Hopi even used the berries of skunkbush sumac to make "lemonade" (1978:84). Skunkbush (Figure 52) berries also act as a spice for meat in modern Native American communities. The fruit of skunkbush stores well and provides a source of nutrition for Ancestral and modern Puebloan groups during the winter.

While skunkbush berries provide food for communities, modern ethnographic research shows a more non-dietary use of sumac in Native American communities. Modern Native American groups in the Southwest use the plant to treat a variety of ailments. Ailments treated by sumac consist of gynecological problems, gastrointestinal problems, sore throats, parasitic worms, colds, and pulmonary problems (Moerman 1998). Modern Native American communities also create dyes, arrows, and baskets from plants in the sumac genus.

As far as a source of food, Sumac species produce fruit from June to October, but fruit sometimes persist on bushes into winter as well. The plant grows in a variety of habitats from sunny to shady and from drainages to sand dunes. In addition, sumac tolerates drought conditions. The production of fruit during periods of drought and possibly into winter suggests that sumac provided a relatively reliable starvation food. Despite the reliability of the plant and evidence of the plants common use in modern Native American groups, evidence of only a single specimen of sumac occurs in the provenience units of the Inscription House midden. The seed of a sumac bush shows an uncommon and infrequent dietary use by the Inscription House occupants during the Pueblo III Period.

Sphaeralcea L. *(Genus Globemallow)*

The Inscription House midden contains three seeds from the genus globemallow, or *Sphaeralcea* L. (Figures 53 and 54). Globemallow grows in elevations between 5,000 and 9,500 ft and in areas with a minimum annual rainfall of 5 cm a year. The low precipitation requirements indicate a high drought tolerance of the plant. The plant likely provided a source of nutrition during periods of drought as well as during wetter conditions. Moerman (1998) argues that Navajo consume seeds of certain species and brew the leaves to make a beverage. Besides the evidence of Navajo

Figure 52. Photograph of a closeup of skunkbush sumac.

Figure 53. Photograph of globemallow.

Figure 54. Globemallow seed from Provenience Unit 1c at 25 x magnification measuring approximately 2 mm in diameter.

using globemallow, ethnographic data show a relatively rare consumption of the plant by modern southwestern groups.

The rarity of the plant in the Inscription House midden correlates with the modern data. The midden data suggests an infrequent consumption of the plant during the occupation of the cliff dwelling. Moerman (1998:540), however, argues that the Navajo chew roots from globemallow during periods of food shortages. The prehistoric community from Inscription House possibly consumed the roots from the plant during similar periods of uncertainty. Evidence for the consumption of roots would not survive in the archaeological record and was not indicated in the midden provenience units.

In addition, evidence of non-dietary uses was not included in the macrobotanical data from the Inscription House midden. Ethnographic research suggests non-dietary uses of the plant in the Inscription House community. Globemallow provides medicinal properties for the alleviation of diarrhea, healing of sores, a hemostat, and aids in healing broken bones (Hogan et al. 2005; Whiting 1978). The Havasupai also mix the juice of globemallow plants with clay to create pots. While the Inscription House occupants likely exploited the plant for similar uses, no evidence survives in the archaeological record. Macrobotanical evidence from the Inscription House midden suggests a more dietary purpose in the community. The seeds of globemallow from the Inscription House midden analysis show that the prehistoric occupants of the cliff dwelling at least consumed the plant on an infrequent basis.

Yucca L. *(Genus Yucca)*

Seven seeds from an unidentified species of yucca (Figures 55 and 56) comprised a portion of the macrobotanical assemblage from the Inscription House midden. Yucca plants produce edible fruit from late summer to early fall. Whiting (1978) argues that the Hopi bake the fruit in large earth ovens for consumption. The prehistoric community of Inscription House probably consumed the fruit in a similar manner. A low frequency of yucca specimens recovered from the provenience units show an uncommon consumption of the fruit at Inscription House.

Figure 55. Photograph of narrow leaf yucca.

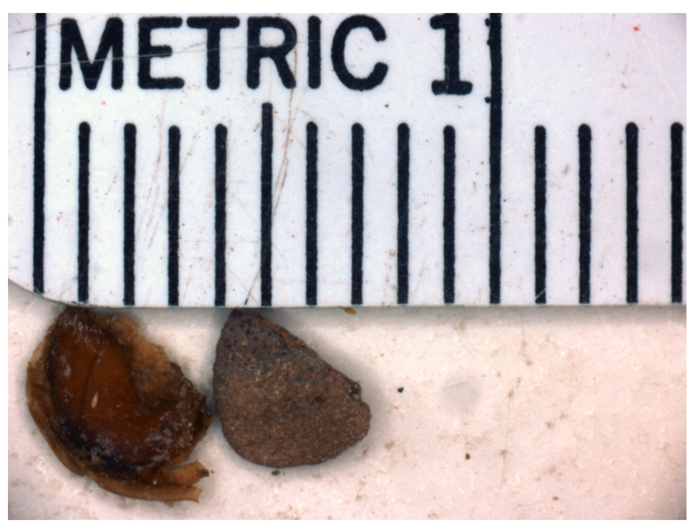


Figure 56. Yucca seeds from Provenience Unit 1 at 10 x magnification.

The Inscription House community likely used yucca more for alternative purposes. Alternative uses by modern Native American groups consist of boiling of roots to make soap, the use of the sap as a laxative, the collection of fibers for baskets, the use of fibers for sandals, and the production of paintbrushes from the fibers (Moerman 1998). The modern applications of the plant show the versatility of yucca in Puebloan communities. The Inscription House occupants probably used parts of yucca plants for a similar range of activities as well. Despite a low frequency of seeds in the Inscription House midden, the appearance of sandals and other artifacts made from yucca fibers indicates a relatively heavy use of the plant during the Pueblo III Period.

Wild Taxa Counts in the Inscription House Midden

The macrobotanical assemblage from the Inscription House midden consisted of 21 edible wild species (Table 4; Figures 57-63). Four taxa in all the samples show a consistent presence in the midden. Indian ricegrass, clammy groundcherry, sand dropseed, and lambsquarter comprised dietary staples for the Inscription House diet during the Pueblo II-Pueblo III Periods. The assemblage of identified wild plant material from the Inscription House midden also shows a consistent count of species in contexts that date from A.D. 1040 to A.D. 1270.

The wild food and domesticated food data from the midden provided no evidence of dietary stress. The frequency of edible taxa varies the most between provenience units of a similar age than between contexts from different ages. The macrobotanical data show a relatively consistent frequency of edible plants in the Inscription House diet throughout the occupation of the cliff dwelling. The macrobotanical evidence suggests that environmental degradation was not the main or only cause behind the migration of the Inscription House community.

Charred Wood from the Inscription House Midden

The soils in the midden consisted of relatively profuse counts of charred wood (706 total). Charred wood shows evidence of household or community fires that occurred

Table 4. Proportions and Ubiquity of Wild Taxa for All Provenience Units.

Wild Species	Counts	Proportion of Specimens (%)	Ubiquity (%)
Achnatherum hymenoides	636	10.7	100
Amaranthus spp.	92	1.6	92
Atriplex canescens	3	0.05	8
Bouteloua curtipendula	50	0.8	92
Bouteloua spp.	2	0.03	8
Chenopodium album	2782	47.1	100
Chenopodium spp.	162	2.7	100
Cleome serrulata	30	0.5	92
Corispermum L.	74	1.3	75
Festuca L.	4	0.07	8
Juniperus monosperma	2	0.03	17
Opuntia spp.	19	0.3	75
Physalis heterophylla Nees.	729	12.3	100
Pinus edulis Engelm.	203	3.4	100
Poaceae_1	2	0.03	17
Portulaca spp.	155	2.6	100
Rhus spp.	1	0.02	8
Rosaceae	1	0.02	8
Sphaeralcea L.	3	0.05	17
Sporobolus cryptandrus	954	16.1	100
Yucca L.	7	0.1	25
Total	**5911**	**100**	**-**

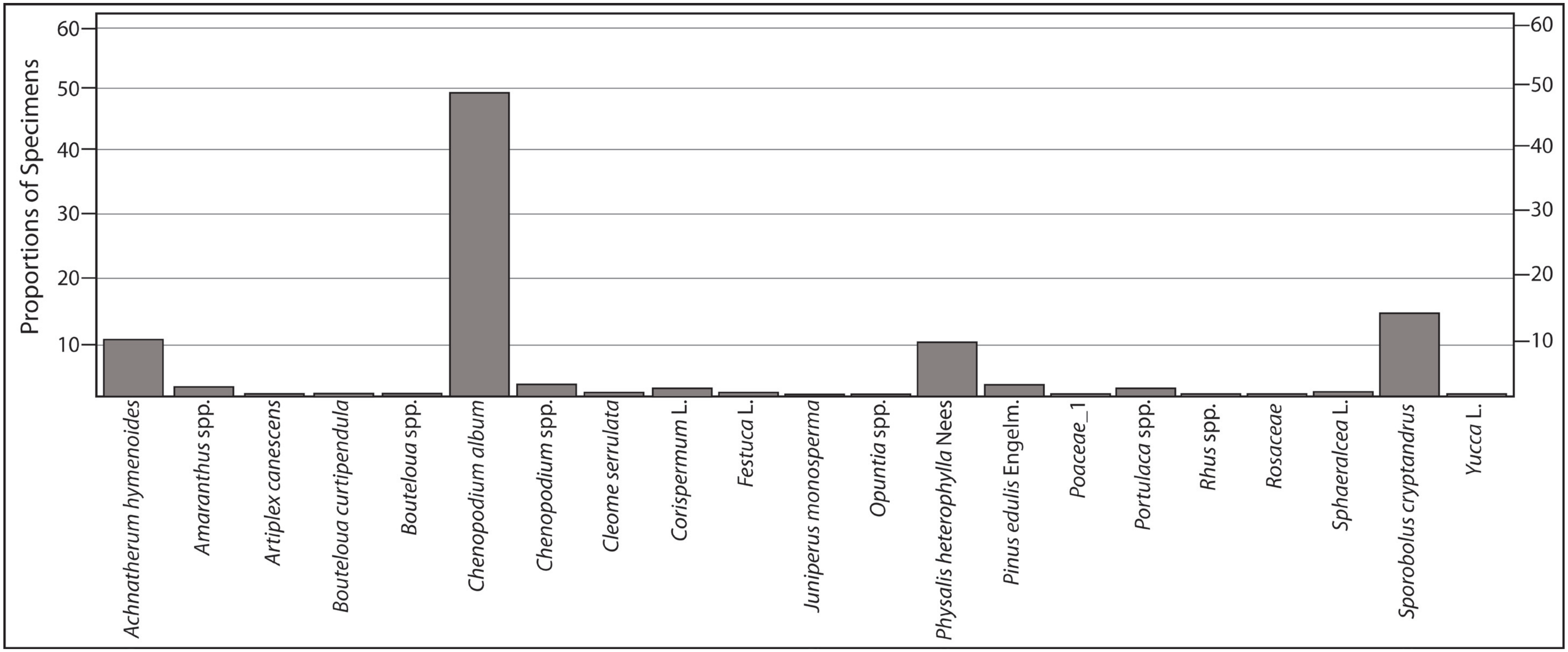


Figure 57. Propotions (%) of wild taxa for all provenience units.

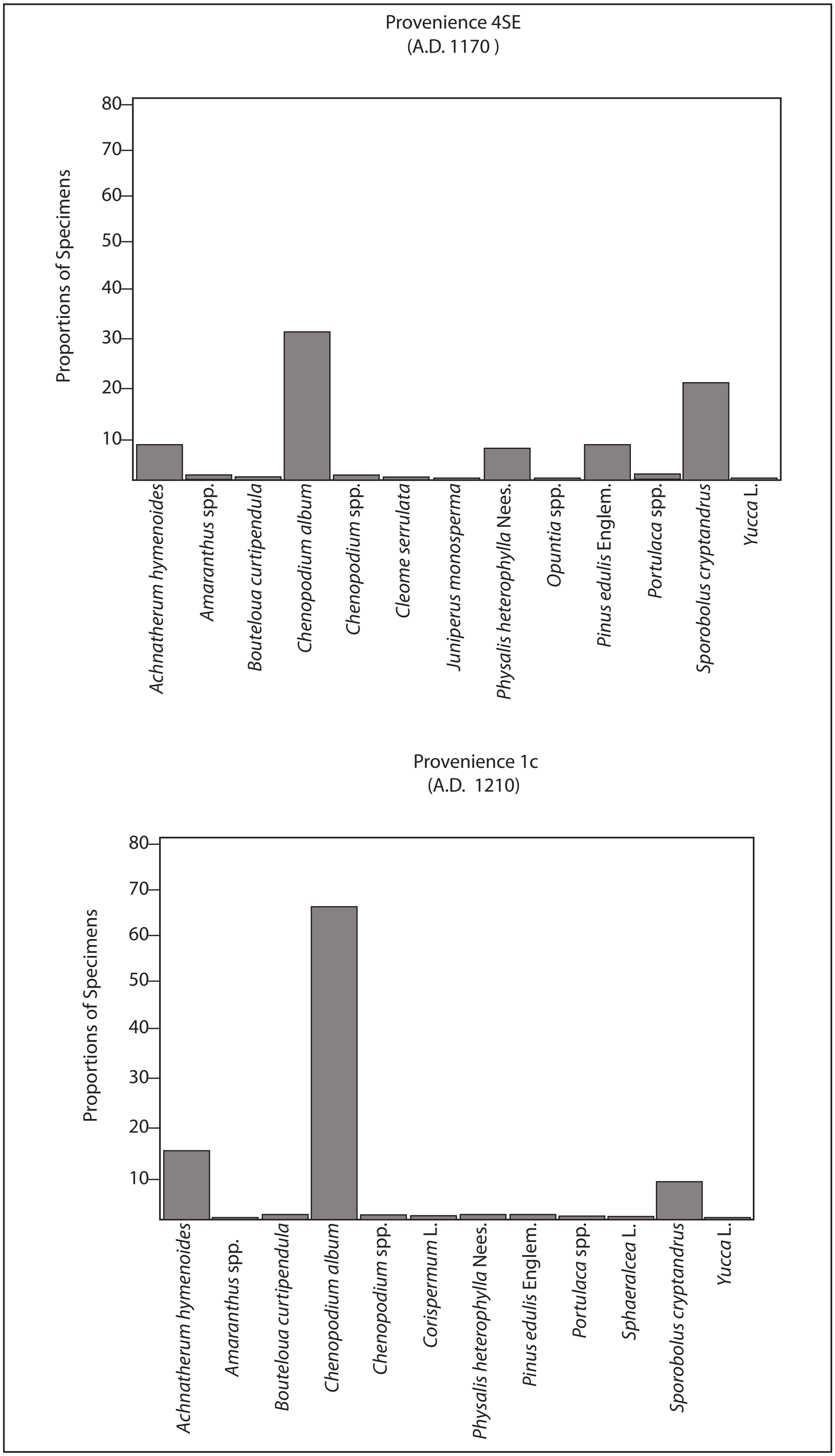


Figure 58. Proportions (%) of wild taxa for Provenience Units 4SE and 1c.

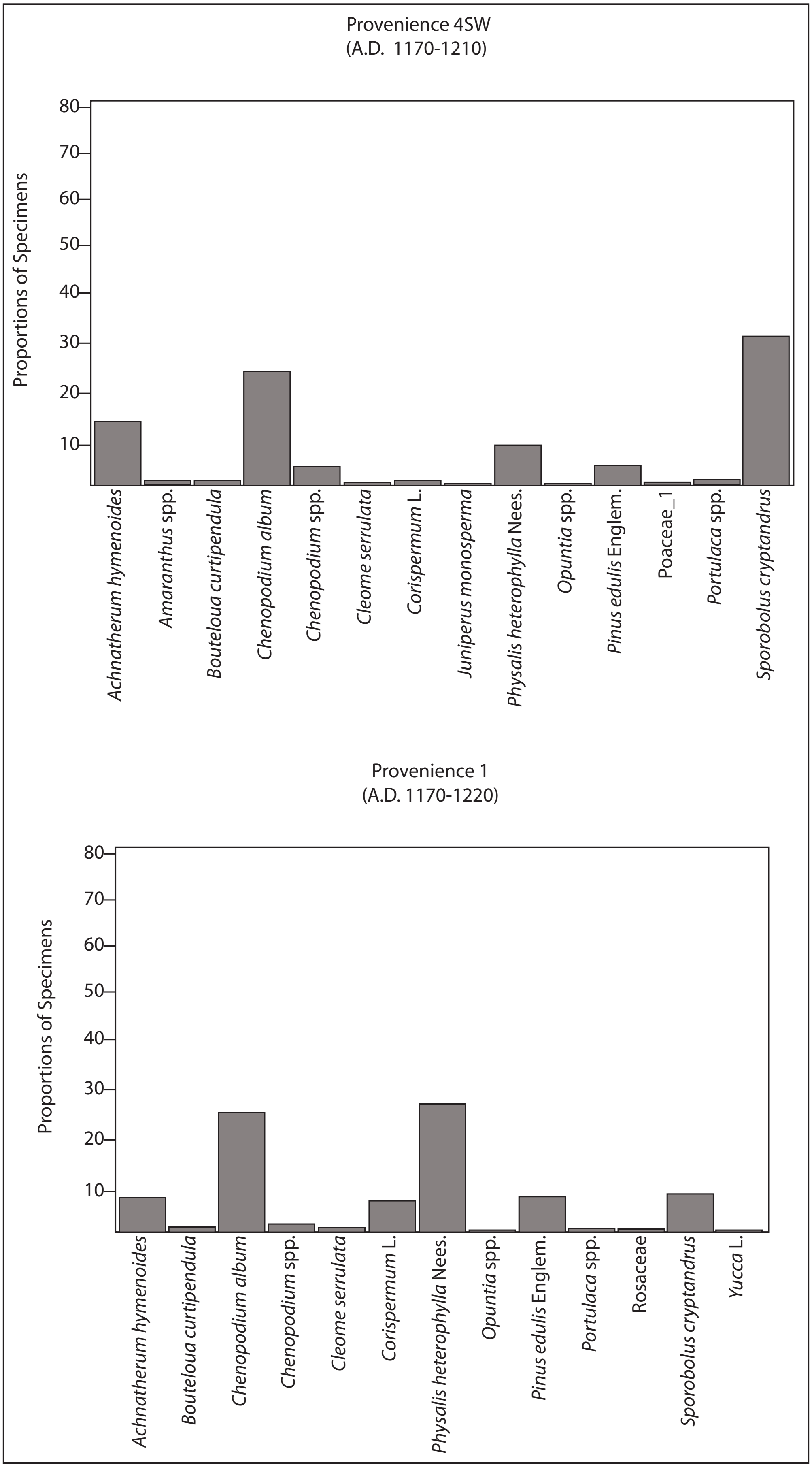


Figure 59. Proportions (%) of wild taxa for Provenience Units 4SW and 1.

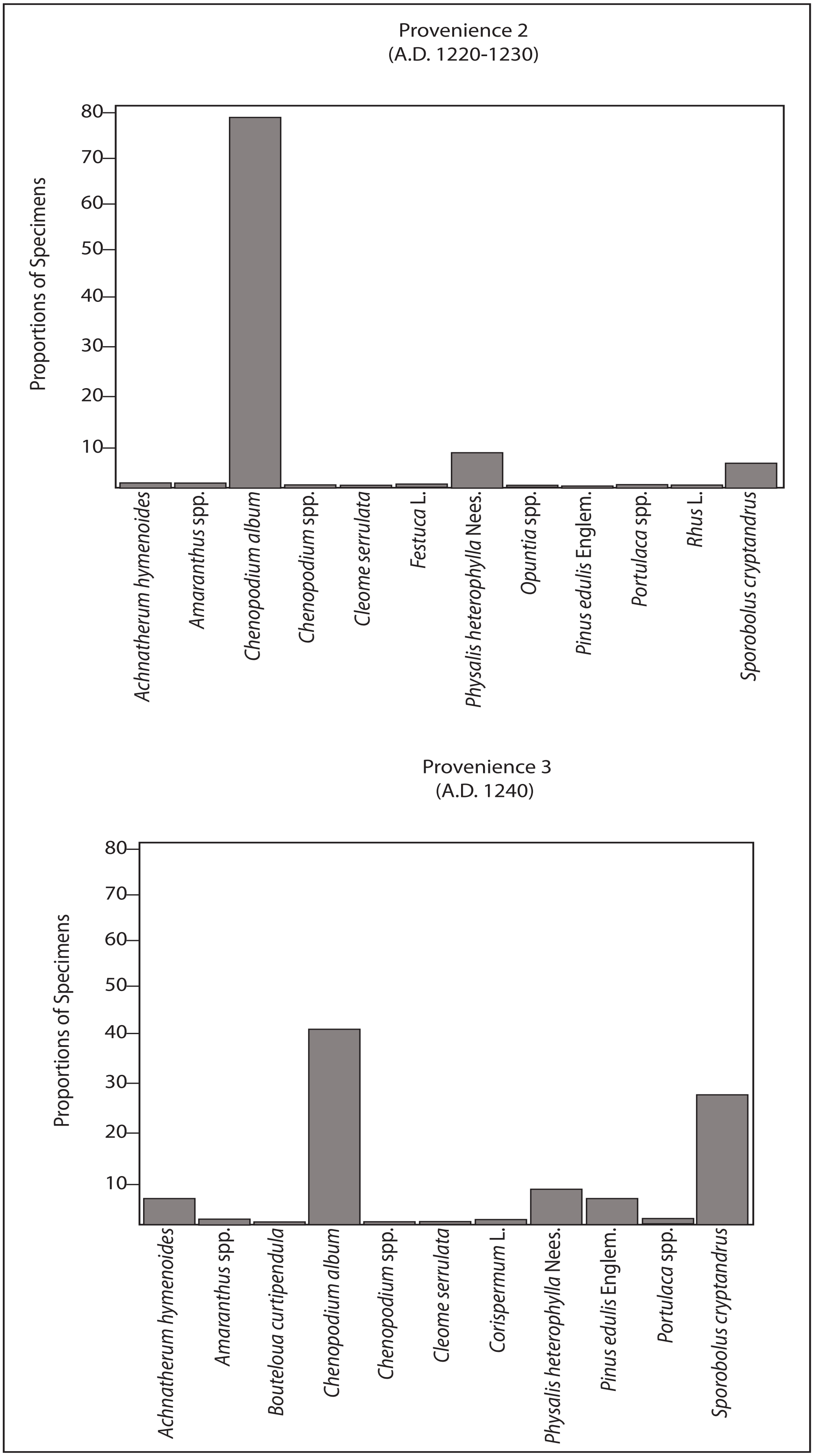


Figure 60. Proportions (%) of wild taxa for Provenience Units 2 and 3.

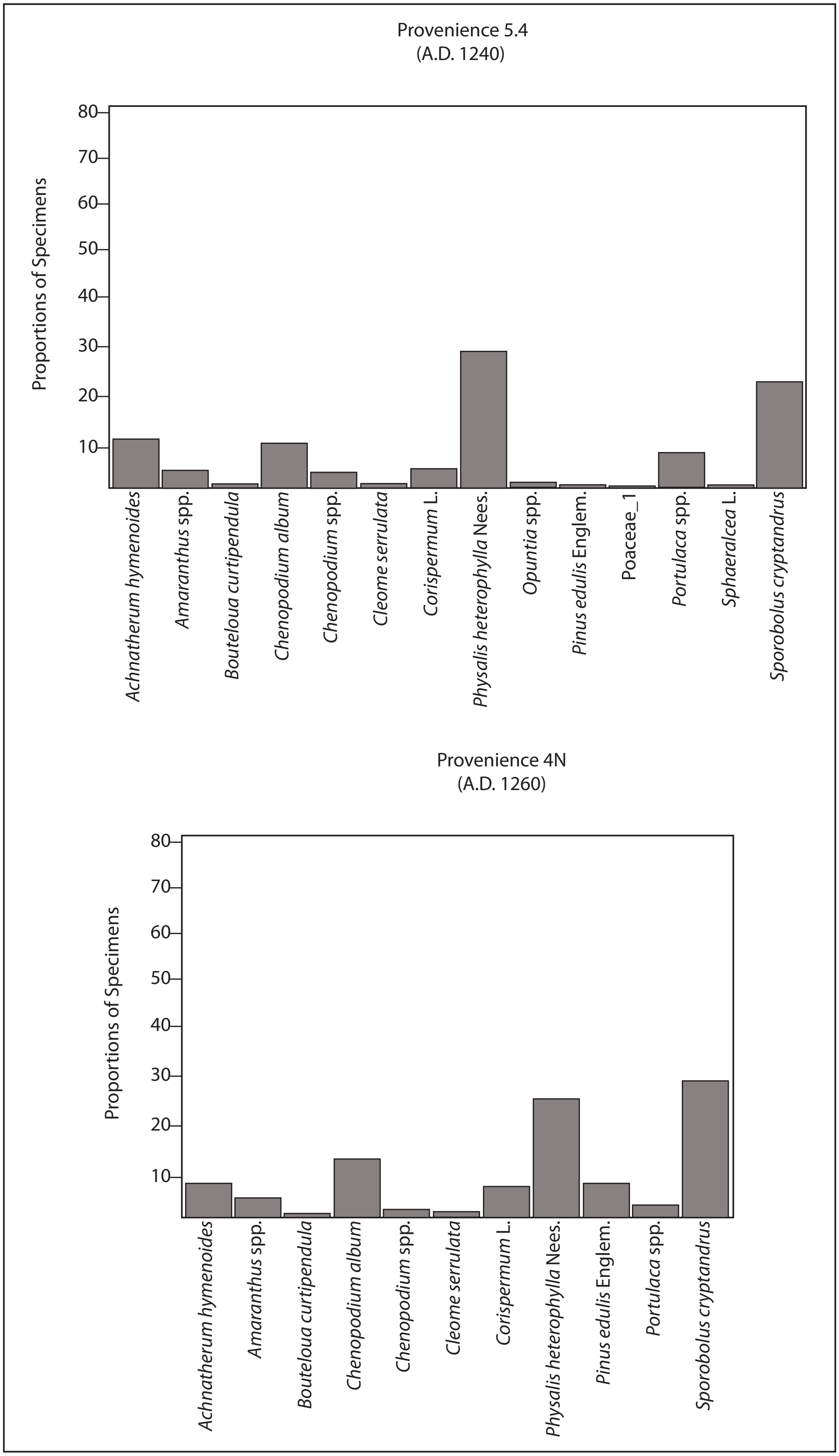


Figure 61. Proportions (%) of wild taxa for Provenience Units 5.4 and 4N.

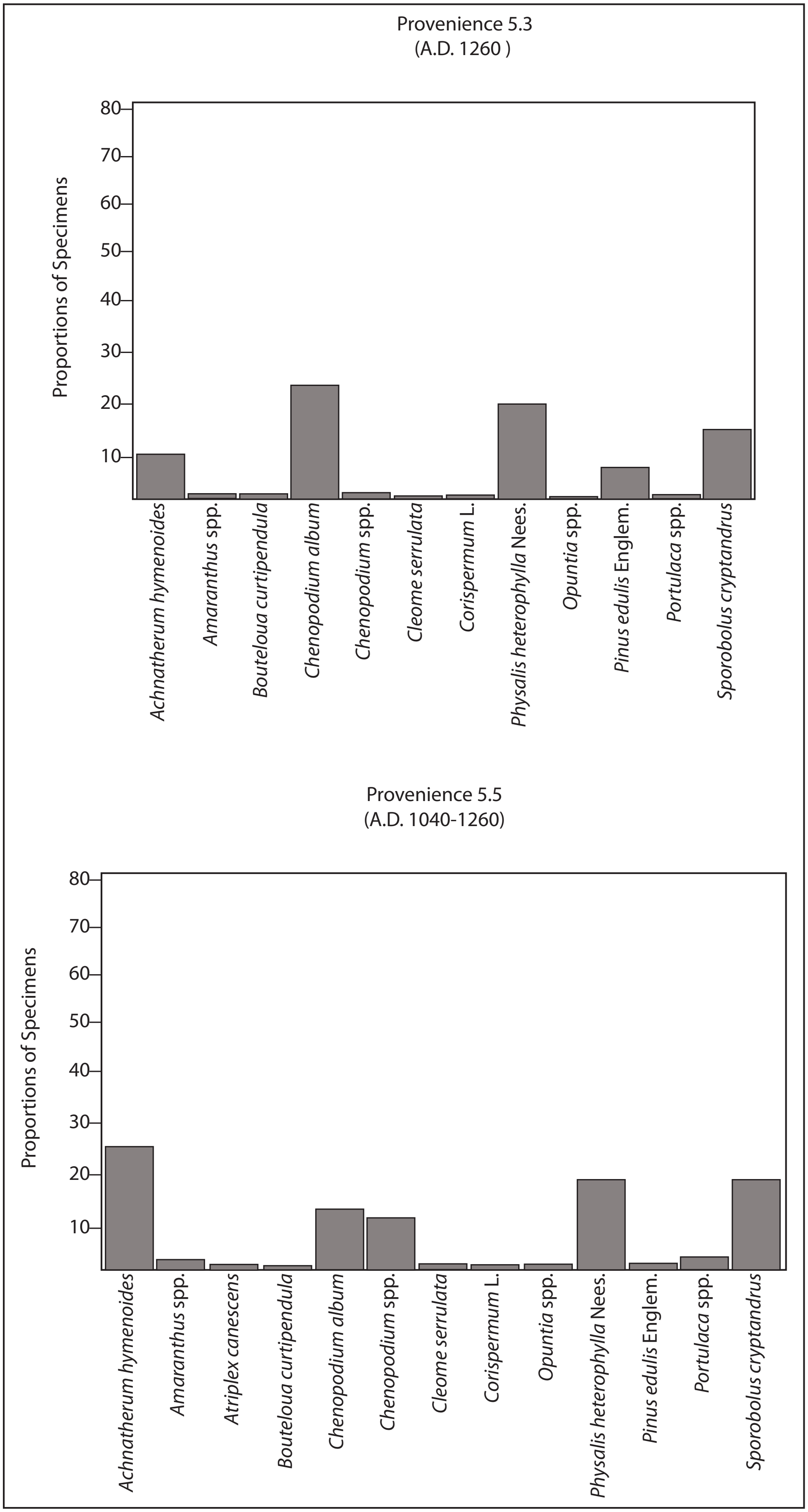


Figure 62. Proportions (%) of wild taxa for Provenience Units 5.3 and 5.5.

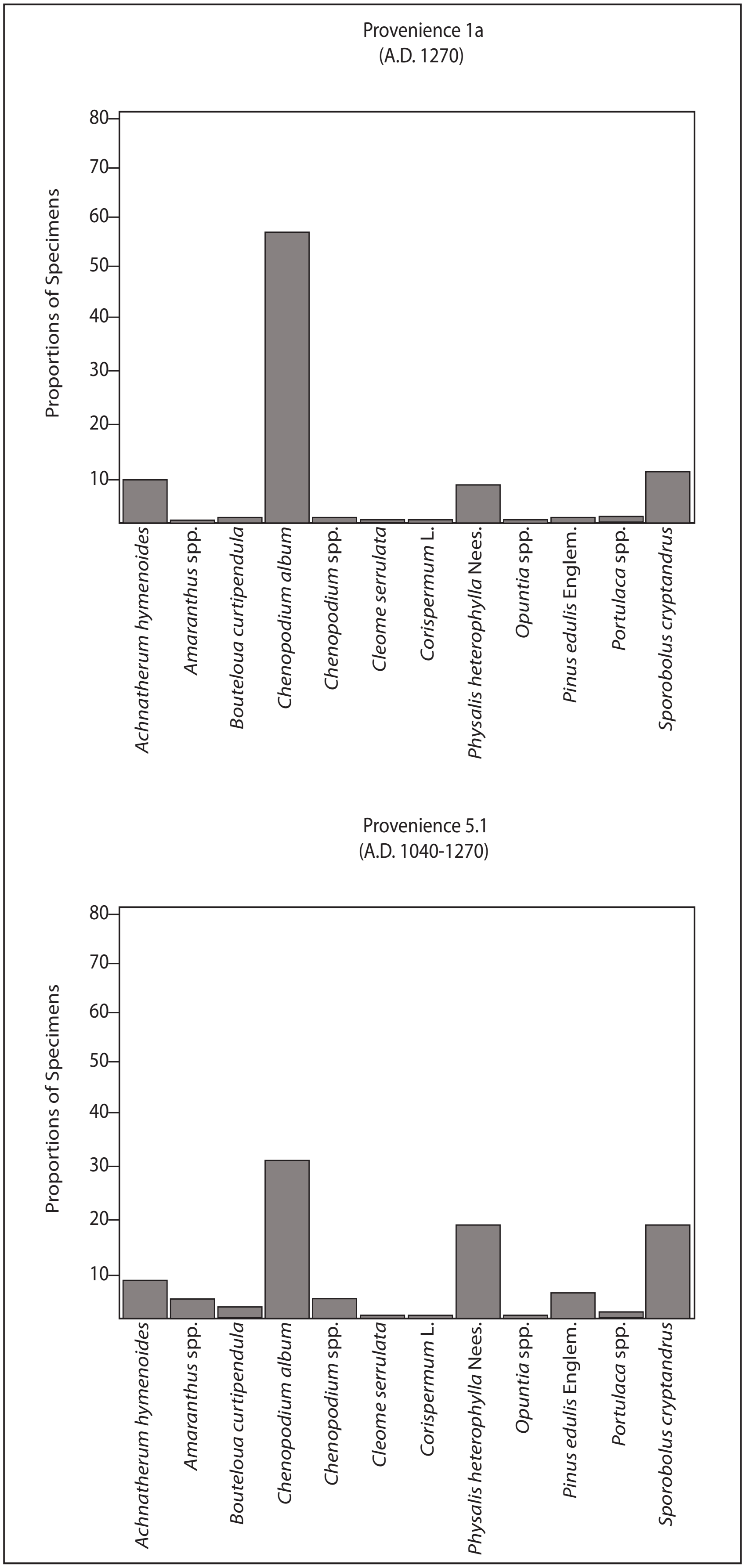


Figure 63. Proportions (%) of wild taxa Provenience Units 1a and 5.1.

in the cliff dwelling. The Inscription House community procured wood from bushes or trees growing directly at the base of the ledge, from further down the canyon, or on top of the canyon. The species of wood that comprise the charred wood assemblage in the Inscription House midden indicate resource collection strategies from a variety of elevations and habitats.

The four identified wood taxa identified (Table 5; Figure 64 - 66) in the provenience units consist of *Juniperus* L., *Pinus edulis* Englem., Salicaceae (willow family), and *Quercus gambelii* Nutt. Var. gambelii (gambel oak). I identified the specimens to the species or family level when possible. The majority of the charred wood fragments (605), however, were too small (less than 4 mm) to determine the taxonomical classification of the plant.

The identifiable species suggest that the Inscription House community relied on a diverse resource base to sustain the construction and fire requirements of the population. The Inscription House community collected materials from habitats along the canyon top as well as habitats along the stream at the base of the canyon. Firewood and construction materials from the streamside consist of wood from the willow family.

Plants from the willow family grow in areas with high water tables and require on average about 30 cm of annual precipitation. Brotherson et al. (1978) argue that five species from the willow family currently grow along the stream banks around Inscription House: consisting of *Populus angustifolia* James (narrowleaf cottonwood), *Populus fremontii* S.Wats (fremont cottonwood), *Salix exigua* Nutt. (narrowleaf willow), *Salix goodingii* Ball. (goodding's willow), and *Salix lasiolepis* Benth. (arroyo willow). Four of the five species from the willow family that grow near Inscription House survive relatively low drops in the annual precipitation. Arroyo willow, however, requires at least 88 cm of annual precipitation, an amount that pushes the limits of annual precipitation in Navajo National Monument. The local climate during periods of heightened aridity in the Pueblo II and III Periods likely did not provide adequate moisture for arroyo willow to survive.

While arroyo willow struggled to grow in the Navajo and Nitsin Canyons, the four other species from the willow family probably survived the droughts during the late Pueblo II and middle Pueblo III Periods. The charred wood data indicate only the presence of the willow family in contexts dating to the latter half of the Pueblo III Period. The macrobotanical data suggest that cottonwood (Figure 67) and willow species continued to grow in the canyon

Table 5. Proportions and Ubiquity of Charred Wood for All Provenience Units.

Species of Wood	Counts	Proportion of Specimens (%)	Ubiquity (%)
Juniperus L.	99	13	100
Pinus edulis Englem.	21	3	75
Quercus gambelii var. Gambelii	12	2	50
Salicaceae	8	1	42
Unidentified	605	81	100
Total	**745**	**100**	**-**

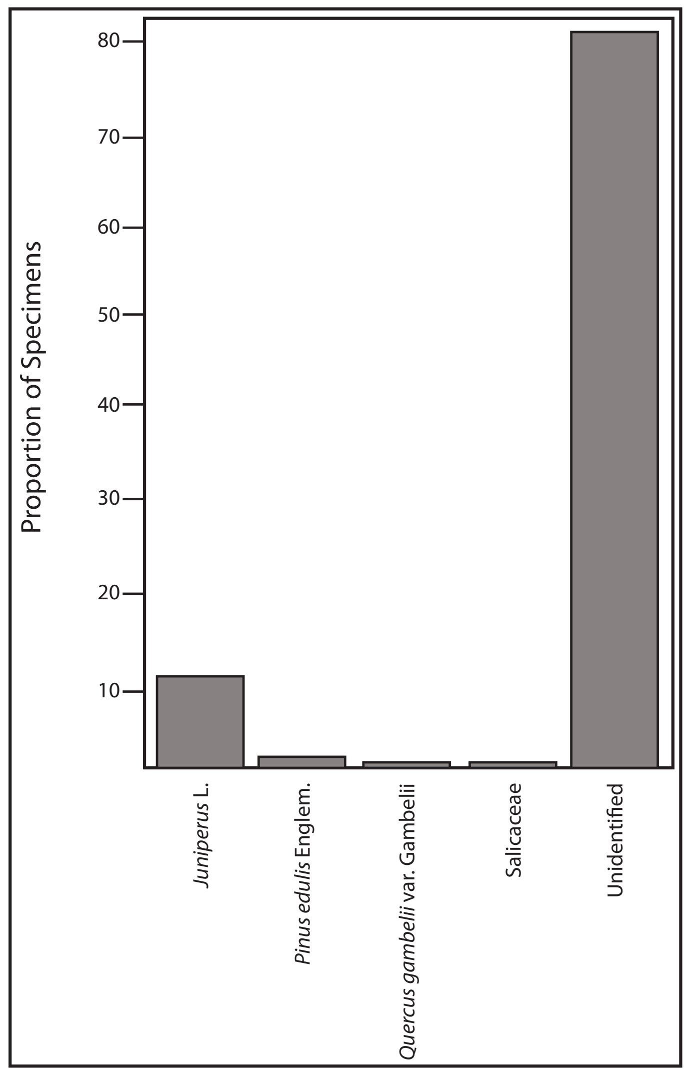


Figure 64. Proportions (%) of charred wood taxa for all provenience units.

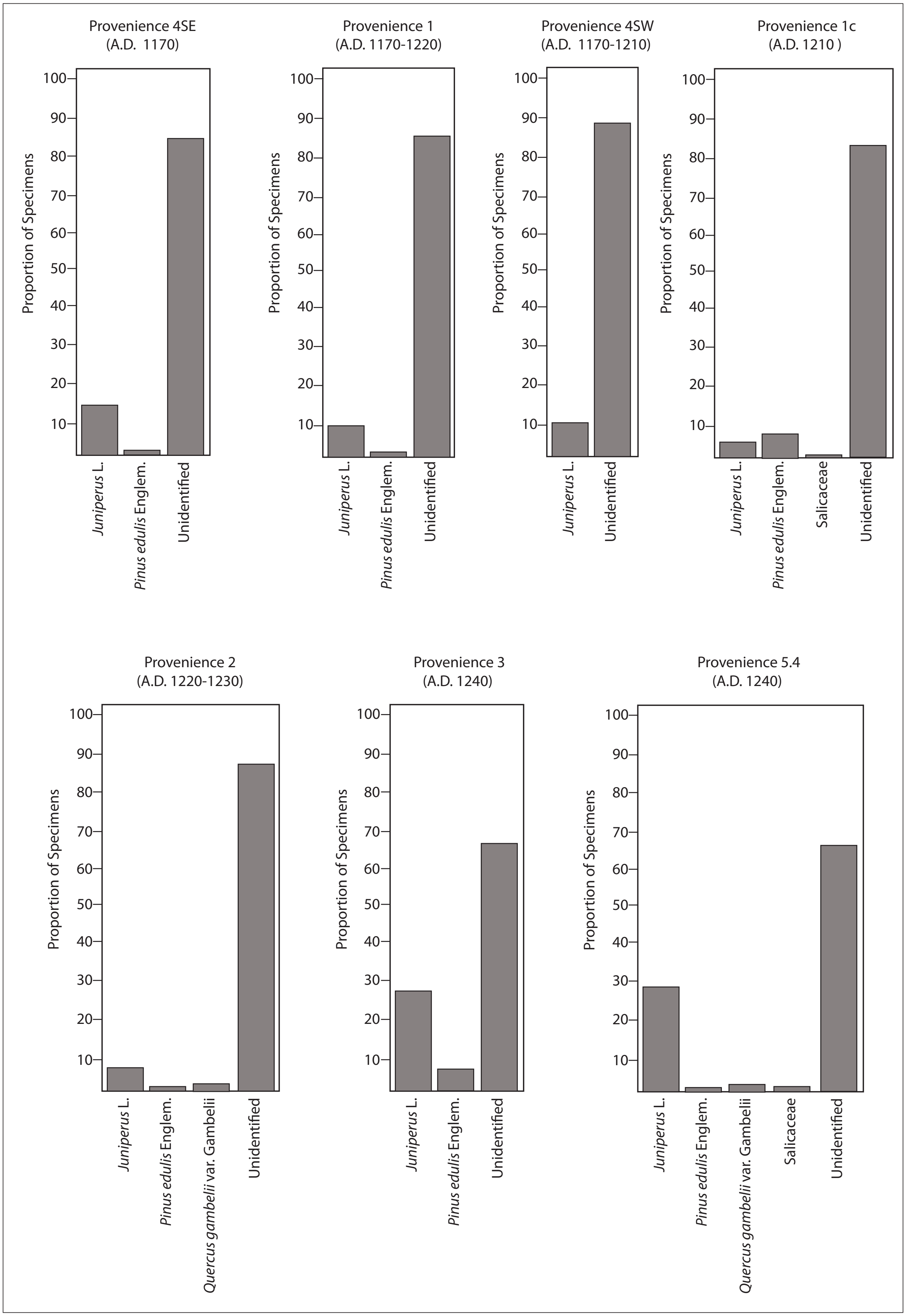


Figure 65. Proportions (%) of charred wood taxa separated by provenience unit and organized by calibrated radiocarbon dates.

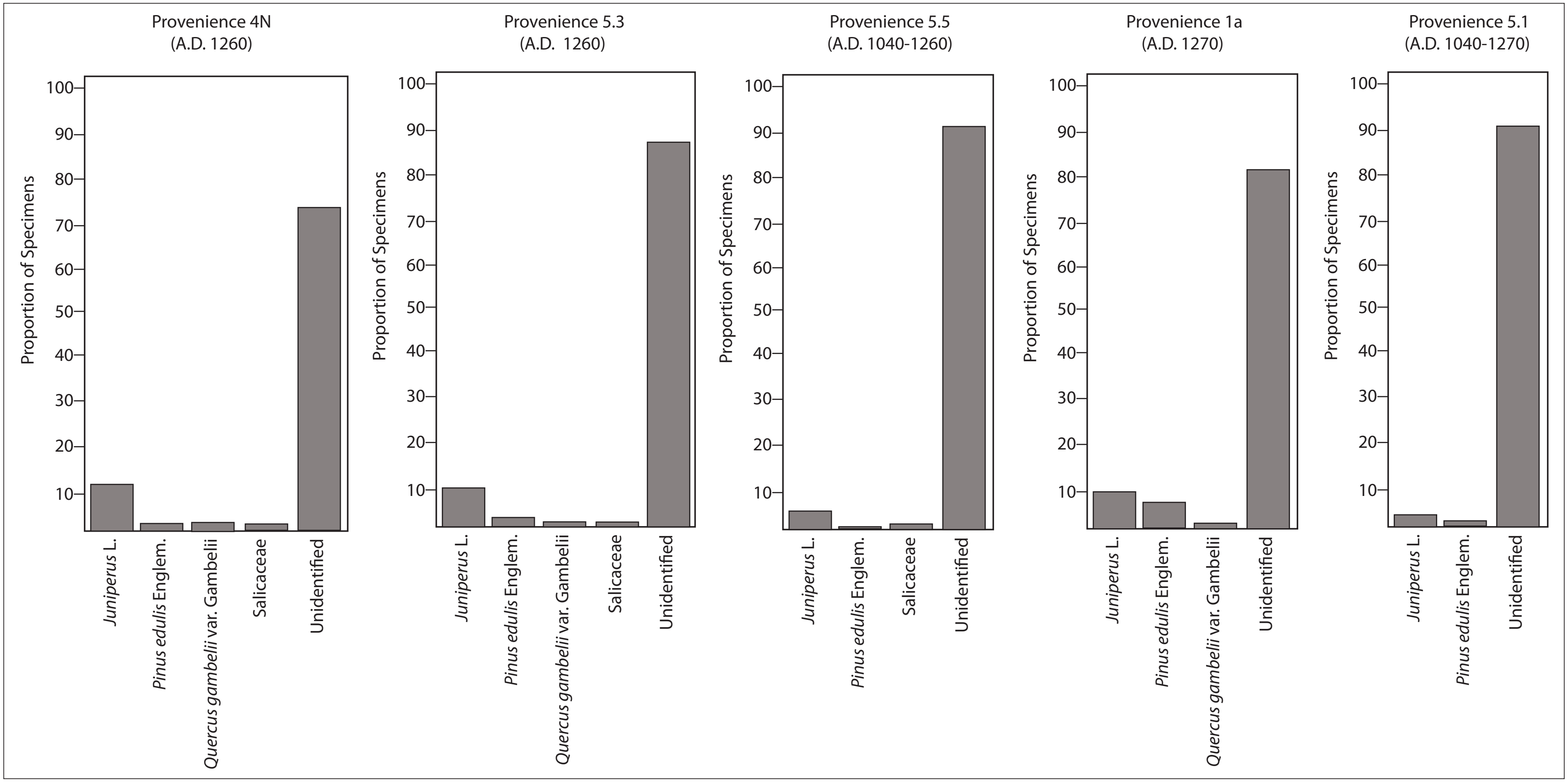


Figure 66. Continued proportions (%) of charred wood taxa separated by provenience unit and organized by calibrated radiocarbon dates.

Figure 67. Photograph of cottonwood trees in Nitsin Canyon.

despite the drop in annual precipitation.

Charred wood from the willow family occur in relatively low frequencies in the midden, but wood from the willow family occurs in relatively high frequencies in an analysis of construction material by Dean (Ward 1975). While the willow family provided preferable wood for construction material at Inscription House, low frequencies of cottonwood or willow in the midden suggest a low reliance on the species for firewood. A relatively higher proportion and ubiquity of juniper and pinyon pine, in comparison with counts of charred wood from the willow family, indicate that the Inscription House community preferred to burn juniper and pinyon wood. Juniper and pinyon pine burn at higher temperatures and occur in higher frequencies in the area compared to species from the willow family. The hotter burning temperatures and higher frequencies of available wood make juniper and pinyon more reliable and preferable as a fuel source for the Inscription House community.

Juniper and pinyon pine grow in areas along the bottom of the Navajo and Nitsin Canyons, but more commonly along the top of the canyons. The pinyon pine and juniper populations currently outnumber the population of species from the willow family. The growth requirements of species from the willow family confine the plants to a narrow area along the stream banks. Brotherson et al. (1978:20) argue that the streamside population composes 1.8% of the Inscription House area. Pinyon pine and juniper, however, grow in areas that comprise approximately 61% of the total area around Inscription House. The areas consist of slick rock and scattered shrub habitats (35% of the Inscription House area) and pinyon pine and juniper mixed shrub habitats (26% of the Inscription House area) (Brotherson et al. 1978:20). A relatively high proportion of pinyon pine and juniper charred wood in the midden shows that a similarly large pinyon and juniper population grew in the area during the Pueblo II and III Periods as the modern ecologies.

The pinyon and juniper populations also occur in higher frequencies than gambel oak populations in the current landscape of Navajo National Monument. Gambel oak currently grows only around Betatakin and Keet Seel according to the plant survey by Brotherson et al. (1978). The lack of wood in the modern landscape around Inscription House suggests that the prehistoric community harvested oak wood from the neighboring canyon systems.

Gambel oak may have also grown in Nitsin and Navajo Canyons during the Pueblo III Period, but the oak populations probably died out in the area. Evidence that the oak populations died out in the area occurs in pollen data from previous research at Inscription House. Scott (1978:37) and Kelso (1976:120) argue that oak pollen occurs in relatively low frequencies in archaeological contexts at Inscription House. The low frequencies of pollen from prehistoric contexts show that at least a small population of oak grew in the canyon during the Pueblo III Period.

Populations of gambel oak in Navajo and Nitsin canyon likely died out or declined around Inscription House as a result of drought or increased population pressures. Population pressure and drought provide feasible explanations, but increased aridity and population pressure would have affected the willow family populations as well. Gambel oak, however, tolerates droughts less than species of willow that grow in Nitsin and Navajo Canyons. A lower drought tolerance suggests why the species from the willow family currently grow in the canyon systems while gambel oak has died out in the area. Gambel oak did not survive the effects of drought while species of willow continued to thrive. Despite the current absence of gambel oak in the area, gambel oak provided a source of fuel for the Inscription House community during the Pueblo III Period.

The species of wood identified in the midden comprise only a few of the species that grow in and around Nitsin and Navajo Canyon today. Since many of the fragments of charred wood from the midden were unidentifiable, some of the charred wood might come from additional species near Inscription House. Besides the four varieties mentioned above, plant communities in Nitsin and Navajo Canyons consist of *Fallugia paradoxa* (apache plume), *Chrysothamnus* Nutt. (rabbit brush), *Artemisia* L. (sage brush), *Ephedra viridis* Coville (mormon tea), and *Atriplex canescens* (fourwing saltbush).

The canyon habitats provided a variety of sources of wood for the Inscription House community to use as fuel. While a large portion of the charred wood specimens was unidentifiable, the identifiable species show that the Inscription House occupants collected wood from a variety of habitats. The Inscription House, however, occupants preferred to use juniper and pinyon pine wood for firewood. Despite evidence from Scott's (1978) analysis of a low juniper pollen count, the trees likely survived in relatively high numbers into the late Pueblo III Period.

Charred wood from the Inscription House midden suggest a continued reliance on pinyon and juniper wood throughout the Pueblo III Period. A variety of charred wood in contexts from the middle to late Pueblo III Period shows possible evidence of a deteriorating environment. Charred wood from species in the willow family only occur in contexts from the middle to late Pueblo III Period. The Inscription House community probably recognized evidence of an overtaxed and declining juniper and pinyon population, and started to use alternative species for firewood. The relatively low counts of willow family and oak specimens (two on average), however, suggest that oak and species from the willow family provided a minimal source of fuel for the Inscription House community. The variety of charred wood species in the macrobotanical record indicates, instead, that the Inscription House community used any readily available wood in the area.

Miscellaneous Parts of Plants from the Inscription House Midden

Miscellaneous and inedible parts from three woody species occur in the soils of the Inscription House midden. The miscellaneous parts show evidence of plants used for non-dietary purposes at Inscription House. Non-dietary purposes of plants consist of construction material, firewood, and medicinal purposes. Since the alternative uses of the woody plants provide information outside the purposes of the Inscription House Midden Project, I briefly discuss the species separately from the edible wild and domesticated species.

Parts of woody species from the Inscription House midden consist of the leaves of apache plume, nuts from spruce trees, and needles from juniper trees. While other woody materials occur in the soil samples, the three previously mentioned species showed charring and likely correlate with human activity. The charred specimens provided no indication of prehistoric use. Ethnographic research, however, of *Picea* L. (genus spruce), *Fallugia paradoxa* (apache plume), and juniper shows several non-dietary purposes of the plants in modern Native American communities. Navajo use the leaves of apache plume (Figure 68) to induce insanity for witchcraft, to create

Figure 68. Photograph of apache plume.

a ceremonial lotion, and to create an emetic (Moerman 1998:232). Tewa and Hopi also boiled the leaves to create a shampoo (Robbins et al. 1916). Hopi create basketry, arrow shafts, and cradleboards from the wood of apache plume as well.

Modern Native Americans also use the wood from spruce trees for ceremonial and utilitarian purposes. Wood from spruce trees (Figure 69) provides material for Paiute bedding and material for a ceremonial emetic in Navajo communities. In addition, ethnobotanical studies show modern Native American uses for juniper needles. Hopi burn the needles for ceremonial or religious purposes. The presence of juniper needles in the Inscription House midden suggests that the Inscription House community burned the needles for similar purposes as Hopi.

The modern ethnographic evidence shows the use of spruce, apache plume, and the needles of juniper in Native American communities. The archaeological record at Inscription House, however, provides no evidence of the alternative uses. The plants probably correlate to human activity, but the specimens of the plants in the Inscription House midden offer no evidence of the exact use of the species at Inscription House.

Figure 69. Photograph of an Engelman spruce tree.

Results of the Pollen Analysis

I sent three pollen samples from Provenience Units 1, 3, and 4SW to Susan Smith for analysis. The pollen in the samples consisted of specimens from 21 identified taxa. The taxa in the pollen samples consisted primarily of beeweed, cattail (*Typha latifolia*), goosefoot, amaranth, sunflower family (Aseraceae), pine, and juniper. Beeweed comprised the highest frequency (51% to 80%) of the taxa in the pollen samples (Smith 2011).

The high frequency of beeweed pollen may result from the growth of beeweed on or near the Inscription House midden, or from a frequent use of the species at Inscription House. However, the frequency of species in the pollen samples likely result from biases caused by modern pollen rain. The accumulation of modern pollen in samples may skew the results of the analysis. Since the pollen data likely contains uncontrollable biases, I left the pollen data out of the main analysis of the Inscription House midden and appended the results of the pollen analysis to the end of this report. Appendix F discusses the detailed results of the pollen analysis.

Conclusion: Dietary Change at Inscription House?

The Inscription House community used a variety of plant species during the Pueblo II and Pueblo III Periods. The species identified in the midden consisted of domesticates and wild taxa. The high frequencies and the ubiquity of sand dropseed, Inidian ricegrass, lambsquarter, and clammy groundcherry in the midden show evidence of wild dietary staples. The Inscription House occupants relied on the four wild species as well as corn, squash, and possibly cotton as the primary sources of food. The consistent frequencies and ubiquity of the foods in the macrobotanical assemblage of the Inscription House midden suggest that the community maintained a relatively stable diet throughout the occupation of the cliff dwelling.

Chapter 5. Comparing the Data with Previous Research

This chapter compares the results of the macrobotanical analysis from the Inscription House midden with previous research to develop a greater understanding of the data from the project. The Inscription House midden provides evidence of 25 edible species very likely consumed by the Pueblo II and III community. The diet of the prehistoric cliff dwellers consisted of a diversity of wild plants with three domesticates (*Zea mays* L., *Gossypium* spp., and *Cucurbita* spp.). The high proportion and ubiquity of specific wild plants in the midden shows that the Inscription House community relied on wild species not only as a supplement of the diet, but as a primary food source. The consistent counts of edible plant species through the main periods of occupation can be, given current samples, interpreted as a lack of evidence for a risk management strategy in the Inscription House midden and a lack of dietary stress.

My work examined previous research at Inscription House and in sites in northern Arizona to identify potential gaps in the Inscription House Midden Project. The previous pollen and macrobotanical research at Inscription House might provide alternative perspectives or results. In addition, the current research focuses on the diet in the cliff dwelling during the late Pueblo II and III Periods. A regional comparison of diets from different temporal sites could indicate that the late Pueblo II Period inhabitants had already initiated a risk management strategy before the first deposition of the trash on the cliff face. Comparisons of the research with previous data might confirm or contradict the results of the Inscription House midden analysis that no evidence of a risk management strategy occurs in the diet of the Pueblo III Period community.

Comparing Regional Data

I compared the frequencies and ubiquity of species in the Inscription House midden with the data from previous excavations of sites in the region. The regional data consist of macrobotanical, pollen, and coprolite analyses of Ancestral Puebloan sites from different periods. An examination of different sites in the area, as well as sites from different temporal ranges, shows examples of changes in the diet as a result of stress.

Highway Salvage Projects

Researchers have conducted limited comparative paleoethnobotanical studies around the Navajo and Tsegi Canyon systems. Early excavations in the area identified the presence of domesticates and wild species at sites, but the researchers rarely analyzed the plant material in depth. The projects usually provided no information on the exact counts, proportions, or ubiquity of individual species. Macrobotanical studies from later reports consisted of detailed information about the diet of Ancestral Puebloans. Archaeological investigations in the area, however, were primarily limited to salvage efforts as a result of erosion in National Park Service land or from a planned construction project. Construction projects requiring the implementation of archaeological surveys occur relatively infrequently due to the remoteness of the area.

An Early Study of Sites along Navajo Route 16. A significant source of paleoethnobotanical data from the Navajo Canyon area consist of an archaeological survey (Shroedl et al. 1989) conducted as a result of proposed road construction for Navajo Route 16 (N16), a project area that stretches from the Arizona State Highway 89 to the southern extent of Navajo Canyon. Heath and Schroedl (1989) analyzed macrobotanical material from the initial excavations in 1989 on ten sites along the road. The sites date from the Archaic periods to the Pueblo III Period. The macrobotanical material from the sites showed a frequency and diversity of wild species and domesticates during the Pueblo III Period similar to species found in the Inscription House midden. The N16 project data (Shroedl et al. 1989), however, suggested that a change occurred in the subsistence strategies of the Ancestral Puebloans by the end of the Pueblo III Period.

N16 project archaeologists analyzed sites in subsets of the Puebloan Periods, consisting of early, middle, and late phases. Sites from the N16 project dating to individual phases in the Pueblo III Period showed significant differences in taxa diversity and proportions of species. The frequency of domesticated and wild edible species from early Pueblo III and middle Pueblo III Period contexts resemble the frequencies of species in the Inscription House midden. The wild taxa occurred in higher frequencies than domesticates in macrobotanical samples from the N16 project. Late Pueblo III Period contexts in the N16 project, however, indicate an increased consumption of domesticates. The frequency of domesticates in the later sites of the N16 project occurs in higher frequencies than wild plants, a change in the diet that was not seen in the Inscription House Midden Project. The changes in the diet suggest that, unlike the Inscription House community, the communities in the N16 project did use a risk management strategy to mitigate for environmental changes.

Schroedl et al. (1989) argue that a higher frequency of corn compared to goosefoot occurs only during the late Pueblo

III period and probably indicates a change from a reliance on cultivars to domesticates. The Inscription House diet, instead, shows a higher ubiquity of goosefoot compared to corn throughout the Pueblo III Period. The consistent frequencies of goosefoot at Inscription House are evidence of a stable diet throughout the occupation of the site.

The counts of domesticates, however, suggest that biases are present in the Inscription House midden. Prehistoric communities could have consumed corn cobs as a risk management strategy or could have used corn cobs for fuel, causing an inaccurate representation of corn consumption in the Inscription House midden. Whole cobs occur in contexts dating from A.D. 1040 to 1220, demonstrating the possibility of a bias in the data. High frequencies of fragmentary cobs, however, continue to occur in later contexts. If the Inscription House occupants used the cobs as fuel or consumed the cobs, then frequencies of fragmentary as well as whole cobs might decrease during the late Pueblo III Period. The provenience units also consisted of consistent frequencies of squash throughout the occupation of the cliff dwelling. Prehistoric communities relying more heavily on corn probably consumed a higher frequency of squash as well.

Despite possible biases in the record, the frequencies of corn in the Inscription House midden indicate continuity of the plant's consumption in the community. The evidence from my study indicates that the diet of the Inscription House community appears to have stayed constant throughout the occupation of the site. The diet shows no evidence of a similar risk management strategy as the 1989 study conducted on route N16. A second investigation in 2007 (Geib et al. 2007) of archaeological sites along N16 also indicates a different subsistence practice during the late Pueblo III Period than the Inscription House midden data.

A Second Study of Sites along Navajo Route 16. The second N16 study provided macrobotanical and pollen data from 33 sites in an area that extends from Arizona State Highway 89 to Navajo Mountain in Utah. Botanical data showed that the Ancestral Puebloan communities in the project area consumed a high frequency of wild plants compared to domesticates into the late Pueblo III Period. The frequency of wild plants increased especially during the end of the period. Matthews and Smith (2007) argue that the increase in wild plant use during the end of the Pueblo III Period occurs as a result of the expansion of agricultural land. The communities farmed a larger area causing an increase in the growth of pioneer species, such as goosefoot and amaranths, which prefer disturbed soils. The Puebloan communities used the advantageous byproduct of increased agricultural production by consuming a higher frequency of the pioneer species.

If the Inscription House community consumed pioneer species similar to the communities in the 2007 study, then the counts for domesticates and pioneer species should both increase during the Pueblo III Period. The counts in the midden, instead, suggest that the number of individual species varied more in similar temporal contexts than between contexts. The Inscription House Midden Project indicates different subsistence strategies during the late Pueblo III Period compared to the 2007 and the 1989 N16 projects. The similarities of the Inscription House diet to the diet of Pueblo II and early Pueblo III Period sites in the N16 projects suggests that the Inscription House community did not need to alter the diet.

Coprolites and Diet in the Four Corners Region

Comparisons with a more comprehensive study of botanical material from the Four Corners region (Minnis 1989) might show that the Inscription House community used a similar subsistence strategy as sites throughout the region. Minnis (1989) analyzed previous research of pollen and macrobotanical data from coprolites that date from the Basketmaker III Period to Pueblo III Period to determine changes in diet through time. The examination of previous research included Fry's and Hall's (1973) report on coprolites from Inscription House and a 1986 report on coprolites from Antelope House in Canyon de Chelly. The comprehensive analysis of previous coprolite data indicated common staples of Ancestral Puebloan diets and the effects of local environments on the diet.

The research compared botanical data from the Basketmaker III Period and the Pueblo III Period as well as the differences between contemporaneous sites to determine temporal and spatial correlations. The comparison of botanical material from Basketmaker III Period and Pueblo III Period coprolites showed that prehistoric communities relied on five staple foods. The five staple foods consisted of corn, squash, goosefoot, purslane, and groundcherry (Minnis 1989:550). The staple foods identified in the coprolite research, with the exception of purslane, occur in relatively high frequencies in the provenience units from the Inscription House midden as well. The botanical data from the two studies provide similar evidence of dietary staples.

Minnis (1989:550-551) also argues in the study that goosefoot, groundcherry, amaranth, and cotton consumption increased in frequency during the Pueblo III Period. The Inscription House midden data correlate with the observed increase in the consumption of the four species through time. Goosefoot, groundcherry, and amaranth show relatively high counts in the provenience units of the Inscription House midden. The midden, however, provides no evidence of high counts of cotton. The community probably did not consume cotton seeds in higher quantities during the Pueblo III Period, but the data from the midden provide limited information on earlier periods. A comparison of material from earlier contexts might indicate that the relatively low counts of cotton in the midden still occur in higher frequencies than the Pueblo I and II Periods.

A second area of discrepancy between the Inscription House midden data and the coprolite study occurs in the decrease in the ubiquity and frequency of beeweed and pinyon specimens from the Basketmaker III to Pueblo III Periods. Minnis (1989) argues that a decrease in the consumption of pinyon nuts and beeweed results from population pressure or environmental degradation. The Inscription House midden data, however, suggest that a relatively consistent consumption of pinyon nuts and beeweed occurred from the late Pueblo II Period to the end of the Pueblo III Period. While the data provide no information on earlier periods, the macrobotanical data show that environmental degradation did not affect the consumption of beeweed or pinyon nuts at Inscription House. The midden contained a high proportion and ubiquity of the species throughout the later periods. The frequencies and ubiquity indicate that the Inscription House community continued to consume beeweed and pinyon nuts as a common source of food into the late Pueblo III Period.

If environmental changes decreased or decimated the local pinyon pine and beeweed populations as Minnis (1989) hypothesizes, the proportion and ubiquity of the specimens in the Inscription House midden should reflect the effects of the environmental changes. The proportions of the specimens, instead, appear relatively high for pinyon pine. Geib et al. (2007) also argue in an analysis of wood from the N16 project that pinyon pine populations in the Navajo Canyon area were relatively large compared to other areas on the Colorado Plateau during the Pueblo III Period.

The evidence of a relatively stable pinyon pine population from the Inscription House Midden Project and the N16 Project compared to Minnis's (1989) research results from differences in the origins of analyzed samples. Minnis (1989) based the hypothesis of a reduced pinyon population during the Pueblo III Period on botanical samples from Mesa Verde. Navajo and Nitsin Canyon consisted of relatively smaller Ancestral Puebloan populations than Mesa Verde. The smaller populations in the Canyons placed less of a burden on the local pinyon populations as compared to the Mesa Verde communities.

In addition, research of coprolites at Hoy House by Scott (1979), as well as a coprolite study of Antelope House by Williams-Dean (1986), indicates that beeweed continued to provide an important source of food for Pueblo III Period communities. The data from individual studies in Minnis's (1989) research revealed a different understanding of the significance of beeweed in the Pueblo III Period diet. Minnis (1989) also identifies the differences in diet in individual communities through a comparison of contemporaneous sites.

The differences in diet occur from differences in the location and size of prehistoric communities. Communities range in size throughout the Colorado Plateau and cause different pressures on the landscape. Sites in the Four Corners region occur in different geological settings, elevations, and ecological zones as well.

The variation in the landscape results in distinct changes in local plant communities and the carrying capacity of the land. Minnis (1989:559) suggests that the growth of certain species in an area guides the dietary decisions of Ancestral Puebloans. The occupants of Inscription House consumed wild plants based on the availability of local resources and the local conditions of the environment.

An analysis of dietary changes in the Inscription House community needs to focus on local factors. Minnis's (1989) research indicates that regional comparisons provide evidence of broad subsistence changes in time, but offer limited information in an understanding of the diets of a specific area. The dietary staples specific to the Inscription House community differ from the diets of contemporaneous sites on the Colorado Plateau. I investigated previous studies at the site to determine possible changes in the local diet through time or for evidence of local dietary stress.

Previous Dietary Studies at Inscription House

The analysis of the diet from the Inscription House midden requires an examination of previous dietary studies at the site. The data from the previous research consist of species not identified in the Inscription House midden, different counts of species, or contexts from earlier periods. Comparing and contrasting the information of the current research with previous studies provides a greater understanding of the local subsistence practices as well as a greater understanding of the local environment during the Pueblo III Period.

Previous Pollen and Coprolite Research

Previous research examining the diet of the occupants of Inscription House consists of two coprolite studies, a pollen analysis, a faunal analysis, and an investigation of human remains at the base of the cliff. The pollen study by Scott (1978) contained one soil sample from a Tsegi Phase cultural layer with enough pollen grain specimens for an accurate analysis. The sample showed paleoenvironmental data and dietary information that confirms information from the Inscription House coprolite studies.

The Local Environment. Environmental data from the pollen study indicated a low juniper and pinyon pine count for the Inscription House area. Scott (1978:41) argues that the arboreal pollen percentage for cultural layers (10.5 % of the total pollen assemblage) provides evidence of lower arboreal pollen percentages than surface layers (19.5 % of the total pollen assemblage). The lower arboreal pollen percentages might indicate a clearing of trees for agricultural land or a high rate of environmental deterioration (Scott 1978).

Since pollen samples from the surface already reflected the effects of environmental stress that occurred during the 1977 excavation, the 9 % lower arboreal pollen percentages in the Tsegi Phase cultural stratum suggest that an additional pressure caused by humans affected the landscape (Scott 1977:41). The analysis, however, relies on data from a single sample. The analysis of arboreal pollen percentages requires an investigation of additional soil samples with a 200 pollen count to develop an accurate understanding of the prehistoric environment.

A comparison of the arboreal pollen percentages with Kelso's (1972) coprolite research provides a more detailed understanding of the tree populations during the Pueblo III Period. Kelso (1972:15) argues that the arboreal pollen record shows a drop in the arboreal pollen count during the main period of occupation at Inscription House. The low arboreal pollen count possibly correlates with an increase in the ancestral populations in the area. A drop in arboreal pollen percentages in the coprolite samples during the main period of occupation suggests that the inhabitants of Inscription House cut an increased number of trees for construction timber, firewood, and to clear land for agriculture.

The coprolite data also show evidence of an increase in arboreal pollen before the last occupants migrated from the area. The increase in arboreal pollen during the last years of occupation likely indicates a decrease in population size in the community. As people started migrating from the area, the community required fewer trees for timber and firewood, which resulted in an increase in the tree population. An increase in the tree popultaions might occur after a couple or several decades.

The coprolite evidence provides a greater understanding of changes in the local environment compared to the pollen analysis by Scott. The pollen study probably provides information on only a single point in time, the main period of occupation. Scott (1978) posits from the pollen sample that the Ancestral Puebloan populations almost denuded the area during the Tsegi Phase. An examination of the coprolite evidence, however, suggests that a fluctuation occurred in tree populations during the main period of occupation. The fluctuations in arboreal pollen over time indicate a general trend towards a decreased tree population during the main period of occupation followed by a relatively fast increase in the tree populations. A relatively fast increase in the tree populations during the end of the occupation shows that the inhabitants did not completely denude the area during the Pueblo III Period.

The coprolite study, however, also contains biases. Kelso (1976) argues after a second analysis of the coprolite data that the deposition of the coprolites might indicate a record of pollen from a fall or winter occupation. A deposition of material during fall or winter would consist of a low frequency of arboreal pollen since trees produce pollen mainly in spring and summer. A similar bias likely occurs in Scott's research. As a result, the pollen studies provide a limited understanding of the paleoenvironmental record.

Paleoenvironmental data from the current research suggest that the tree population was not completely decimated. A high proportion and ubiquity of charred wood from juniper and pinyon pine in the Inscription House Midden Project indicate that the trees continuous supplied resources for the community throughout the Pueblo III Period. The macrobotanical data from Inscription House suggest a more moderate understanding of the paleoenvironmental record compared to Kelso's (1976) and Scott's (1978) research. The community and changes in the environment probably impacted the local ecology, but the local ecology continued to provide a stable source of resources for the Inscription House community.

The Local Diet. Kelso's (1972; 1976) coprolite studies provide information on the local ecology and diet during the broader occupation of the site compared to the pollen study. Kelso's (1972 :14-15) coprolite study, as well as the initial coprolite research by Fry and Hall (1973), provide evidence of 6 dietary staples consisting of corn, beeweed, groundcherry, grasses, goosefoot, cacti, and *Helianthus* L. (sunflower genus). The dietary staples occur in different frequencies in different temporal contexts at the site. The frequencies of the species show a possible trend in the consumption of wild species and domesticates.

The trend in the coprolite study consists of a high frequency of beeweed, groundcherry, cacti, and goosefoot in early deposits that were replaced by corn during the main period of occupation (Pueblo III Period). The main period of occupation also shows an increase in the consumption of sunflower and grasses. Changes in the diet near the end of occupation consisted of an increasing variety of wild species and a decrease in the proportion of individual species. Kelso argues that homogeneity of the macrobotanical assemblage in the youngest coprolite samples indicates "a dietary shift away from vegetal resources" and "a winter occupation near the end of human activity at the site" (1972:15). The occupants of Inscription House may have relied less on agricultural practices and more on hunting and gathering during the end of the occupation. The shift in subsistence strategies through time might indicate the use of risk management strategies to mitigate for a deteriorating environment.

The dietary trends in the coprolite study differ from the relatively consistent dietary patterns indicated in the Inscription House Midden Project. The data from the coprolite study, however, have biases associated with population size. The sample size for the coprolite study consists of 27 coprolites. While the coprolite samples outnumber the midden provenience units, the coprolites consist of material from only a single or a few meals consumed by an individual. The botanical material from the midden samples shows evidence of many meals from multiple households. The macrobotanical data from the midden provide broader information on the diet than the coprolite study, but a comparison of the studies provides greater detail on the Inscription House diet.

Kelso's (1972) hypothesized shift in subsistence strategies may only indicate a difference in seasonal practices rather than an overall change in the Inscription House diet. If the occupants deposited the coprolites during the winter as proposed by Kelso (1972:15), then the botanical material in the coprolites would provide evidence of an increased consumption of animals and a decrease in vegetal material. A community occupying Inscription House during the winter probably consumed a high frequency of animals as available vegetal food sources died off in the colder months.

In addition, a shift in a high frequency of wild plants to a high frequency in corn likely indicates differences in an individual's meal rather than a community wide change in subsistence practices. The hypothesized increase in corn consumption relies on data obtained from samples excavated from a single room. The coprolite analysis requires a larger set of samples to develop a greater understanding of the subsistence practices of the Pueblo III Period community. The Inscription House community probably consumed a relatively consistent proportion and ubiquity during the later periods of occupation as shown in the current midden project.

Despite possible biases in the coprolite studies, the Inscription House midden research needs to investigate the presence and frequencies of sunflower, bugseed, beeweed, and cacti in the coprolite samples. The coprolite samples consisted of high frequencies of the species during the main period of occupation at Inscription House (Kelso 1972; Fry and Hall 1973). The frequencies of the species suggest that the community relied on the taxa.

Bugseed, beeweed, and cacti, however, were present in low frequencies throughout the midden samples. The low frequencies and relatively high ubiquity of the species in the midden indicate that the species provided a supplement to the diet, while the coprolite studies indicate that the three taxa comprised a portion of the staples of the Inscription House community's diet. The midden also showed no evidence of sunflower in the diet, a plant commonly consumed in Ancestral Puebloan communities.

The dietary practices of the community could have caused the absence of sunflower specimens and the low frequencies of beeweed, bugseed, and cacti in the midden. The community possibly consumed the entire plant, as shown by modern ethnographic studies (Moerman 1998), and deposited evidence of the plants primarily in the coprolites from Inscription House. If the community consumed the taxa before the plant's production of seeds, a low frequency or absence of the taxa would occur in the midden samples.

Pollen from the species, however, would deposit in the coprolites and indicate the consumption of the species. Since the coprolite studies examined the pollen as well as the macrobotanical remains, the researchers were able to identify high frequencies of the taxa. Kelso, for example, identified a high pollen frequency of cacti (cholla and *Echinocactus* spp.) in the coprolites and argues that the evidence shows "that the flowers, or at least the very young fruits were eaten" (1972:8). Pollen provided evidence of dietary staples that do not always appear in macrobotanical studies.

The macrobotanical analysis of the midden should have shown evidence of sunflowers, but the macrobotanical assemblage from the midden contains no evidence of the use of sunflowers. Kelso argues that the coprolites contained "considerable crushed *Helianthus* achenes" (1972:8). The absence of crushed sunflower seeds in the midden likely results from the origins of the deposits. The community might not have deposited matrix with sunflower seeds in the midden area. The occupants also possibly consumed the entirety of the crushed seeds. The consumption of an entire seed would leave no evidence of the seeds in Inscription House midden.

The biases of a small sample size also skew the coprolite data by causing a misrepresentation of the consumption of sunflower. The coprolite evidence relies on the presence of sunflower in three of the 27 coprolites. The presence of sunflower in only three coprolites of a relatively small set of samples suggests a greater reliance on sunflowers than actually occurred at Inscription House.

The dietary information could also show an infrequent consumption of sunflower seeds over several decades. Kelso argues that the "temporal control for the fills of the various structures is nonexistent, and the chronological portion of the occupation covered by the coprolite pollen record is not evident in the archaeological data" (1976:137). Coprolite samples likely date in a decade or more of each other. The absence of chronological control in the coprolite research results in an inability to accurately interpret the dietary and environmental changes through time. The small sample size and the poor chronology of the coprolites develop biases in Kelso's research. The high frequencies of cacti, beeweed, bugseed, and sunflower shown in the coprolite research may only occur infrequently in the Inscription House community's diet through time.

Although Kelso's (1972; 1976) research contained biases, the coprolite data indicate a gap in the Inscription House midden data. The community consumed sunflower seeds and possibly consumed a higher frequency of cacti, bugseed, and beeweed than indicated by the data from the midden. The coprolite data and the pollen study also provided evidence of supplementary foods not identified in the Inscription House midden. The coprolite and pollen data indicate the possible consumption of hackberry (*Celtis* L.), cattails (*Typha* L.), pepperweed (*Lepidium* L.), greasewood (*Sarcobatus* L.), a plant from the nightshade family (*Solanum* L.), and evening primrose (Onagraceae) (Scott 1977; Kelso 1976). The plants occur in low frequencies in the previous studies and provided uncommon sources of food for the Inscription House community. The low frequency, however, probably shows that the pollen of the species entered the archaeological record through natural deposition or through natural ingestion of pollen.

Despite biases that occur in the pollen and coprolite studies, the previous research shows that the Inscription House diet consisted of a broader range of plant species than determined by the midden analysis alone. A comparison of the investigations at least confirms that the community relied on corn, squash, grasses, and goosefoot as staples of the diet. In addition, the diet consisted of a broader variety of supplementary wild plants. The trends in subsistence practices shown in the coprolite data, however, might not have occurred at Inscription House. The variety of wild plants and domesticates probably provided the Inscription House community with a stable source of nutrition. The macrobotanical data from the midden suggest that the Inscription House community consistently consumed vegetal sources of food throughout the occupation of the site.

Previous Osteological Research

An analysis of human remains from the 1966 excavation provides possible evidence for an inadequate supply of nutrition from animals in the Inscription House community. Harris et al. (1973) analyzed the human bones for mortality rates and causes of death. Half of the individuals (13 out of 26) analyzed showed evidence of porotic hyperostosis, or skeletal deformities consisting of unnaturally porous cranial surfaces, caused by iron deficiency anemia. Anemia results in a low red blood cell production that sometimes leads to death.

Iron deficiency anemia forms in an individual through a low iron diet, chronic diarrhea, or through intestinal parasites (Harris et al. 1973). A low iron diet consists of a high frequency of vegetal material and a low frequency of meat, a diet common in Pueblo III Period communities on the Colorado Plateau. The vegetation consumed by Ancestral Puebloan communities contains insoluble iron. The low amounts of iron from vegetal sources provide insufficient amounts of the element to support a human.

Humans require a certain amount of animal protein to acquire enough iron to survive. An absence of iron from animals in a diet could result in the skeletal deformities in the Inscription House skeletal remains. The current midden project, as well as the previous excavations in 1966 and 1977, identified a low count of animal bones in cultural contexts. The faunal assemblage for the Inscription House midden consisted of five fragmentary pieces (less than 4 cm long) of burned bone from an unidentified small mammal.

The researchers during the 1966 excavation also identified a relatively low count of animal bones in the midden at the base of the cliff. The highest count of animal bones (106) occurs in the cultural contexts excavated during the 1977 project at Inscription House. Emslie, however, argues in the analysis from the 1977 excavation report that due to the "small sample size and the inability to identify much of this bone, little can be said regarding interpretations on the use of animals by the prehistoric Indians at the site" (1977:52). The research failed to identify many of the animal species because of the fragmentary nature of the bones. The fragments of bones also suggest that multiple specimens from an individual occur in the cultural strata.

The high count of specimens indicates a bias as a result of post-depositional activities. The bones showed a high rate of weathering (Emslie 1977). Mechanical and chemical processes eroded the bones into smaller and smaller fragments. Preparation techniques of the Inscription House community also probably resulted in the deposition of fragmentary bones. The occupants of Inscription House likely broke down the animals prior to consumption. The result of post-depositional and pre-depositional activities probably resulted in a high count of specimens that originated from an originally low count of individuals.

A low count of individuals in the 1977 excavation, as well as the low counts from the 1966 and the current project, suggest that the Inscription House community consumed relatively small proportions of meat. A diet low in animal meat likely caused the anemia in the Inscription House population. A comparative study of porotic hyperostosis by Reinhard (1992) of Pueblo III Period sites in the American Southwest, however, shows that the Inscription House diet consisted of a sufficient amount of meat to sustain the community. Reinhard argues that statistical analyses of the data indicate that "maize consumption and meat consumption have no causal relationship with anemia" (1992:248). Anemia occurs in Pueblo III Period communities, such as Inscription House, independently of the frequency of meat consumption. The research, instead, identifies a direct correlation with the presence of intestinal parasites in coprolites. Prehistoric people likely ingested the parasites while drinking from small pools of water where the parasites thrive.

A correlation of parasites to the anemia at Inscription House suggests that the animal populations supplied a sufficient source of meat to support the community during the Pueblo III Period. Population pressure and environmental degradation probably did not affect the consumption of meat. Malnutrition as a result of insufficient meat consumption was not a reason for the Inscription House community to migrate.

The analysis of human remains, however, suggests that a relatively high mortality rate affected the Inscription House community's decision to migrate. The average death at Inscription House occurred at age 21 with an average maximum life span of about 40 (Harris et al. 1973). While the average lifespan of the Inscription House community shows a lower lifespan compared to modern populations, the data indicate a relatively old lifespan compared to contemporaneous Ancestral Puebloan sites (Harris et al. 1973). The Inscription House community lived relatively healthy lives compared to contemporaneous communities in the area. The human remains also provided evidence of a relatively normal frequency of injuries for an Ancestral Puebloan population.

The sample population of human remains from the base of the cliff, however, consists of only a portion of the community during the Pueblo III Period. The burials consisted of 32 individuals that date to an approximately 150 year period. Seven of the individuals from the burials at the base of the cliff lived past the age of 40, which leaves 25 individuals that died at a young age (Harris et al. 1973). The population at Inscription House consisted of at least 70 individuals during the main period of occupation (Ward 1975). The sample size of the study on human remains may include too small a population to indicate the health of the entire community during the Pueblo III Period. The data from the osteological research at Inscription House show that at least a portion of the Inscription House community lived relatively healthy lives in comparison to populations in contemporaneous communities on the Colorado Plateau.

Synopsis of the Comparative Research

Evidence of illnesses, injuries, and malnutrition at Inscription House indicates relatively typical frequencies for prehistoric agricultural communities on the Colorado Plateau. In addition, the frequencies of plants in cultural contexts at Inscription House suggest that the community had a stable diet throughout the Pueblo III Period. A stable diet suggests that the community did not change the diet as a risk management strategy during the Pueblo III Period. The pollen and coprolite evidence show minor fluctuations in the diet, but biases associated with small sample size provide a limited understanding of changes in subsistence patterns through time. The previous research indicates that population pressure and environmental deterioration affected the Inscription House community, but no evidence correlates directly between the effects of environmental degradation and the migration from Inscription House during the end of the Pueblo III Period.

Chapter 6.
Migration from Inscription House

This research investigates the macrobotanical material to determine if changes in the diet occurred at Inscription House during the Pueblo III Period. My research indicates that the Inscription House diet was stable throughout the Pueblo III Period. An absence of dietary changes at Inscription House suggests that the community did not implement a starvation food risk management strategy to mitigate the effects of environmental changes and population pressure. Accordingly, the effects of environmental changes and population pressures probably did not cause the Inscription House community to migrate during the end of the Pueblo III Period. This chapter provides the results of the study by briefly summarizing the data and examining the potential causes for the Inscription House migration.

Examining the Causes for Migration

The Inscription House midden project analyzed macrobotanical data from 25 provenience units in the salvaged midden that dated from approximately A.D. 1040-1270 (Pueblo II-III Periods). The macrobotanical data showed evidence of relatively consistent frequencies of wild and domesticated taxa in the Inscription House diet throughout the main periods of occupation. The consistent frequencies of plant taxa provided no evidence of changes in the diet that indicate the employment of a risk management strategy. Previous investigations of faunal and osteological data at Inscription House suggest a similar stability in the Inscription House diet during the Pueblo III Period. The absence of evidence for a starvation food risk management strategy in the macrobotanical data suggests that population pressure and environmental degradation did not directly cause the migration from Inscription House.

The Inscription House Diet during the Pueblo III Period

The Inscription House community relied on a variety of wild plant species as well as three domesticated species during the Pueblo II and III Periods to survive. The main dietary staples identified in the midden analysis consisted of squash, corn, Indian ricegrass, lambsquarter, sand dropseed, groundcherry, and cotton. Comparisons with previous research at the site show that the main diet also consisted of beeweed, cacti, bugseed, and sunflower. Biases resulting from a small sample size, however, skew the importance of the four taxa in the diet. Counts of specimens from the Inscription House midden indicate relatively consistent proportions and ubiquity of species across the Pueblo II-Pueblo III Periods.

The frequencies of plant species in the Inscription House midden vary more in contexts from the same age than between provenience units with different ages. Previous coprolite research at Inscription House, however, suggests that a higher consumption of corn and a consumption of a wider variety of wild plants occurred near the end of the occupation. The coprolite data suffer from small-sample bias. The samples indicate evidence of a few meals consumed by an individual in an unknown temporal context. The coprolite project provides data only on a narrow research domain. We would benefit enormously from a broad interpretation of the community diet as well as an understanding of the exact age of the coprolites.

The macrobotanical data from the Inscription House Midden Project provides a greater understanding of the subsistence strategies of the community. Mixed contexts in Provenience Units 5.1 and 5.5, however, affect any interpretations of the Pueblo II Period diet. The oldest dated materials (A.D. 1030 - 1040) come from Provenience Units 5.1 and 5.5 with material that dates to A.D. 1260 and 1270. Since Provenience Units 5.1 and 5.5 consist of the only identified Pueblo II Period material in the midden, the research does not provide a meaningful interpretation of the Pueblo II Period diet. The interpretation of the research should focus mainly on the diet during the Pueblo III Period.

The midden data suggest that the diet of the Inscription House community during the Pueblo III Period stayed relatively constant. The occupants appear to have continued to consume similar frequencies of plant taxa for over 150 years without implementing an observable risk management strategy. A lack of temporal variation in the diet shows that the Inscription House community could have survived in the area despite the occurrence of two heightened periods of aridity (Dean 1970) and a possible drop in the annual precipitation as a result of volcanic activity (Salzer 2000). The consistent frequencies in the diet and the consistent frequencies of species in the charred wood assemblage also suggest that population pressure caused minimal effects on the local ecology.

Population Pressure: The Pollen and Macrobotanical Evidence

Previous pollen and coprolite studies at Inscription House, however, indicate a possible decline in the juniper and pinyon populations during the main period of occupation. The data in the previous studies, however, contain biases associated with seasonal deposition and small sample sizes. The pollen study by Scott (1978) relied on a single soil sample from prehistoric contexts, while the coprolite study by Kelso (1972) relied on data from 27 coprolites from unknown temporal contexts. The samples from the studies also consist of pollen assemblages from a probable winter habitation. A pollen assemblage from winter will include a low arboreal pollen assemblage and cause an inaccurate interpretation of the size of the tree populations. The data from the Inscription House Midden Project likely provide a relatively more accurate understanding of the pinyon and juniper populations.

The consistent proportions and ubiquity of burned juniper and pinyon in the Inscription House midden suggest that the tree populations were large enough to support the requirements of the community. The community preferred to burn juniper and pinyon. The community probably collected wood from outside Nitsin Canyon if resources declined in the immediate area. The high proportion of pinyon and juniper in the charred wood assemblage at least suggests that the local canyon systems provided enough wood to support the firewood requirements of the community.

The demands of the increased populations during the middle to late Pueblo III Period did not cause a complete denuding of the area as demonstrated at larger Ancestral Puebloan sites. The resource demands of larger, aggregated communities in the Nitsin and Navajo canyon systems during the Pueblo III Period, however, had to at least cause a decline in the local tree populations. The effects of population pressure on the landscape likely affected the decision to migrate, but population pressure probably did not comprise the main cause for the migration from Inscription House.

The Health of a Pueblo III Period Community

The Inscription House community could have decided to migrate from the area as a result of disease. Harris et al. (1973) argue that the community experienced the effects of anemia, possibly from a low protein diet. A low protein diet results from a lack of animal meat. Despite a low frequency of animal bones in studies at Inscription House, Reinhard (1992:248) argues in an analysis of health in Pueblo III Period communities that no statistical correlation occurs between the consumption of meat and anemia. The researcher, instead, identifies intestinal parasites as the cause of anemia at Inscription House and contemporaneous sites on the Colorado Plateau.

The apparently prevalent anemia probably resulted in a high mortality rate. Fifty percent of the burials showed evidence of high levels of anemia. A high rate of disease could have affected the decision to migrate. In addition, the burials suggest that the community died, on average, at a relatively young age, at the age of 21 (Harris et al. 1973). The causes for the young average age of death likely influenced the decision to migrate as well. The mortality rate for Inscription House, however, appears to show a lower rate of death for infants and children than contemporaneous Ancestral Puebloan communities (Harris et al. 1973).

More people lived past childhood, but the average age of death was still low at the age of 21. Harris et al. (1973) argue that the data show a relatively normal mortality rate for an agricultural community on the Colorado Plateau despite the relatively low average age of death. The human remains also provide no evidence of increases in dietary problems or health concerns that would have forced the community to migrate by the end of the Pueblo III Period. In addition, the bones show no evidence of injuries as a result of violence. The absence of violence related injuries suggests that conflict was also not a main influence in the decision to migrate.

Possible Causes for the Inscription House Migration

Conflict, population pressure, and environmental changes did not cause the migration from Inscription House during the end of the Pueblo III Period, according to the macrobotanical data and previous research at Inscription House. The decision to migrate from Inscription House, however, likely did not result from the effects of a single cause. The accumulation of multiple variables may have eventually forced the community to migrate.

Population pressure and environmental changes apparently caused no changes in the diet, but the community still experienced the indirect effects of the stresses on the regional ecologies. Dendrochronological evidence provided by Dean (1970) shows that two periods of increased aridity in 100 years caused erratic cycles of erosion in the canyon systems of northeastern Arizona. Under Dean's (1970) model, the two erosion cycles resulted in a significant loss of soil, a significant loss of vegetation, and a significant drop in the water table. The loss of agricultural soils in the drainages and the floor of the canyon likely caused stress on the Inscription House community. The occupants of Inscription House probably mitigated the effects of erosion, but no evidence of the mitigation occurs in the macrobotanical data of the Inscription House midden.

The community's water supplies also diminished as a result of a lowered water table and decreased annual precipitation. Springs could have dried up along the canyon and the streams at the base of the canyon probably flowed at an unpredictable rate. The lowered water table, increased aridity, increased erosion, and a decrease in annual precipitation as a result of volcanic activity affected the Inscription House community.

The effects of population pressure probably also created stress on the Inscription House community. The communities in the Nitsin and Navajo Canyons increased in size during the Pueblo III Period. The larger populations required more from the environment than previous periods. A large population in Nitsin and Navajo Canyons even under less arid conditions likely caused significant alterations to the landscape. The local ecologies during the Pueblo III Period continued to support the occupants of Inscription House, but the inhabitants affected the population sizes of the local plant and animal communities. The combined effects of population pressure and environmental changes during the end of the Pueblo II Period and throughout the Pueblo III Period affected the Inscription House community to a certain extent.

The data from the Inscription House, however, provide no evidence that the communities suffered from the effects of environmental deterioration. Accordingly, additional factors likely affected the decision to migrate. Despite a lack of evidence for violent conflict, the community may have experienced social tensions from the influx of different cultural groups to the area. Changes in the culture and society could have also influenced the community's determination to migrate.

Although, the data from the Inscription House Midden Project and previous research at Inscription House provide no definitive evidence of changes in the culture or society of the Inscription House community. Since the Inscription House data show no evidence for a main cause for migration, a probable model for the migration of the Inscription House community occurs in the multivariate model of Long House Valley (Axtell et al. 2002). Axtell et al. argue that a combination of social, cultural, and environmental factors caused communities to migrate from Long House Valley during the Pueblo III Period.

Groups from communities in Long House Valley started to migrate from the area because of the effects of changes in the environment and population pressure. The local environment was capable of supporting a smaller population in the area, but communities continued to migrate from the valley. The populations that continued to live in the area probably experienced social tensions resulting from an influx of outside cultural groups, such as Mesa Verde communities and Numic speakers. In addition, population segments important in ceremonial, political, or social aspects of communities migrated from the area. Axtell et al. (2002) posit that the final inhabitants of Long House Valley ceased to function as a community. The loss of integral groups in the society, the lack of a cohesive group identity, and social tensions necessitated the rest of the occupants to migrate from Long House Valley by the end of the Pueblo III Period.

A similar scenario likely occurred at Inscription House. Data from Inscription House suggest the community migrated slowly from the area in a similar manner to Long House Valley. In addition, a lack of dietary stress suggests that the community could have continued to survive in the area. Neighboring communities, however, probably started to migrate as a result of the deteriorating environment. The Inscription House occupants were connected to the communities that were leaving the area through social and cultural ties. Bernadini (2005) argues that "At some point…the demographic balance in northern Arizona must have tipped so heavily toward Hopi and Zuni that continued residence elsewhere would have been isolating, undesirable, and perhaps even dangerous" (2005:162). Communities that could have continued to survive in an area, such as the Inscription House community, needed to migrate to stay connected with the groups that started coalescing in areas to the south.

The groups that started to coalesce around A.D. 1300 created a large network of communities, such as at Hopi or Zuni. Stuart (2000:168) suggests that the new aggregated communities during the A.D. 1400s did not prevent all hardships, but at least provided comfort and security of a large community network. The Inscription House occupants likely migrated to stay connected with the other groups that inhabited the canyon systems of northeastern Arizona. The macrobotanical data from Inscription House and previous research on the site, however, show no direct evidence of the social or cultural causes of the late Pueblo III Period migration. The data from the Inscription House Midden Project and the previous research only suggest that the Inscription House community migrated as a result of multiple causes.

Conclusions

The Inscription House midden data shed light on the occupants' diet as well as the causes and processes of migration from the area during the late A.D. 1200s. Future studies should investigate the possible social and cultural factors behind the migration. In addition, future research should examine the macrobotanical remains of the in situ midden deposits. The in situ deposits may provide more information on the diet during the Pueblo II Period. Pueblo

II Period cultural material in the Inscription House Midden Project occurred in mixed contexts with Pueblo III Period material. An analysis of the intact portions of the midden needs to develop a tighter control of the stratigraphy in the soils by excavating before the material erodes.

An excavation of intact soils from the midden would also provide future researchers with better samples for a pollen analysis. The recovery of unexposed midden material allows for the mitigation of biases caused by the accumulation of modern pollen rain. The long period of exposure of the broken down midden material from the Inscription House Midden Project likely resulted in the accumulation of modern pollen rain that biases the results of the pollen analysis.

Despite gaps and biases in the research, the macrobotanical analysis suggests that the community maintained a relatively stable diet throughout the Pueblo III Period. A stable diet indicates that population pressure and environmental changes were probably not the main causes behind migration. Previous explanations for the migration of Ancestral Puebloan communities have relied on environmental changes or population pressure as the main causes for migration. The current study suggests that the Inscription House community migrated from not one, but multiple factors. The results from the analysis add to the intensively analyzed, but poorly understood occupation of Inscription House.

References Cited

Adams, Karen R.
1994. A Regional Synthesis of Zea Mays in the Prehistoric American Southwest. In *Corn and Culture in the Prehistoric New World* 273-302. Edited by Sissel Johannessen, and Christine A. Hastorf. Westview Press, Boulder.

Ambler, J. Richard
1985. Navajo National Monument: An Archaeological Assessment. In *Northern Arizona University Archaeological Report No. 974*. Archaeology Laboratory: Northern Arizona University, Flagstaff.

Androy, Jerry
2003. *Agriculture and Mobility During the Basketmaker II Period: The Coprolite Evidence*. M.A. Thesis, Northern Arizona University, Flagstaff.

Axtell, Robert L., Joshua M. Epstein, Jeffrey S. Dean, George J. Gumerman, Alan C. Swedlund, Jason Harburger, Shubha Chakravarty, Ross Hammond, Jon Parker, and Miles Parker
2002. Population Growth and Collapse in a Multiagent Model of the Kayenta Anasazi in Long House Valley. In *Proceedings of the National Academy of Sciemces of the United States of America*. 99: 7275-7279. National Academy of the Sciences of the United States of America, Washington D. C.

Barkley, William D. and Alexander C. Martin
1961. *Seed Identification Manual*. University of California Press, Berkeley.

Bernadini, Wesley
2005. *Hopi Oral Tradition and the Archaeology of Identity*. University of Arizona Press, Tuscon.

Bohrer, Vorsila L.
1970. Ethnobotanical Aspects of Snaketown, a Hohokam Village in Southern Arizona. In *American Antiquity* 35:413-430.

Breternitz, David A.
1977. I*nscription House: Salvage Excavations in the Trash Midden*. University of Colorado, Boulder.

Brotherson, J. D., G. Nebeker, M. Skougard, and J. Fairchild
1978. Plants of Navajo National Monument. In *Great Basin Naturalist* 38: 94-114. Monte L. Bean Museum, Brigham Young University, Provo.

Brubaker, Curt L. and Jonathan F. Wendel
1994. Reevaluating the Origin of Domesticated Cotton (Gossypium Hirsutum; Malvaceae) Using Nuclear Restriction Fragment Length Polymorphisms (RFLPs). In *American Journal of Botany*. Vol. 81, No. 10: 1309-1326.

Burbaker, Curt L. and Jonathan F. Wendel
1994. Reevaluating the Origin of Domesticated Cotton (Gossypium hirsutum; Malvaceae) Using Nuclear Restriction Fragment Length Polymorphisms (RFLPs). In *American Journal of Botany* Vol. 81, No. 10, pp. 1309-1326.

Clay-Poole, Scott T.
1989. *Pollen Flora and Paleoecology of Holocene Alluvial Tsegi and Naha Formations, Northeastern Arizona*. Ph.D. Dissertation. Northern Arizona University, Flagstaff.

Colson, Elizabeth
1980. In Good Years and in Bad Years: Food Strategies of Self-Reliant Societies. In *Journal of Anthropological Research* 35:1-29.

Cummings, Byron
1910. The Ancient Inhabitants of the San Juan Valley. In *Bulletin of the Unversity of Utah 3(3), Part 2*, Salt Lake City.

1920. The National Monuments of Arizona. In *Art and Archaeology* 101(1-2): 27-36. Washington

1926. White Man's Discovery of the Rainbow Bridge. In *Progressive Arizona* 3(1): 22-24. Tucson.

Cutler, Hugh C., and Thomas W. Whitaker
1961. History and Distribution of the Cultivated Cucurbits in the Americas. In *American Antiquity* 4: 469-485.

Dean, Jeffrey S.
1970. Aspects of Tsegi Phase Social Organization: A Trial Reconstruction. In *Reconstructing Prehistoric Pueblo Societies*, edited by William A. Longacre. pp; 140-74. University of New Mexico Press, Albequerque.

1988. A Model of Anasazi Behavioral Adaptation. In *The Anasazi in a Changing Environment* 25-35. Edited by George J. Gumerman. Cambridge University Press, Cambridge.

2002. Late Pueblo II-Pueblo III in Kayenta-Branch Prehistory. In *Prehistoric Culture Change on the Colorado Plateau: Ten Thousand Years on Black Mesa* pp. 121-159. Edited by Shirley Powell and Francis E. Smiley. University of Arizona Press, Tucson.

2006. Subsistence Stress and Food Storage at Kiet Siel, Northeastern Arizona. In *Environmental Change and Human Adaptation in the Ancient American Southwest* pp. 160-179. Edited by David E. Doyel and Jeffrey S. Dean. The University of Utah Press, Salt Lake City.

Delorit, R. J.
1970. *An Illustrated Taxonomy: Manual of Weed Seeds*. Agronomy Publications, River Falls.

Deschambre, David A.
1983. *The Settlement of East Central Black Mesa: A.D. 600-1250*. M.A. Thesis, Northern Arizona University, Flagstaff.

Dunmire, William W. and Gail D. Tierney
1997. *Wild Plants and Native Peoples of the Four Corners*. Museum of New Mexico Press, Santa Fe.

Dunk, Christine
2006. *An Archaeobotanical Investigation of Shields Pueblo's (5MT3807) Pueblo II Period*. Masters Thesis. Simon Fraser University, Burnaby.

Ebeling, Walter
1986. *Handbook of Indian Foods and Fibers of Arid America*. University of Calfiornia Press, Berkeley.

Elmore, Francis H.
1943. *Ethnobotany of the Navajo*. Bulletin 392, Monograph Series, Vol. 1, No. 7, University of New Mexico Press, Albuquerque.

Elmore, Francis H., and Jeanne R. Janish
1976. Shrubs and Trees of the Southwest Uplands. In *Southwest Parks and Monuments Association Popular Series* No. 19. Vol. 19, Western National Parks Association, Tuscon.

Emslie, S. D.
1977. Appendix B: Vertebrate Fauna From Inscription House, 1977. In *Inscription House: Salvage Excavations in the Trash Midden*. pp. 52-53. University of Colorado, Boulder.

Erickson, David L., Bruce D. Smith, Andrew C. Clarke, Daniel H. Sandweiss, and Noreen Tuross
2005. An Asian Origin for a 10,000-Year-Old Domesticated Plant in the Americas. In *Proceedings of the National Academy of Sciences of the United States of America*, 102(51):18315-18320.

Ford, Richard I.
1972. An Ecological Perspective on the Pueblos. In *New Perspectives on the Pueblos*, edited by Alfonso Ortiz, pp. 1-17. University of New Mexico Press, Albuquerque.

Fry, Gary F. and H. J. Hall
1973. *The Analysis of Human Coprolites from Inscription House*. Ms. on file, National Park Service, Western Archaeological and Conservation Center, Tucson.

Geib, Phil R. and Kimberly Spurr
2007. *Prehistory of the Northern Kayenta Anasazi Region:Archaeological Excavations Along the Navajo Mountain Road. Navajo Nation Archaeology Department Report No. 02-48*. Navajo Nation Archaeology Department, Bureau of Indian Affairs Navajo Area Office, Gallup.

Hack, John T.
1945. Recent Geolog of the Tsegi Canyon. In *Archaeological Studies in Northeastern Arizona* 151-158. Edited by Ralph Beals, George Brainerd, and Watson Smith. University of California Publications in American Archaeology and Ethnology Vol. 44, No. 1. Berkeley.

Harris, Edward F., W. Paul Jones, Dennis J. Ryan, Christy G. Turner II
1973. *Supplemental Findings on the Physical Anthropology of the Prehistoric Western Pueblo Indians of Inscription House*. Arizona State University, Tempe.

Hastorf, Christine A. and Virginia S. Popper
1988. *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*. University of Chicago Press, Chicago.

Heath, Kathleen M. and Alan R. Shroedl
1989. Plant Macrofossils. In *Kayenta Anasazi Archeology and Navajo Ethnohistory on the Northwestern Shonto Plateau: The N-16 Project.* 775-790. P-III Associates, Inc., Salt Lake City.

Hitchcock, Albert Spear
1971. *Manual of the Grasses of the United States*. Dover Publications Inc., New York.

Hocking, George M.
1956. Some Plant Materials Used Medicinally and Otherwise by the Navajo Indians in the Chaco Canyon, New Mexico. In *El Palacio* 63:146-165.

Hogan, P., K. Husinga, K. Kampe
2005. *An Annotated Catalog of Native and Naturalized Flora of Arizona*. Arizona Ethnobotanical Research Association, Flagstaff.

Hough, Walter
1897. The Hopi Relation to Their Plant Environment. In *American Anthropologist* 11:133-155.

Janetski, Joel C.
1999. Role of Pinyon-Juniper Woodlands in Aboriginal Societies of the Desert West. In *USDA Forest Service Proceedings RMRS-P-9*. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden.

Karlstrom, Thor
1988. Alluvial Chronology and Hydrologic Chane of Black Mesa and Nearby Regions. In *Anasazi in a Changing Environment*. Edited by George Gumerman. Pp. 45-91. Cambridge University Press, Cambridge

Kent, Kate Peck and Virginia Loehr
1973. *Cordage and Textile Material from Inscription House*. Unpublished Ms., National Park Service, Santa Fe.

Kelso, Gerald K.
1972. *Pollen Analysis of Human Coprolites from Inscription House*. National Park Service, Navajo National Monument, Tonalea.

1976. *Absolute Pollen Frequencies Applied to the Interpretation of Human Activities in Northern Arizona*. Doctoral Dissertation. University of Arizona, Tuscon.

Lanner, Roland M.
1981. *The Pinon Pine: A Natural and Cultural History*. University of Nevada Press, Reno.

Lindsay, Alexander J., Jr.
1969. *The Tsegi Phase of the Kayenta Culture Tradition, Northeastern Arizona.* Doctoral dissertation. University of Arizona, Tuscon.

Matthews, Meredith
2007. Chapter 10: Macrobotanical Analysis. In *Prehistory of the Northern Kayenta Anasazi Region: Archaeological Excavations Along the Navajo Mountain Road*. Pps. 10.1-10.19. Edited by Phil Geib and Kimberly Spurr. Navajo Nation Archaeology Department, Bureau of Indian Affairs Navajo Area Office, Gallup.

Mabry, Jonathan B.
2005. Changing Knowledge and Ideas about the First Farmers in Southeastern Arizona. In *The Late Archaic Across the Boderlands: From Foraging to Farming.* Pp. 41-83. Edited by Bradley J. Vierra. University of Texas Press, Tuscon.

McDougall, W. B.
1973. *Seed Plants of Northern Arizona.* Museum of Northern Arizona. Northern Arizona Society of Science and Art, Inc., Flagstaff.

Miller, William C.
1968. *1661 Chas Arnod or 1861 Anno D? At Inscription House Ruin*. In Plateau 40(4): 143-47. Flagstaff.

Minnis, Paul E.
1989. Perhistoric Diet in Northern Southwest: Macroplant Remains from Four Corners Feces. In *American Antiquity*, Vol. 54, No. 3, pp. 543-563. Salt Lake City.

1996. Notes on Economic Uncertainty and Human Behavior in the Prehistoric North American Southwest. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest* pp. 57-79. Edited by Joseph A. Tainter and Bonnie Bagley Tainter. Addison-Wesley Publishing Company, Reading.

Moerman, Daniel E.
1998. *Native American Ethnobotany*. Timber press, Inc. Portland.

Moreno, Jerryll L.
1995. *An Examination of the Over-Hunting Hypothesis at Casas Malpais, A Pueblo III-IV Community*. M.A. thesis. Northern Arizona University, Flagstaff.

Morris, Don P.
1986. *Archaeological Investigations at Antelope House*. National Park Service, U. S. Department of the Interior, Washington, D. C.

Musil, Albina
1980. *Identification of Crop and Weed Seeds*. Scientific Publishers, New Pali.

Nelson, Margaret C.
1996. Technological Strategies Responsive to Subsistence Stress. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest* pp. 57-79. Edited by Joseph A. Tainter and Bonnie Bagley Tainter. Addison-Wesley Publishing Company, Reading.

Pearsall, Deborah M.
2000. *Paleoethnobotany: A Handbook of Procedures*. Academic Press, San Diego.

Plog, Stephen and Shirley Powell
1984. *Papers on the Archaeology of Black Mesa, Arizona, Volume II. Vol. II of II*. Southern Illinois University Press, Carbondale.

Reed, Erik K.
1967. *Human Skeletal Material from Navajo National Monument, Arizona*. Ms. On file, National Park Service, Santa Fe.

Reinhard, K. J.
1992. The impact of diet and parasitismon anemia in the prehistoric West. In *Diet, Demography and Disease: Changing Perspectives of Anemia*. Edited by P Stuart-McAdam and S Kent 219-258. Aldine deGruyter, New York.

Richert, Roland Von S.
1958. *Stabilization Records: Inscription House Ruin*. Unpublished Manuscript. Navajo National Monument and the Arizona Archaeological Center, Tonalea and Tucson.

Robbins, Wilfred William, John Peabody Harrington, and Barbara Freire-Marreco
1916. *Ethnobotany of the Tewa Indians*. Smithsonian Institution, Bureau of American Ethnology Bulletin 55, Washington, D. C.

Roberts, Ted
2008. *Inscription House Midden Recovery and Research Project* [digitized map]. National Park Service, Navajo National Monument, Tonalea.

Rocek, Thomas
1995. *Sedentarization and Agricultural Dependence: Perspectives from the Pithouse-to-Pueblo Transition in the American Southwest*. American Antiquity, Vol. 60, No. 2, pp. 218-239. Salt Lake City.

Sanchez Gonsalez, Jesus
1989. *Relationships Among the Mexican Races of Maize*. Doctoral Dissertation. North Carolina University, Raleigh.

Salzer, Matthew
2000. Temperature Variability and the Northern Anasazi: Possible Implications for Regional Abandonment. In *Kiva* Vol 65, No. 4: 295-318. University of Arizona, Tuscon.

Sauer, Jonathan D.
1967. The Grain Amaranths and their Relatives: A Revised Taxonomic and Geographic Survey. In *Missouri Botanical Garden Annals* 54: 103-137.

Scott, Linda J.
1978. Pollen Analysis of Midden 2 at Inscription House, Arizona. In *Inscription House: Salvage Excavations in the Trash Midden* 26-53. David Breternitz. University of Colorado, Boulder.

1979. Dietary Inferences from Hoy House Coprolites: A Palynological Interpretation. In *Kiva* 44:257-281. University of Arizona, Tuscon.

Sharp, John B.
1990. *Wood Identification: A Manual for the Non-Professional*. University of Tennessee Agricultural Extension Service Publication, Knoxville.

Smith, Bruce D.
1997. The Initial Domestication of Cucurbita pepo in the Americas 10,000 Years Ago. In *Science* New Series, Vol. 276, No. 5314, pp. 932-934.

1998. *The Emergence of Agriculture*. Scientific American Library, New York.

Smith, Susan
2007. Chapter 11: Pollen Analysis. In *Prehistory of the Northern Kayenta Anasazi Region: Archaeological Excavations Along the Navajo Mountain Road*. Pps. 11.1-10.23. Edited by Phil Geib and Kimberly Spurr. Navajo Nation Archaeology Department, Bureau of Indian Affairs Navajo Area Office, Gallup.

2011. Pollen Analysis Results from Three Midden Samples from Inscription House Ruin. In *Paleoethnobotany of Inscription House, Arizona: Subsistence in Nitsin Canyon.* Appendix E. Archaeological Report 1308. Anthropology Laboratories. Northern Arizona, Flagstaff.

Smiley, Francis E.
2002. The First Black Mesa Farmers. In *Prehistoric Culture Change on the Colorado Plateau: Ten Thousand Years on Black Mesa*, edited by Shirley Powell and Francis E. Smiley, pp. 37-65. University of Arizona Press, Tucson.

Spielmann, Katherine A. and Eric A. Angstadt-Leto
1996. Hunting, Gathering, and Health in the Prehistoric Southwest. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest* pp. 79-107. Edited by Joseph A. Tainter and Bonnie Bagley Tainter. Addison-Wesley Publishing Company, Reading.

Steen, Charles R.
1940. *Stabilization of Inscription House: Navajo National Monument*. Unpublished Manuscript. Navajo National Monument and the Arizona Archaeological Center, Tonalea and Tucson.

Steinshouer, James Brian
1985. *Wood Identification Key and Description of Selected Tree Species in Arizona*. Masters Thesis. Northern Arizona University, Flagstaff.

Stuart, David E.
2000. *Anasazi America*. University of New Mexico Press, Albequerque.

Toll, H. Wolcott, Mollie S. Toll, Marcia L. Newren, and William B. Gillespie
1985. Chapter Three. Experimental Corn Plots in Chaco Canyon: The Life and Hard Times of Zea Mays L. In *Environmental and Subsistence of Chaco Canyon, New Mexico*. 79-133. Edited by Frances Joan Mathien. National Park Service, U.S. Department of the Interior, Albuquerque.

USDA Plants Database
2008. *The PLANTS Database*. Electronic Document, http://plants.usda.gov. Accessed July 2010-December 2010.

United States Geological Survey
1970. *Inscription House Ruin Quadrangle* [map]. 1:24000 7.5 Minute Series. United States Department of the Interior, USGS, Reston.

Vivian, Gwinn
1959. *Sherd Identification*. Personal communication. Correspondence to Navajo National Monument. Laboratory Anthropology, Santa Fe.

Ward, Albert
1975. *Inscription House: Two Research Reports*. Northern Arizona Society of Arts and Sciences, Flagstaff.

Whiting, Alfred F.
1978. *Ethnobotany of the Hopi*. Museum of Northern Arizona Bulletin No. 15. AMS Press, New York.

Williams-Dean, G.
1986. *Pollen Analysis of Human Coprolites from Antelope House*. In Kiva Vol 45: 97-112. University of Arizona, Tuscon.

Young, James A. and Cheryl G. Young
1992. *Seeds of Woody Plants in North America*. Dioscorides Press, Portland.

Appendix A:

Domesticates Table Containing Counts and Proportions of Specimens from Comparative Samples

Provenience Unit	Taxa	Common Name	Count	Percent Frequency	Weight (g)
1	Zea mays L.	Corn	9	9	13.208
1	Cucurbita L.	Squash	92	91	2.8247
1a	Zea mays L.	Corn	6	16	1.9463
1a	Cucurbita L.	Squash	30	81	4.3131
1a	Gossypium spp.	Cotton	1	3	0.0051
1c	Cucurbita L.	Squash	10	56	0.6378
1c	Zae mays L.	Corn	8	44	0.0272
2	Gossypium spp.	Cotton	2	2	0.0185
2	Zea mays L.	Corn	3	3	0.0752
2	Cucurbita L.	Squash	96	95	1.2905
3	Zea mays L.	Corn	5	7	0.372
3	Cucurbita L.	Squash	68	93	1.862
4N	Gossypium spp.	Cotton	1	2	0.0807
4N	Cucurbita L.	Squash	56	89	7.3429
4N	Zea mays L.	Corn	6	10	0.0811
4SE	Zea mays L.	Corn	13	54	0.4045
4SE	Curcubita L.	Squash	11	46	0.4718
4SW	Zea mays L.	Corn	19	23	0.1268
4SW	Cucurbita L.	Squash	63	77	1.8291
5.1	Zea mays L.	Corn	5	7	0.1897
5.1	Cucurbita L.	Squash	64	93	0.4113
5.3	Cucurbita L.	Squash	27	56	0.2683
5.3	Zea mays L.	Corn	21	44	9.8228
5.4	Curcubita L.	Squash	134	79	4.5718
5.4	Zea mays L.	Corn	34	20	1.4808
5.4	Gossypium spp.	Cotton	2	1	0.0154
5.5	Zea mays L.	Corn	16	27	10.0179
5.5	Curcubita L.	Squash	42	71	1.0087
5.5	Gossypium spp.	Cotton	1	2	0.0359

Appendix B:

Wild Species Table Containing Counts and Proportions of Specimens from Comparative Samples

Provenience Unit	Taxa	Common Name	Count	Percent Frequency
1	Cleome serrulata	Beeweed	7	2
1	Corispermum L.	Bugseed	22	7
1	Physalis heterophylla Nees	Clammy Groundcherry	96	28
1	Chenopodium spp.	Goosefoot	14	4
1	Achnatherum hymenoides	Indian Ricegrass	27	8
1	Chenopodium album	Lambsquarter	85	25
1	Opuntia	Prickly Pear	1	0.3
1	Portulaca spp.	Purslane	7	2
1	Sporobolus cryptandrus	Sand Dropseed	36	11
1	Bouteloua curtipendula	Sideoats Grama	9	3
1	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	29	9
1	Unidentified_1	Unknown Nutlet	1	
1	Rosaceae	Unknown Rose Family	1	0.3
1	Yucca	Yucca	3	1
1a	Amaranthus spp.	Amaranth	2	0.3
1a	Fallugia paradoxa	Apache Plume Leaves	1	
1a	Cleome serrulata	Beeweed	3	0.5
1a	Corispermum L.	Bugseed	9	1
1a	Physalis heterophylla Nees	Clammy Groundcherry	51	8
1a	Chenopodium spp.	Goosefoot	15	2
1a	Achnatherum hymenoides	Indian Ricegrass	60	10
1a	Chenopodium album	Lambsquarter	357	57
1a	Opuntia	Prickly Pear	1	0.2
1a	Portulaca spp.	Purslane	20	3
1a	Sporobolus cryptandrus	Sand Dropseed	85	13
1a	Bouteloua curtipendula	Sideoats Grama	10	2
1a	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	17	3
1c	Amaranthus spp.	Amaranth	2	0.2
1c	Corispermum L.	Bugseed	7	0.6
1c	Physalis heterophylla Nees	Clammy Groundcherry	27	2
1c	Sphaeralcea L.	Globemallow	1	0.1
1c	Chenopodium spp.	Goosefoot	3	0.2
1c	Achnatherum hymenoides	Indian Ricegrass	182	16
1c	Chenopodium album	Lambsquarter	766	67
1c	Portulaca spp.	Purslane	19	2
1c	Sporobolus cryptandrus	Sand Dropseed	120	10
1c	Bouteloua curtipendula	Sideoats Grama	5	0.4
1c	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	18	2
1c	Yucca	Yucca	1	0.1
2	Amaranthus spp.	Amaranth	12	1
2	Cleome serrulata	Beeweed	5	0.5
2	Physalis heterophylla Nees	Clammy Groundcherry	102	9
2	Festuca L.	Fescue	4	0.4
2	Chenopodium spp.	Goosefoot	14	1
2	Achnatherum hymenoides	Indian Ricegrass	22	2
2	Chenopodium album	Lambsquarter	866	78

2	Opuntia	Prickly Pear	1	0.1
2	Portulaca spp.	Purslane	16	1
2	Sporobolus cryptandrus	Sand Dropseed	61	6
2	Rhus	Sumac	1	0.1
2	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	2	0.2
3	Amaranthus spp.	Amaranth	6	1
3	Fallugia paradoxa	Apache Plume Leaves	4	
3	Cleome serrulata	Beeweed	1	0.2
3	Corispermum L.	Bugseed	6	1
3	Physalis heterophylla Nees	Clammy Groundcherry	43	8
3	Chenopodium spp.	Goosefoot	7	1
3	Achnatherum hymenoides	Indian Ricegrass	29	6
3	Chenopodium album	Lambsquarter	217	41
3	Portulaca spp.	Purslane	15	3
3	Sporobolus cryptandrus	Sand Dropseed	139	26
3	Bouteloua curtipendula	Sideoats Grama	1	0.2
3	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	33	6
4N	Amaranthus spp.	Amaranth	9	5
4N	Cleome serrulata	Beeweed	4	2
4N	Physalis heterophylla Nees	Clammy Groundcherry	42	25
4N	Chenopodium spp.	Goosefoot	5	3
4N	Achnatherum hymenoides	Indian Ricegrass	16	9
4N	Chenopodium album	Lambsquarter	25	15
4N	Portulaca spp.	Purslane	7	4
4N	Sporobolus cryptandrus	Sand Dropseed	48	28
4N	Bouteloua curtipendula	Sideoats Grama	1	0.6
4N	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	12	7
4N	Unidentified_3	Unknown Seed	2	
4SE	Amaranthus spp.	Amaranth	7	3
4SE	Cleome serrulata	Beeweed	1	0.4
4SE	Physalis heterophylla Nees	Clammy Groundcherry	18	7
4SE	Chenopodium spp.	Goosefoot	9	3
4SE	Achnatherum hymenoides	Indian Ricegrass	25	9
4SE	Chenopodium album	Lambsquarter	86	31
4SE	Juniperus monosperma	One Seed Juniper Nutlet	1	0.4
4SE	Opuntia	Prickly Pear	2	0.7
4SE	Portulaca spp.	Purslane	6	2
4SE	Sporobolus cryptandrus	Sand Dropseed	60	22
4SE	Bouteloua curtipendula	Sideoats Grama	1	0.4
4SE	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	22	8
4SE	Unidentified_4	Unknown Nutlet	3	
4SE	Unidentified_5	Unknown Nutlet	1	
4SE	Unidentified_2	Unknown Seed	1	
4SE	Yucca	Yucca	3	1
4SW	Amaranthus spp.	Amaranth	10	2
4SW	Cleome serrulata	Beeweed	1	0.2
4SW	Corispermum L.	Bugseed	7	2

4SW	Physalis heterophylla Nees	Clammy Groundcherry	46	10
4SW	Chenopodium spp.	Goosefoot	21	5
4SW	Achnatherum hymenoides	Indian Ricegrass	68	15
4SW	Chenopodium album	Lambsquarter	110	24
4SW	Juniperus monosperma	One Seed Juniper Nutlet	1	0.2
4SW	Opuntia	Prickly Pear	2	0.4
4SW	Portulaca spp.	Purslane	15	3
4SW	Sporobolus cryptandrus	Sand Dropseed	144	32
4SW	Bouteloua curtipendula	Sideoats Grama	7	2
4SW	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	21	5
4SW	Poaceae_1	Unknown Grass	1	0.2
5.1	Amaranthus spp.	Amaranth	8	5
5.1	Cleome serrulata	Beeweed	2	1
5.1	Corispermum L.	Bugseed	2	1
5.1	Physalis heterophylla Nees	Clammy Groundcherry	32	19
5.1	Chenopodium spp.	Goosefoot	8	5
5.1	Achnatherum hymenoides	Indian Ricegrass	13	8
5.1	Chenopodium album	Lambsquarter	54	31
5.1	Opuntia	Prickly Pear	1	0.6
5.1	Portulaca spp.	Purslane	5	3
5.1	Sporobolus cryptandrus	Sand Dropseed	32	19
5.1	Bouteloua curtipendula	Sideoats Grama	5	3
5.1	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	10	6
5.3	Amaranthus spp.	Amaranth	11	2
5.3	Cleome serrulata	Beeweed	2	0.4
5.3	Corispermum L.	Bugseed	5	1
5.3	Physalis heterophylla Nees	Clammy Groundcherry	103	20
5.3	Chenopodium spp.	Goosefoot	8	2
5.3	Achnatherum hymenoides	Indian Ricegrass	55	11
5.3	Chenopodium album	Lambsquarter	122	24
5.3	Opuntia	Prickly Pear	3	0.6
5.3	Portulaca spp.	Purslane	6	1
5.3	Sporobolus cryptandrus	Sand Dropseed	79	16
5.3	Bouteloua curtipendula	Sideoats Grama	4	0.8
5.3	Picea L.	Spruce Nutlet	2	
5.3	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	35	7
5.3	Unidentified_6	Unknown Seed	1	
5.4	Amaranthus spp.	Amaranth	15	4
5.4	Cleome serrulata	Beeweed	3	0.8
5.4	Corispermum L.	Bugseed	14	4
5.4	Physalis heterophylla Nees	Clammy Groundcherry	101	28
5.4	Sphaeralcea L.	Globemallow	2	0.6
5.4	Chenopodium spp.	Goosefoot	14	4
5.4	Achnatherum hymenoides	Indian Ricegrass	47	13
5.4	Chenopodium album	Lambsquarter	40	11
5.4	Opuntia	Prickly Pear	4	1
5.4	Portulaca spp.	Purslane	29	8

5.4	Sporobolus cryptandrus	Sand Dropseed	86	24
5.4	Bouteloua curtipendula	Sideoats Grama	2	0.6
5.4	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	1	0.3
5.4	Poaceae_1	Unknown Grass	1	0.3
5.4	Unidentified_7	Unknown Seed	9	
5.4	Unidentified_8	Unknown Seed	2	
5.5	Amaranthus spp.	Amaranth	10	3
5.5	Cleome serrulata	Beeweed	1	0.3
5.5	Corispermum L.	Bugseed	2	0.5
5.5	Physalis heterophylla Nees	Clammy Groundcherry	68	19
5.5	Atriplex canescens	Fourwing Saltbush	3	0.8
5.5	Chenopodium spp.	Goosefoot	40	11
5.5	Bouteloua spp.	Grama	2	0.5
5.5	Achnatherum hymenoides	Indian Ricegrass	92	25
5.5	Chenopodium album	Lambsquarter	54	15
5.5	Opuntia	Prickly Pear	4	1
5.5	Portulaca spp.	Purslane	10	3
5.5	Sporobolus cryptandrus	Sand Dropseed	64	18
5.5	Bouteloua curtipendula	Sideoats Grama	5	1
5.5	Picea L.	Spruce Nutlet	2	
5.5	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	3	0.8

Appendix C:

Charred Wood Table Containing Counts and Proportions of Specimens from Comparative Samples

Provenience Unit	Taxa	Common Name	Count	Percent Frequency
1	Unidentified	Unidentified	60	87
1	Pinus Edulis Engelm.	Two Needle Pinon Pine	2	3
1	Juniperus L.	Juniper	7	10
1a	Unidentified	Unidentified	39	81
1a	Quercus Gambelii var. Gambelii	Gambel Oak	1	2
1a	Juniperus L.	Juniper	5	10
1a	Pinus Edulis Engelm.	Two Needle Pinon Pine	3	6
1c	Unidentified	Unidentified	83	86
1c	Pinus Edulis Engelm.	Two Needle Pinon Pine	7	7
1c	Juniperus L.	Juniper	5	5
1c	Salicaceae	Willow Family	1	1
2	Unidentified	Unidentified	98	88
2	Pinus Edulis Engelm.	Two Neelde Pinon Pine	2	2
2	Quercus Gambelii var. Gambelii	Gambel Oak	3	3
2	Juniperus L.	Juniper	8	7
3	Salicaceae	Willow Family	1	7
3	Juniperus L.	Juniper	4	27
3	Unidentified	Unidentified	10	67
4N	Salicaceae	Willow Family	1	2
4N	Quercus Gambelii var. Gambelii	Gambel Oak	2	4
4N	Pinus Edulis Engelm.	Two Needle Pinon Pine	2	4
4N	Juniperus L.	Juniper	6	13
4N	Unidentified	Unidentified	35	76
4SE	Juniperus L.	Juniper	8	14
4SE	Unidentified	Unidentified	48	84
4SE	Quercus Gambelii var. Gambelii	Gambel Oak	1	2
4SW	Unidentified	Unidentified	48	89
4SW	Juniperus L.	Juniper	6	11
5.1	Pinus Edulis Engelm.	Two Needle Pinon Pine	1	2
5.1	Juniperus L.	Juniper	2	4
5.1	Unidentified	Unidentified	52	95
5.3	Juniperus L.	Juniper	9	10
5.3	Pinus Edulis Engelm.	Two Needle Pinon Pine	2	2
5.3	Quercus Gambelii var. Gambelii	Gambel Oak	1	1
5.3	Salicaceae	Willow Family	1	1
5.3	Unidentified	Unidentified	80	86
5.4	Pinus Edulis Engelm.	Two Needle Pinon Pine	1	0.9
5.4	Unidentified	Unidentified	70	66
5.4	Salicaceae	Willow Family	1	0.9
5.4	Quercus Gambelii var. Gambelii	Gambel Oak	4	4

5.4	Juniperus L.	Juniper	30	28
5.5	Salicaceae	Willow Family	3	2
5.5	Pinus Edulis Englem.	Two Needle Pinon Pine	1	0.5
5.5	Unidentified	Unidentified	164	92
5.5	Juniperus L.	Juniper	9	5

Appendix D:

Corn Morphology Tables Containing Measurements of Corn Specimens from Comparative Samples

Provenience Unit	Taxa	Row Number	Number of Husks	Cob Length (mm)	Cob Diameter (mm)	Rachis Diameter (mm)	Kernel Width (mm)	Kernel Thickness (mm)	Kernel Length (mm)	Cupule Width (mm)	Rachis Segment Length (mm)	Cupule Depth (mm)
1	Husk	0	1	0	0	0	0	0	0	0	0	0
1	Kernel	0	0	0	0	0	7	4	9	0	0	0
1	Cob_Fragment	0	0	0	0	0	0	0	0	3	3	3
1	Cob_Fragment	0	0	0	7	3	0	0	0	2	2	2
1	Cob_Fragment	10	0	0	7	3	0	0	0	3	3	3
1	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	2
1	Cob	10	0	32	19	12	0	0	0	5	2	2
1	Cob	10	0	65	15	9	0	0	0	5	6	4
1	Cob	10	0	40	15	11	0	0	0	5	2	2
1a	Cob_Fragment	6	0	24	15	11	0	0	0	6	4	3
1a	Kernel	0	0	0	0	0	5	2	6	0	0	0
1a	Husk	0	6	0	0	0	0	0	0	0	0	0
1c	Husk	0	4	0	0	0	0	0	0	0	0	0
2	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
2	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	3
2	Cob_Fragment	0	0	0	0	0	0	0	0	3	0	2
2	Cob_Fragment	0	0	0	0	0	0	0	0	3	0	2
2	Husk	0	3	0	0	0	0	0	0	0	0	0
3	Cob_Fragment	0	0	0	0	0	0	0	0	5	3	3
3	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	3
3	Kernel	0	0	0	0	0	4	2	4	0	0	0
3	Kernel	0	0	0	0	0	4	2	4	0	0	0
4	Kernel	0	0	0	0	0	0	0	0	0	0	0
4	Kernel	0	0	0	0	10	10	5	0	0	0	0
4N	Kernel	0	0	0	0	0	4	1	5	0	0	0
4N	Husk	0	1	0	0	0	0	0	0	0	0	0
4N	Kernel	0	0	0	0	0	3	1	4	0	0	0
4N	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4N	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Husk	0	6	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0

4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3
4SE	Kernel	0	0	0	0	0	4	1	6	0	0	0
4SE	Kernel	0	0	0	0	0	3	3	5	0	0	0
4SE	Kernel	0	0	0	0	0	7	5	7	0	0	0
4SE	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Kernel	0	0	0	0	0	5	2	6	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	1
4SW	Kernel_Fragment	0	0	0	0	0	4	0	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	3	2	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
4SW	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	4	0	0	0
4SW	Husk	0	3	0	0	0	0	0	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	5	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	3	2	0	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	4	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	5	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	4	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	7	0	0	0
5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
5.1	Cob_Fragment	0	0	0	0	0	0	0	0	6	2	2
5.1	Husk	0	2	0	0	0	0	0	0	0	0	0
5.1	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	2
5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	3	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0

5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	1	8	0	0	0
5.3	Kernel	0	0	0	0	0	3	1	5	0	0	0
5.3	Kernel	0	0	0	0	0	5	1	5	0	0	0
5.3	Kernel	0	0	0	0	0	4	1	5	0	0	0
5.3	Kernel	0	0	0	0	0	4	1	4	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	4	2	4
5.3	Cob	8	0	0	7	4	0	0	0	4	2	2
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Husk	0	1	0	0	0	0	0	0	0	0	0
5.3	Cob	10	0	90	17	11	0	0	0	6	2	4
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	2
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	1	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	7	1	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	1	4	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0

5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel	0	0	0	0	0	4	2	5	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Husk	0	6	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	3
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	4	2	2
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3
5.4	Kernel	0	0	0	0	0	4	3	5	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	5	3	4
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel	0	0	0	0	0	3	1	4	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	12	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	1
5.5	Cob_Fragment	0	0	0	0	12	0	0	0	0	0	0
5.5	Cob_Fragment	8	0	30	17	9	0	0	0	4	2	4
5.5	Cob	10	0	90	15	10	0	0	0	6	3	3

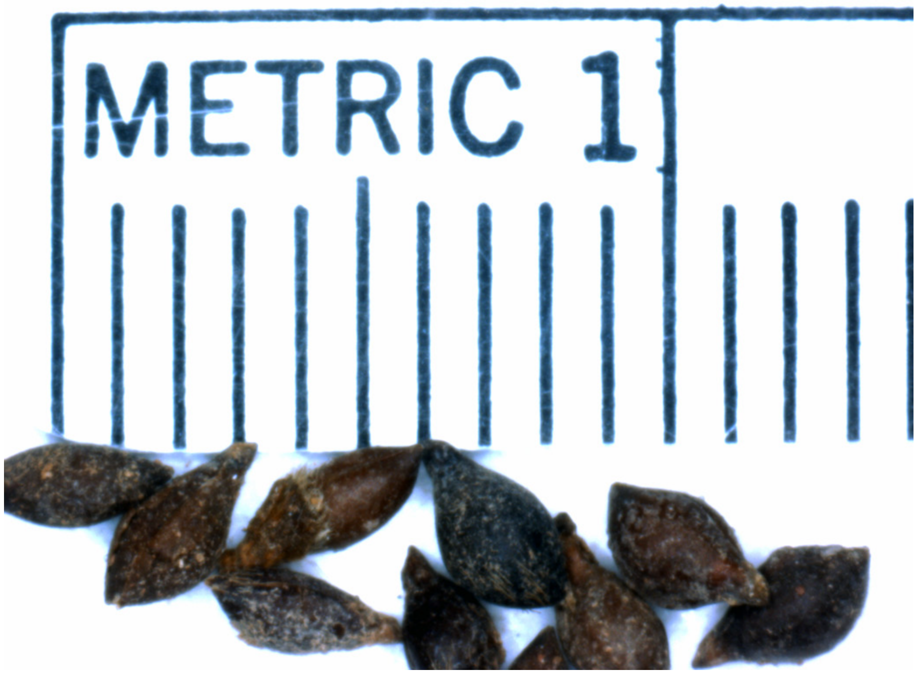
5.5	Cob_Fragment	0	0	0	0	11	0	0	0	0	0	0
5.5	Cob	8	0	45	13	9	0	0	0	3	2	1
5.5	Cob	10	0	55	10	7	0	0	0	3	2	2
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	2
5.5	Cob_Fragment	0	0	0	0	3	0	0	0	3	0	2
5.5	Cob	10	0	70	13	10	0	0	0	6	2	2
5.5	Cob_Fragment	10	0	0	8	3	0	0	0	4	3	4
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	3
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Husk	0	2	0	0	0	0	0	0	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Kernel	0	0	0	0	0	6	5	7	0	0	0
5.5	Kernel	0	0	0	0	0	4	2	6	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	2
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3

Appendix E:

Radiocarbon Sample Photographs

Radiocarbon sample 1.

Radiocarbon sample 2.



Radiocarbon sample 3 at 10 x magnification.

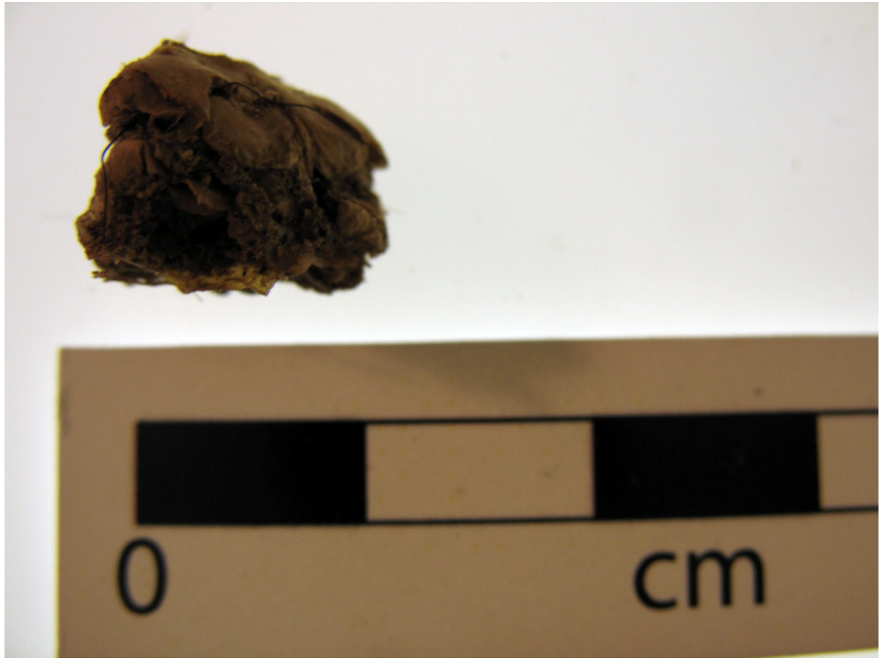
Radiocarbon sample 4 at 10 x magnification.

Radiocarbon sample 5 at 10 x magnification.

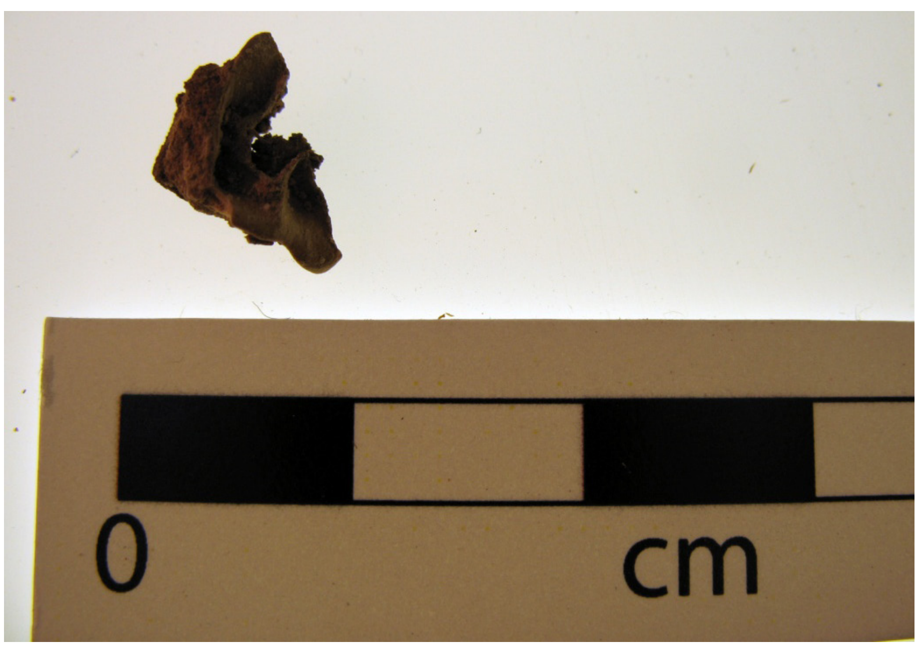
Radiocarbon sample 6 at 8 x magnification.

Radiocarbon sample 7 at 10 x magnification

Radiocarbon sample 8



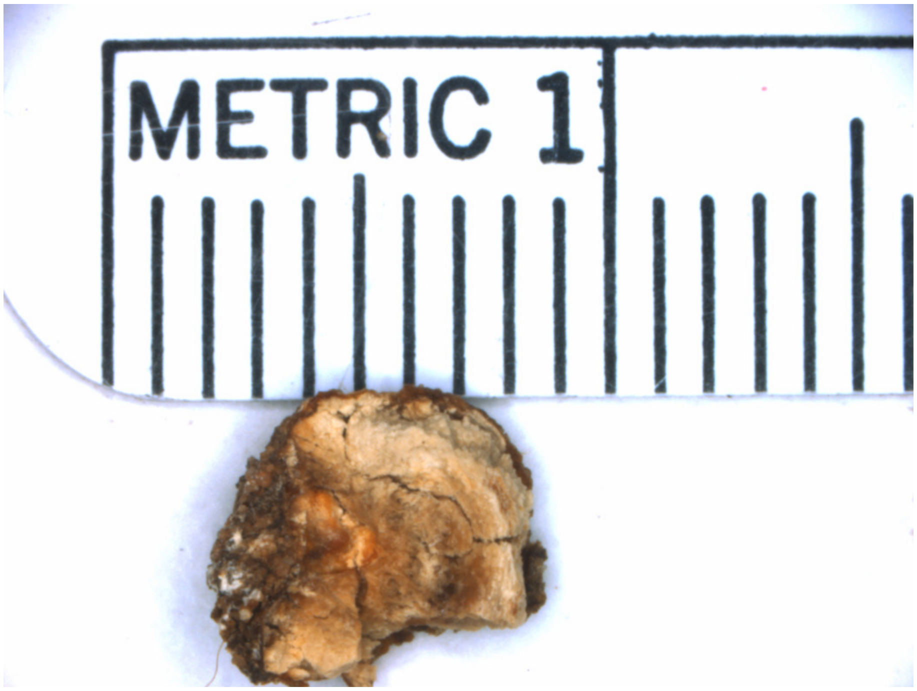
Radiocarbon sample 9



Radiocarbon sample 10

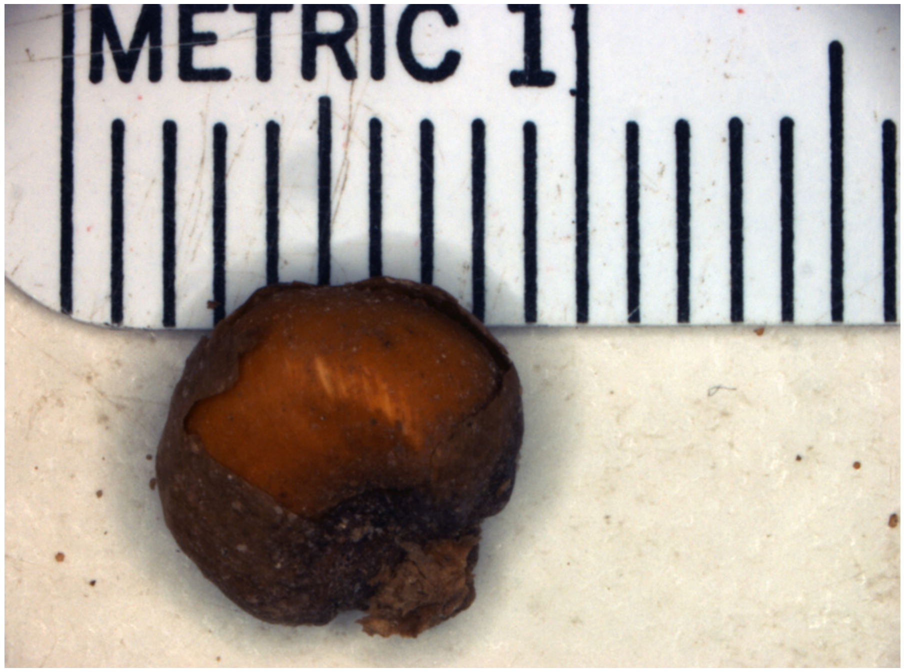
Radiocarbon sample 11 at 8 x magnification.

Radiocarbon sample 12 at 8 x magnification.

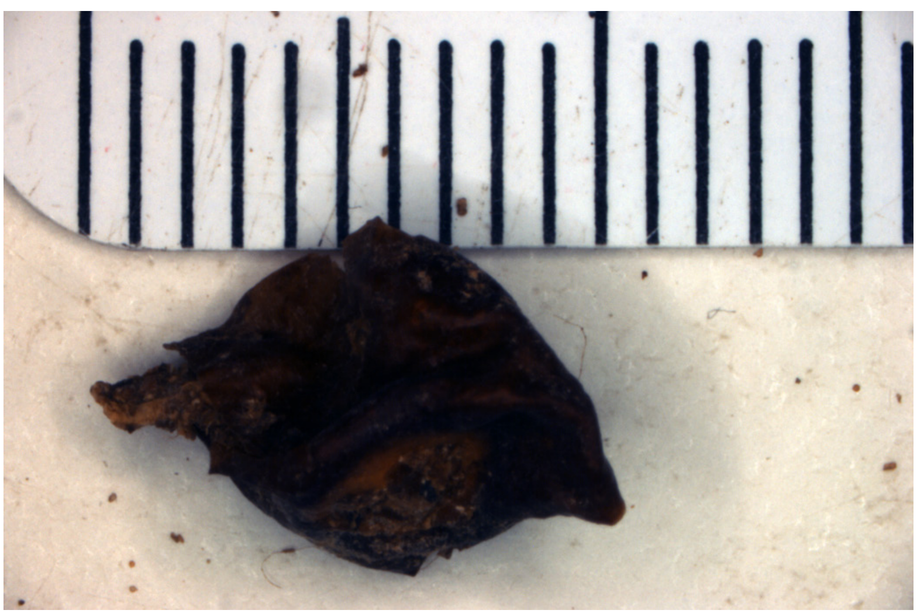


Radiocarbon sample 13 at 8 x magnification.

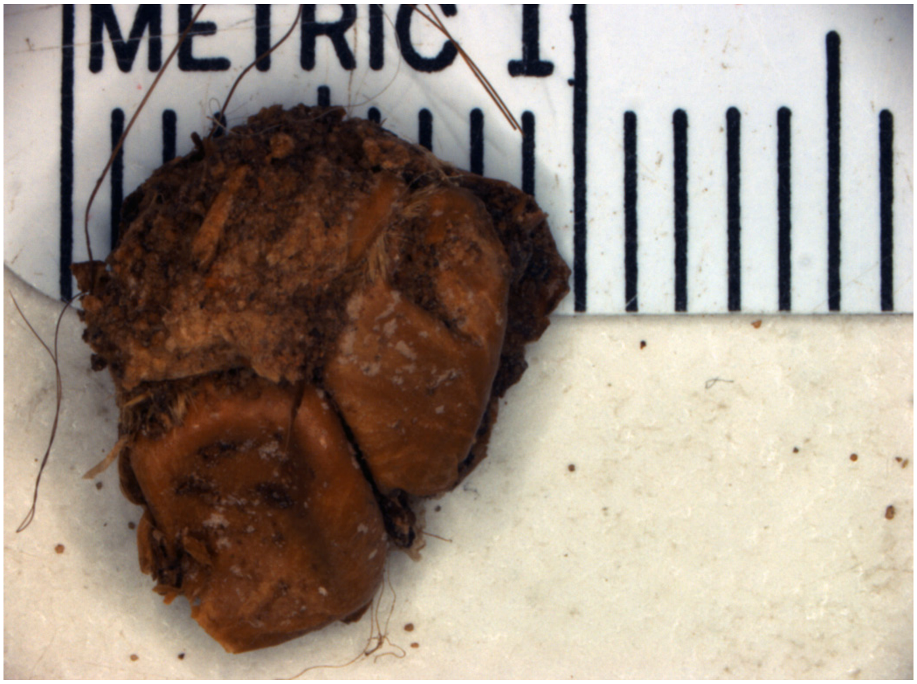
Radiocarbon sample 14



Radiocarbon sample 15 at 8 x magnification



Radiocarbon sample 16 at 8 x magnification



Radiocarbon sample 17 at 8 x magnification

Appendix F:

Pollen Analysis Report

Pollen Analysis Results from Three Midden Samples from Inscription House Ruin

Submitted by: Susan Smith, Consulting Archaeopalynologist

Submitted to: Northern Arizona University, Anthropology Department

Dr. Francis Smiley and Matt Marques

June 14, 2011

METHODS

Subsamples (20 cc volume) were taken from the sample bags and spiked with a known concentration (37,168 spores) of club moss spores (*Lycopodium*) to monitor degradation from the extraction procedure and to enable pollen concentration calculations. Samples were pretreated with hydrochloric acid (10% solution) to dissolve caliche and sieved through 180 µm mesh to remove coarse material (rocks, roots, charcoal etc). The fine fractions were mixed with 20 ml of warm sodium hexametaphosphate (less than 2% solution) and 1 L of distilled water and allowed to settle for 8 hours. After 8 hours, the muddy liquids were decanted. The timed decants were repeated using only distilled water until liquids were clear after 8 hours settling time. The technique removes organic and inorganic particles lighter than pollen and is an efficient non-toxic method to concentrate pollen. After the physical separations, samples were treated for 24 hours with hydrofluoric acid, followed by a density separation in lithium polytungstate (1.9 specific gravity) and acetolysis (reduces organics). The recovered residues were transferred to one dram vials and stored in glycerol.

Pollen assemblages were identified by counting transects on microscope slides at 400x magnification to 200 or more grains, and then scanning the entire slide at 100x magnification to record additional taxa. Aggregates (clumps of the same pollen type) were counted as one grain per occurrence, and the taxon and size recorded separately. For example, 1(10) in the Cheno-am Aggregates row refers to one clump of Cheno-am pollen consisting of 10 grains. Pollen identifications were made to the lowest taxonomic level possible based on published keys and the Laboratory of Paleoecology pollen reference collection at Northern Arizona University.

RESULTS

The pollen results are presented in Table 1, which includes summary measures of pollen concentration and taxon richness, and the counts and transformed percentages for each variable. The samples produced abundant pollen and rich assemblages dominated by beeweed (52-80% pollen sums). Beeweed is an important economic plant used for food, medicine, and a black paint that is prized even today by Hopi artists (see Adams et al. 2002). Beeweed is also an opportunistic weed that might have thrived on the organic-rich substrates of the midden. Other cultigens and important resources visible in the pollen results include maize, squash, cholla, prickly pear, and a pollen type that matches *Helianthus* or sunflower. There is also evidence for a local riparian environment in the presence of cattail and willow.

Maize is a member of the grass family (Poaceae) and all of the grasses produce simple, round pollen grains with a single pore. Maize is distinguished by a diameter of greater than 60 µm and a large pore with thickened border called an annulus (Fægri and Iversen 1989:285). The maize pollen grains in all three Inscription House samples are particularly large. Sixteen maize grains were measured at 400x magnification using a reticule inserted inside the microscope ocular with an imprinted scale of 100 divisions. The Inscription House average maize diameter is 106.6 µm. Based on examination of archaeological maize pollen from a variety of field contexts; it is the author's experience that irrigated maize pollen grains tend to be larger than dryland fields. It is possible that the samples analyzed here reflect maize from irrigated gardens and/or fields.

REFERENCES

Adams, Karen R., Joe D. Stewart, and Stuart J. Baldwin
2002. Pottery Paint and Other Uses of Rocky Mountain Beeweed (Cleome serrulata Pursh) in the Southwestern United States; Ethnographic Data, Archaeological Record, and Elemental Composition. *Kiva* 67(4):339-362.

Fægri, K., and J. Iversen
1989 *Textbook of Pollen Analysis*. 4th ed. John Wiley & Sons.

Table 1. Pollen Results from Inscription House Midden.

			1		4 SW		3	
Summary Measures	Sample Number		1		4 SW		3	
Summary Measures	Chronology		Mid-Late PIII		Early PIII			
Summary Measures	Tracers		22		9		33	
Summary Measures	Pollen Sum		237		232		233	
Summary Measures	Pollen Concentration gr/cc[a]		20020.0		47905.4		13121.4	
Summary Measures	Taxon Richness[b]		14		17		20	
	Common Name	**Taxon Name**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Economic Taxa	Cattail	*Typha latifolia*	5	2.1	4	1.7	20	8.6
Economic Taxa	Willow	*Salix*	0	0.0	0	0.0	1	0.4
Economic Taxa	Beeweed	*Cleome*	186	78.5	186	80.2	120	51.5
Economic Taxa	Maize	*Zea*	2	0.8	1	0.4	2	0.9
Economic Taxa	Squash	*Cucurbita*	X[c]		X		X	
Economic Taxa	Cholla	*Cylindropuntia*	X		X		X	
Economic Taxa	Prickly Pear	*Platyopuntia*	0	0.0	X		0	0.0
Economic Taxa	Long Spine type	cf. *Helianthus*	0	0.0	1	0.4	2	0.9
Local Shrubs, Herbs and Weeds, Possible Economic Types	Cheno-am	Cheno-Am includes saltbush (*Atriplex*), goosefoot (*Chenopodium*), pigweed (*Amaranthus*), and others	12	5.1	12	5.2	25	10.7
Local Shrubs, Herbs and Weeds, Possible Economic Types	Sunflower Family	Asteraceae includes rabbitbrush (*Chrysothamnus*), snakeweed (*Gutierrezia*), and others	8	3.4	12	5.2	18	7.7
Local Shrubs, Herbs and Weeds, Possible Economic Types	Thistle	*Cirsium*	0	0.0	0	0.0	1	0.4
Local Shrubs, Herbs and Weeds, Possible Economic Types	Ragweed type	*Ambrosia*	1	0.4	1	0.4	1	0.4
Local Shrubs, Herbs and Weeds, Possible Economic Types	Grass	Poaceae	0	0.0	3	1.3	3	1.3
Local Shrubs, Herbs and Weeds, Possible Economic Types	Evening Primrose	Onagraceae	X		0	0.0	0	0.0
Local Shrubs, Herbs and Weeds, Possible Economic Types	Greasewood	*Sarcobatus*	1	0.4	0	0.0	0	0.0
Regional to Local Trees and Shrubs	Fir	*Abies*	0	0.0	0	0.0	X	
Regional to Local Trees and Shrubs	Pine	*Pinus*	3	1.3	2	0.9	4	1.7
Regional to Local Trees and Shrubs	Pinon	*Pinus edulis* type	2	0.8	1	0.4	3	1.3
Regional to Local Trees and Shrubs	Juniper	*Juniperus*	10	4.2	3	1.3	8	3.4
Regional to Local Trees and Shrubs	Oak	*Quercus*	0	0.0	2	0.9	4	1.7
Regional to Local Trees and Shrubs	Buckbrush	*Ceanothus*	0	0.0	0	0.0	1	0.4
Regional to Local Trees and Shrubs	Lemonade-berry	*Rhus*	0	0.0	0	0.0	2	0.9
Regional to Local Trees and Shrubs	Mormon Tea	*Ephedra*	0	0.0	1	0.4	0	0.0
Regional to Local Trees and Shrubs	Sagebrush	*Artemisia*	3	1.3	3	1.3	9	3.9
	Deteriorated		4	1.7	0	0.0	6	2.6
	Unknown		0	0.0	0	0.0	2	0.9

Aggre-gates	Total Aggregates[d]	0	0.0	0	0.0	1	0.4
	Cheno-am Aggregates	0	0	0	0	1(10)	0
	Sunflower Family Aggregates	0	0	X(10)	0	0	0

a. Pollen concentration is an estimate of pollen abundance and is expressed as grains/cc.

b. Taxon richness is the number of pollen types identified in a sample.

c. X notes scan-identified taxa.

d. Aggregate notation shows number of aggregates and size of largest aggregate in parentheses.

Table 2. Measurements (microns) of Inscription House Maize Pollen Grains.

Diameter Long Dimension of Grain	Diameter of Pore	Diameter of Pore plus Annulus
95	7.5	
110		
100		
100	12.5	25
100		
100	7.5	20
150	5	17.5
100		22.5
105	2.5	20
100	7.5	10
112.5	7.5	10
115	7.5	15
95	7.5	15
110		
		20
		25
Average 106.6	**4.1**	**12.4**

Appendix G:

Artifact Table (Not including botanicals)

Provenience Unit	Artifact	Description	Count
1	Cotton Thread		8
1	Cotton Thread		1
1	Textile Fragment	Cotton	2
1	Chert	Shatter	4
1	Ceramic	Tusayan Greyware handle	1
1	Ceramic	Tusayan Greyware jar	2
1	Ceramic	Tusayan Polychrome variety b	1
1	Ceramic	Tusayan Polychrome variety b bowl	1
1	Ceramic	Tusayan Whiteware	1
1	Folded Bark	Unknown use	1
1	Prayer Stick?	Yucca and feather	3
1a	Cotton Thread		1
1a	Chert	Shatter	1
1a	Ceramic	Tusayan Greyware	1
1b	Ceramic	Tusayan Greyware	3
1c	Cotton Thread		1
1c	Bead	Ceramic	1
1c	Bone	Unidentified small mammal	2
1d	Reed	Ceremonial item?	2
2	Cotton Thread		1
2	Ceramic	Tusayan Greyware bowl	1
2	Ceramic	Tusayan Polychrome variety b	1
2	Prayer Stick?	Yucca and feather	1
4	Ceremonial item?	Cotton textile with stick	1
4N	Chert	Biface thinning flake	1
4N	Ceramic	Tusayan Greyware	1
4SE	Cotton Thread		2
4SE	Bone	Fragment. Unidentified small mammal	1
4SE	Chert	Shatter	1
4SE	Ceramic	Tusayan Polychrome	1
4SE	Ceramic	Tusayan Polychrome variety b bowl	1
4SE	Sandal Fragment	Yucca	1
4SW	Cotton Thread		2
4SW	Cotton Thread		1
4SW	Bead	Ceramic	1
4SW	Ceramic	Tusayan Greyware jar	1
5.1	Cotton Thread		1
5.1	Chert	Biface thinning flake	1
5.1	Ceramic	Tusayan Greyware Jar	1
5.3	Cotton Thread		1
5.3	Cotton Thread		1
5.3	Ceramic	Tusayan Greyware jar	1
5.3	Ceramic	Tusayan Greyware jar corregated	1
5.3	Ceramic	Tusayan Polychrome	1
5.5	Quid		3
5.5	Cotton Thread		1

5.5	Cotton Thread		1
5.5	Chert	Shatter	4
5.5	Ceramic	Tusayan Greyware corrugated jar	1
5.5	Ceramic	Tusayan Greyware jars	4
5.5	Ceramic	Tusayan Polychrome variety b bowl	1
5.5	Ceramic	Tusayan Polychrome variety b jar	1
5.5	Ceramic	Tusayan Polychrome variety b jar	3
5.5	Unidentified Tool	Wood. Shaped flat end.	1
5.5	Unidentified Tool	Wood. Sharpened end.	1
5.5	Sandal Fragment	Yucca	2
5.5	Knots	Yucca. Unknown use.	4
5.6	Textile Fragment	Cotton	1
5.6	Chert	Shatter	2
5.6	Ceramic	Tusayan Greyware	1
5.6	Ceramic	Tusayan Greyware jar	4
5.6	Ceramic	Tusayan Polychrome	1
5.6	Ceramic	Tusayan Polychrome	2
5.6	Ceramic	Tusayan Whiteware	1
5.6	Prayer Stick?	Yucca and feather	3
5a	Quid		2
5a	Cotton Thread		1
5a	Cotton Thread		1
5a	Textile Fragment	Cotton	1
5a	Chert	Shatter	1
5a	Ceramic	Tusayan Polychrome variety b bowl	1
6	Quid		3
6	Bone	Unidentified small mammal	1
7	Bead	Ceramic	1
9	Ceramic	Tusayan Greyware jar	1
9	Ceramic	Tusayan Polychrome variety b bowl	1

Appendix H:

Domesticate Table for All Provenience Units

Provenience Unit	Taxon	Common Name	Count
1	Zea mays L.	Corn	15
1	Cucurbita L.	Squash	117
1a	Zea mays L.	Corn	8
1a	Cucurbita L.	Squash	30
1a	Gossypium spp.	Cotton	1
1b	Cucurbita L.	Squash	11
1c	Cucurbita L.	Squash	10
1c	Zae mays L.	Corn	8
1d	Cucurbita L.	Squash	4
2	Zea mays L.	Corn	7
2	Cucurbita L.	Squash	98
2	Gossypium spp.	Cotton	2
3	Zea mays L.	Corn	6
3	Cucurbita L.	Squash	68
4	Zea mays L.	Corn	2
4a	Cucurbita L.	Squash	28
4a	Zea mays L.	Corn	15
4a	Gossypium spp.	Cotton	2
4N	Cucurbita L.	Squash	72
4N	Zea mays L.	Corn	6
4N	Gossypium spp.	Cotton	1
4SE	Zea mays L.	Corn	14
4SE	Curcubita L.	Squash	13
4SW	Zea mays L.	Corn	19
4SW	Cucurbita L.	Squash	63
5.1	Zea mays L.	Corn	7
5.1	Cucurbita L.	Squash	71
5.3	Cucurbita L.	Squash	35
5.3	Zea mays L.	Corn	34
5.4	Curcubita L.	Squash	152
5.4	Zea mays L.	Corn	41
5.4	Gossypium spp.	Cotton	2
5.5	Zea mays L.	Corn	33
5.5	Curcubita L.	Squash	46
5.5	Gossypium spp.	Cotton	1
5.6	Cucurbita L.	Squash	7
5.6	Zea mays L.	Corn	12
5a	Zea mays L.	Corn	2
5a	Cucurbita L.	Squash	3
5b	Zea mays L.	Corn	10
5b	Cucurbita L.	Squash	1
7	Cucurbita L.	Squash	1
7a	Cucurbita L.	Squash	1
8	Cucurbita L.	Squash	2
8a	Cucurbita L.	Squash	2
9	Cucurbita L.	Squash	16

9	Zea mays L.	Corn	1

Appendix I:

Wild Species Table for All Provenience Units

Provenience Unit	Taxon	Common Name	Count
1	Sporobolus cryptandrus	Sand Dropseed	288
1	Chenopodium album	Lambsquarter	673
1	Portulaca spp.	Purslane	53
1	Rosaceae	Unknown Rose Family	1
1	Physalis heterophylla Nees	Clammy Groundcherry	746
1	Opuntia	Prickly Pear	3
1	Yucca	Yucca	4
1	Bouteloua curtipendula	Sideoats Grama	72
1	Achnatherum hymenoides	Indian Ricegrass	215
1	Cleome serrulata	Beeweed	60
1	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	236
1	Corispermum L.	Bugseed	179
1	Chenopodium spp.	Goosefoot	14
1	Unidentified_1	Unknown Nutlet	1
1a	Sporobolus cryptandrus	Sand Dropseed	85
1a	Chenopodium album	Lambsquarter	357
1a	Amaranthus spp.	Amaranth	2
1a	Corispermum L.	Bugseed	9
1a	Bouteloua curtipendula	Sideoats Grama	10
1a	Opuntia	Prickly Pear	1
1a	Portulaca spp.	Purslane	20
1a	Chenopodium spp.	Goosefoot	15
1a	Cleome serrulata	Beeweed	3
1a	Achnatherum hymenoides	Indian Ricegrass	60
1a	Physalis heterophylla Nees	Clammy Groundcherry	51
1a	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	17
1a	Fallugia paradoxa	Apache Plume Leaves	1
1b	Portulaca spp.	Purslane	2
1b	Chenopodium album	Lambsquarter	32
1b	Chenopodium spp.	Goosefoot	1
1b	Achnatherum hymenoides	Indian Ricgrass	6
1b	Physalis heterophylla Nees	Clammy Groundcherry	7
1b	Amaranthus spp.	Amaranth	2
1b	Sporobolus cryptandrus	Sand Dropseed	6
1b	Juniperus L.	Juniper Needles	10
1c	Chenopodium spp.	Goosefoot	3
1c	Physalis heterophylla Nees	Clammy Groundcherry	27
1c	Yucca	Yucca	1
1c	Corispermum L.	Bugseed	7
1c	Bouteloua curtipendula	Sideoats Grama	5
1c	Achnatherum hymenoides	Indian Ricegrass	182
1c	Portulaca spp.	Purslane	19
1c	Sphaeralcea L.	Globemallow	1
1c	Amaranthus spp.	Amaranth	2
1c	Sporobolus cryptandrus	Sand Dropseed	120
1c	Chenopodium album	Lambsquarter	766

1c	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	18
1d	Juniperus L.	Juniper Needles	6
1d	Sporobolus cryptandrus	Sand Dropseed	5
1d	Amaranthus spp.	Amaranth	3
1d	Physalis heterophylla Nees	Clammy Groundcherry	1
1d	Achnatherum hymenoides	Indian Ricegrass	5
1d	Chenopodium album	Lambsquarter	28
1d	Portulaca spp.	Purslane	3
1d	Corispermum L.	Bugseed	1
2	Chenopodium album	Lambsquarter	915
2	Amaranthus spp.	Amaranth	23
2	Portulaca spp.	Purslane	18
2	Achnatherum hymenoides	Indian Ricegrass	32
2	Opuntia	Prickly Pear	1
2	Sporobolus cryptandrus	Sand Dropseed	76
2	Chenopodium spp.	Goosefoot	24
2	Physalis heterophylla Nees	Clammy Groundcherry	131
2	Festuca L.	Fescue	4
2	Rhus	Sumac	1
2	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	4
2	Cleome serrulata	Beeweed	5
3	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	33
3	Chenopodium spp.	Goosefoot	7
3	Physalis heterophylla Nees	Clammy Groundcherry	43
3	Sporobolus cryptandrus	Sand Dropseed	139
3	Bouteloua curtipendula	Sideoats Grama	1
3	Achnatherum hymenoides	Indian Ricegrass	29
3	Amaranthus spp.	Amaranth	6
3	Chenopodium album	Lambsquarter	217
3	Cleome serrulata	Beeweed	1
3	Portulaca spp.	Purslane	15
3	Corispermum L.	Bugseed	6
3	Fallugia paradoxa	Apache Plume Leaves	4
4	Pinus Edulis Englem.	Two Needle Pinon Pine Nut	1
4a	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	11
4a	Juniperus L.	Juniper Needles	32
4a	Achnatherum hymenoides	Indian Ricegrass	11
4a	Sporobolus cryptandrus	Sand Dropseed	33
4a	Portulaca spp.	Purslane	23
4a	Amaranthus spp.	Amaranth	8
4a	Bouteloua curtipendula	Sideoats Grama	1
4a	Corispermum L.	Bugseed	4
4a	Cleome serrulata	Beeweed	3
4a	Chenopodium spp.	Goosefoot	43
4a	Chenopodium album	Lambsquarter	31
4a	Physalis heterophylla Nees	Clammy Groundcherry	16
4N	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	18

4N	Achnatherum hymenoides	Indian Ricegrass	21
4N	Amaranthus spp.	Amaranth	12
4N	Chenopodium spp.	Goosefoot	11
4N	Portulaca spp.	Purslane	13
4N	Physalis heterophylla Nees	Clammy Groundcherry	58
4N	Cleome serrulata	Beeweed	12
4N	Bouteloua curtipendula	Sideoats Grama	3
4N	Sporobolus cryptandrus	Sand Dropseed	62
4N	Chenopodium album	Lambsquarter	44
4N	Unidentified_3	Unknown Seed	2
4SE	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	31
4SE	Yucca	Yucca	3
4SE	Physalis heterophylla Nees	Clammy Groundcherry	28
4SE	Achnatherum hymenoides	Indian Ricegrass	54
4SE	Chenopodium album	Lambsquarter	114
4SE	Cleome serrulata	Beeweed	5
4SE	Juniperus monosperma	One Seed Juniper	1
4SE	Opuntia	Prickly Pear	4
4SE	Bouteloua curtipendula	Sideoats Grama	3
4SE	Portulaca spp.	Purslane	7
4SE	Amaranthus spp.	Amaranth	11
4SE	Chenopodium spp.	Goosefoot	16
4SE	Sporobolus cryptandrus	Sand Dropseed	71
4SE	Unidentified_2	Unknown Seed	1
4SE	Unidentified_4	Unknown Nutlet	3
4SE	Unidentified_5	Unknown Nutlet	1
4SW	Amaranthus spp.	Amaranth	10
4SW	Chenopodium spp.	Goosefoot	21
4SW	Opuntia	Prickly Pear	2
4SW	Corispermum L.	Bugseed	7
4SW	Chenopodium album	Lambsquarter	110
4SW	Bouteloua curtipendula	Sideoats Grama	7
4SW	Sporobolus cryptandrus	Sand Dropseed	144
4SW	Achnatherum hymenoides	Indian Ricegrass	68
4SW	Physalis heterophylla Nees	Clammy Groundcherry	46
4SW	Cleome serrulata	Beeweed	1
4SW	Juniperus monosperma	One Seed Juniper	1
4SW	Portulaca spp.	Purslane	15
4SW	Poaceae_1	Unknown Grass	1
4SW	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	21
5.1	Chenopodium album	Lambsquarter	57
5.1	Cleome serrulata	Beeweed	8
5.1	Portulaca spp.	Purslane	5
5.1	Amaranthus spp.	Amaranth	10
5.1	Opuntia	Prickly Pear	1
5.1	Achnatherum hymenoides	Indian Ricegrass	17
5.1	Chenopodium spp.	Goosefoot	15

5.1	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	11
5.1	Corispermum L.	Bugseed	5
5.1	Sporobolus cryptandrus	Sand Dropseed	41
5.1	Physalis heterophylla Nees	Clammy Groundcherry	36
5.1	Bouteloua curtipendula	Sideoats Grama	6
5.3	Bouteloua curtipendula	Sideoats Grama	4
5.3	Chenopodium spp.	Goosefoot	15
5.3	Physalis heterophylla Nees	Clammy Groundcherry	123
5.3	Sporobolus cryptandrus	Sand Dropseed	92
5.3	Achnatherum hymenoides	Indian Ricegrass	74
5.3	Portulaca spp.	Purslane	12
5.3	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	43
5.3	Chenopodium album	Lambsquarter	152
5.3	Cleome serrulata	Beeweed	9
5.3	Opuntia	Prickly Pear	3
5.3	Corispermum L.	Bugseed	6
5.3	Amaranthus spp.	Amaranth	14
5.3	Picea L.	Spruce	2
5.3	Unidentified_6	Unknown Seed	1
5.4	Sphaeralcea L.	Globemallow	2
5.4	Bouteloua curtipendula	Sideoats Grama	2
5.4	Sporobolus cryptandrus	Sand Dropseed	90
5.4	Achnatherum hymenoides	Indian Ricegrass	54
5.4	Portulaca spp.	Purslane	35
5.4	Amaranthus spp.	Amaranth	16
5.4	Corispermum L.	Bugseed	17
5.4	Physalis heterophylla Nees	Clammy Groundcherry	120
5.4	Cleome serrulata	Beeweed	5
5.4	Poaceae_1	Unknown Grass	1
5.4	Opuntia	Prickly Pear	6
5.4	Chenopodium spp.	Goosefoot	34
5.4	Chenopodium album	Lambsquarter	53
5.4	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	1
5.4	Unidentified_7	Unknown Seed	9
5.4	Unidentified_8	Unknown Seed	2
5.5	Achnatherum hymenoides	Indian Ricegrass	815
5.5	Physalis heterophylla Nees	Clammy Groundcherry	588
5.5	Corispermum L.	Bugseed	12
5.5	Chenopodium spp.	Goosefoot	200
5.5	Opuntia	Prickly Pear	6
5.5	Sporobolus cryptandrus	Sand Dropseed	567
5.5	Portulaca spp.	Purslane	50
5.5	Amaranthus spp.	Amaranth	34
5.5	Cleome serrulata	Beeweed	4
5.5	Bouteloua curtipendula	Sideoats Grama	22
5.5	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	9

5.5	Chenopodium album	Lambsquarter	615
5.5	Bouteloua spp.	Grama	3
5.5	Atriplex canescens	Fourwing Saltbush	3
5.5	Picea L.	Spruce	2
7	Corispermum L.	Bugseed	23
7	Sporobolus cryptandrus	Sand Dropseed	4
7	Festuca L.	Fescue	4
7	Physalis heterophylla Nees	Clammy Groundcherry	1
7	Amaranthus L.	Amaranth	8
7	Chenopodium album	Lambsquarter	1
7a	Chenopodium album	Lambsquarter	4
7a	Sporobolus cryptandrus	Sand Dropseed	2
7a	Chenopodium spp.	Goosefoot	3
7a	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	1
7b	Physalis heterophylla Nees	Clammy Groundcherry	1
7b	Chenopodium album	Lambsquarter	2
7b	Portulaca spp.	Purslane	2
7b	Bouteloua spp.	Grama	1
7b	Pinus edulis Engelm.	Two Needle Pinon Pine Nuts	5
7b	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	1
7c	Juniperus L.	Juniper Needles	3
7c	Sporobolus cryptandrus	Sand Dropseed	3
7c	Juniperus L.	Juniper Needles	23
8	Corispermum L.	Bugseed	30
8	Chenopodium spp.	Goosefoot	1
8	Achnatherum hymenoides	Indian Ricegrass	2
8	Physalis heterophylla Nees	Clammy Groundcherry	1
8	Sporobolus cryptandrus	Sand Dropseed	3
8a	Portulaca spp.	Purslane	1
8a	Chenopodium album	Lambsquarter	2
8a	Bouteloua spp.	Grama	1
8a	Bouteloua curtipendula	Sideoats Grama	1
8a	Physalis heterophylla Nees	Clammy Groundcherry	1
8a	Corispermum L.	Bugseed	3
8a	Juniperus L.	Juniper Needles	3
8b	Sporobolus cryptandrus	Sand Dropseed	1
8b	Chenopodium spp.	Goosefoot	1
8b	Physalis heterophylla Nees	Clammy Groundcherry	1
8b	Achnatherum hymenoides	Indian Ricegrass	1
9	Achnatherum hymenoides	Indian Ricegrass	6
9	Physalis heterophylla Nees	Clammy Groundcherry	9
9	Chenopodium album	Lambsquarter	4
9	Chenopodium spp.	Goosefoot	13
9	Portulaca spp.	Purslane	3
9	Pinus edulis Engelm.	Two Needle Pinon Pine Nut	1
9	Amaranthus spp.	Amaranth	1

9	Juniperus L.	Juniper Needles	4
9	Opuntia	Prickly Pear	1
9	Cleome Serrulata	Beeweed	11
9	Sporobolus cryptandrus	Sand Dropseed	19

Appendix J:

Charred Wood Table for All Provenience Units

Provenience Unit	Taxon	Common Name	Count
1	Pinus Edulis Engelm.	Two Needle Pinon Pine	8
1	Unidentified	Unidentified	90
1	Juniperus L.	Juniper	12
1a	Unidentified	Unidentified	39
1a	Quercus Gambelii var. Gambelii	Gambel Oak	1
1a	Pinus Edulis Engelm.	Two Needle Pinon Pine	3
1a	Juniperus L.	Juniper	5
1b	Pinus Edulis Englem.	Two Needle Pinon Pine	2
1b	Juniperus L.	Juniper	1
1b	Salicaceae	Willow Family	1
1b	Unidentified	Unidentified	38
1c	Salicaceae	Willow Family	1
1c	Unidentified	Unidentified	83
1c	Pinus Edulis Engelm.	Two Needle Pinon Pine	7
1c	Juniperus L.	Juniper	5
1d	Unidentified	Unidentified	19
1d	Pinus Edulis Englem.	Two Needle Pinon Pine	1
2	Pinus Edulis Engelm.	Two Neelde Pinon Pine	2
2	Juniperus L.	Juniper	8
2	Quercus Gambelii var. Gambelii	Gambel Oak	3
2	Unidentified	Unidentified	98
3	Juniperus L.	Juniper	4
3	Salicaceae	Willow Family	1
3	Unidentified	Unidentified	10
4a	Salicaceae	Willow Family	1
4a	Unidentified	Unidentified	48
4a	Pinus Edulis Englem.	Two Needle Pinon Pine	4
4a	Juniperus L.	Juniper	5
4N	Quercus Gambelii var. Gambelii	Gambel Oak	5
4N	Salicaceae	Willow Family	3
4N	Pinus Edulis Engelm.	Two Needle Pinon Pine	4
4N	Juniperus L.	Juniper	13
4N	Unidentified	Unidentified	40
4SE	Juniperus L.	Juniper	13
4SE	Quercus Gambelii var. Gambelii	Gambel Oak	2
4SE	Unidentified	Unidentified	57
4SW	Unidentified	Unidentified	48
4SW	Juniperus L.	Juniper	6
5.1	Juniperus L.	Juniper	4
5.1	Unidentified	Unidentified	58
5.1	Pinus Edulis Engelm.	Two Needle Pinon Pine	1
5.3	Juniperus L.	Juniper	11
5.3	Unidentified	Unidentified	106
5.3	Salicaceae	Willow Family	1
5.3	Quercus Gambelii var. Gambelii	Gambel Oak	1

5.3	Pinus Edulis Engelm.	Two Needle Pinon Pine	5
5.4	Pinus Edulis Engelm.	Two Needle Pinon Pine	2
5.4	Salicaceae	Willow Family	1
5.4	Unidentified	Unidentified	83
5.4	Quercus Gambelii var. Gambelii	Gambel Oak	4
5.4	Juniperus L.	Juniper	32
5.5	Juniperus L.	Juniper	21
5.5	Salicaceae	Willow Family	3
5.5	Pinus Edulis Englem.	Two Needle Pinon Pine	4
5.5	Unidentified	Unidentified	213
7	Unidentified	Unidentified	79
7	Juniperus L.	Juniper	7
7	Pinus Edulis Englem.	Two Needle Pinon Pine	3
7a	Juniperus L.	Juniper	1
7a	Unidentified	Unidentified	12
7b	Pinus Edulis Englem.	Two Needle Pinon Pine	2
7b	Unidentified	Unidentified	8
7c	Juniperus L.	Juniper	1
7c	Unidentified	Unidentified	6
8	Juniperus L.	Juniper	9
8	Unidentified	Unidentified	179
8	Pinus Edulis Englem.	Two Needle Pinon Pine	3
8	Quercus Gambelii var. Gambelii	Gambel Oak	1
8	Salicaceae	Willow Family	1
8a	Pinus Edulis Englem.	Two Needle Pinon Pine	1
8a	Unidentified	Unidentified	5
8a	Juniperus L.	Juniper	1
8b	Unidentified	Unidentified	4
8b	Juniperus L.	Juniper	2
8b	Pinus Edulis Englem.	Two Needle Pinon Pine	1
9	Unidentified	Unidentified	17
9	Juniperus L.	Juniper	3
9	Quercus Gambelii var. Gambelii	Gambel Oak	1

Appendix K:

Corn Morphology Table for All Provenience Units

Provenience Unit	Artifact Type	Row Number	Number of Husks	Cob Length (mm)	Cob Diameter (mm)	Rachis Diameter (mm)	Kernel Width (mm)	Kernel Thickness (mm)	Kernel Length (mm)	Cupule Width (mm)	Rachis Segment Length (mm)	Cupule Depth (mm)
1	Cob	10	0	65	15	9	0	0	0	5	6	4
1	Cob	10	0	32	19	12	0	0	0	5	2	2
1	Cob	10	0	40	15	11	0	0	0	5	2	2
1	Cob	10	0	0	10	7	0	0	0	4	2	2
1	Cob_Fragment	0	0	0	7	3	0	0	0	2	2	2
1	Cob_Fragment	0	0	0	0	0	0	0	0	3	3	3
1	Cob_Fragment	10	0	0	7	3	0	0	0	3	3	3
1	Cob_Fragment	8	0	0	10	7	0	0	0	4	2	2
1	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	2
1	Cob_Fragment	8	0	0	7	6	0	0	0	5	3	2
1	Husk	0	1	0	0	0	0	0	0	0	0	0
1	Kernel	0	0	0	0	0	7	4	9	0	0	0
1a	Cob_Fragment	6	0	24	15	11	0	0	0	6	4	3
1a	Husk	0	6	0	0	0	0	0	0	0	0	0
1a	Kernel	0	0	0	0	0	5	2	6	0	0	0
1c	Husk	0	4	0	0	0	0	0	0	0	0	0
2	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
2	Cob_Fragment	0	0	0	0	0	0	0	0	3	0	2
2	Cob_Fragment	0	0	0	0	0	0	0	0	3	0	2
2	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	3
2	Husk	0	3	0	0	0	0	0	0	0	0	0
3	Cob_Fragment	0	0	0	0	0	0	0	0	5	3	3
3	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	3
3	Kernel	0	0	0	0	0	4	2	4	0	0	0
3	Kernel	0	0	0	0	0	4	2	4	0	0	0
4	Kernel	0	0	0	0	0	0	0	0	0	0	0
4	Kernel	0	0	0	0	10	10	5	0	0	0	0
4a	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	1
4a	Husk	0	8	0	0	0	0	0	0	0	0	0
4a	Kernel	0	0	0	0	0	4	1	6	0	0	0
4a	Kernel	0	0	0	0	0	3	3	5	0	0	0

4a	Kernel	0	0	0	0	0	5	2	6	0	0	0
4a	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4a	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4a	Kernel_Fragment	0	0	0	0	0	0	3	5			
4N	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4N	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4N	Husk	0	1	0	0	0	0	0	0	0	0	0
4N	Kernel	0	0	0	0	0	4	1	5	0	0	0
4N	Kernel	0	0	0	0	0	3	1	4	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SE	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3
4SE	Husk	0	6	0	0	0	0	0	0	0	0	0
4SE	Kernel	0	0	0	0	0	7	5	7	0	0	0
4SE	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SW	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
4SW	Husk	0	3	0	0	0	0	0	0	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	5	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	7	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	4	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	4	0	0	0
4SW	Kernel	0	0	0	0	0	4	2	5	0	0	0
4SW	Kernel	0	0	0	0	0	3	2	4	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	4	0	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	3	2	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
4SW	Kernel_Fragment	0	0	0	0	0	3	2	0	0	0	0
5.1	Cob_Fragment	0	0	0	0	0	0	0	0	6	2	2
5.1	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	2
5.1	Husk	0	2	0	0	0	0	0	0	0	0	0
5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0

5.1	Kernel_Fragment	0	0	0	0	0	0	2	0	0	0	0
5.3	Cob	10	0	90	17	11	0	0	0	6	2	4
5.3	Cob	8	0	0	7	4	0	0	0	4	2	2
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	2
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	4	2	4
5.3	Cob_Fragment	14	0	0	17	9	0	0	0	3	2	1
5.3	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Husk	0	1	0	0	0	0	0	0	0	0	0
5.3	Kernel	0	0	0	0	0	5	1	5	0	0	0
5.3	Kernel	0	0	0	0	0	4	1	4	0	0	0
5.3	Kernel	0	0	0	0	0	3	1	5	0	0	0
5.3	Kernel	0	0	0	0	0	4	1	5	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	1	8	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	7	1	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	1	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	3	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0

5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.3	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	5	3	4
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	4	2	2
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	4	0	3
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Husk	0	6	0	0	0	0	0	0	0	0	0
5.4	Kernel	0	0	0	0	0	3	1	4	0	0	0
5.4	Kernel	0	0	0	0	0	4	2	5	0	0	0
5.4	Kernel	0	0	0	0	0	4	3	5	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	1	4	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0

5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.4	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob	10	0	90	15	10	0	0	0	6	3	3
5.5	Cob	18	0	75	18	13	0	0	0	5	2	3
5.5	Cob	12	0	90	15	11	0	0	0	4	3	2
5.5	Cob	8	0	45	13	9	0	0	0	3	2	1
5.5	Cob	10	0	55	10	7	0	0	0	3	2	2
5.5	Cob	10	0	70	13	10	0	0	0	6	2	2
5.5	Cob_Fragment	0	0	0	0	11	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	12	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	12	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	2
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	1
5.5	Cob_Fragment	8	0	30	17	9	0	0	0	4	2	4
5.5	Cob_Fragment	14	0	0	7	3	0	0	0	4	2	2
5.5	Cob_Fragment	0	0	0	0	3	0	0	0	3	0	2
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	10	0	0	8	3	0	0	0	4	3	4
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	3
5.5	Cob_Fragment	12	0	0	9	7	0	0	0	5	3	3
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	5	0	3
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	3	2	2
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Cob_Fragment	0	0	0	0	0	0	0	0	0	0	0

5.5	Husk	0	2	0	0	0	0	0	0	0	0	0
5.5	Kernel	0	0	0	0	0	6	5	7	0	0	0
5.5	Kernel	0	0	0	0	0	4	2	6	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.5	Kernel_Fragment	0	0	0	0	0	0	0	0	0	0	0
5.6	Cob_Fragment	0	0	0	0	0	0	0	0	4	3	3
5.6	Cob_Fragment	8	0	0	10	7	0	0	0	4	2	2
5.6	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	3
5.6	Cob_Fragment	10	0	0	12	7	0	0	0	4	2	3
5.6	Cob_Fragment	0	0	0	0	0	0	0	0	5	2	2
5.6	Cob_Fragment	10	0	0	6	4	0	0	0	4	3	3
5.6	Cob_Fragment	8	0	0	7	3	0	0	0	4	3	3
5.6	Cob_Fragment	10	0	0	12	7	0	0	0	4	3	2
5.6	Cob_Fragment	8	0	0	6	4	0	0	0	4	3	2
5a	Cob	10	0	7	11	4	0	0	0	4	2	2
5a	Cob	12	0	8	10	4	0	0	0	4	2	3
5a	Kernel_Fragment	0	0	0	0	0	4	3	0	0	0	0
5a	Kernel_Fragment	0	0	0	0	0	0	2	5	0	0	0
5b	Cob_Fragment	0	0	0	13	10	0	0	0	6	3	3
5b	Cob_Fragment	0	0	0	0	0	0	0	0	4	2	2
5b	Cob_Fragment	0	0	0	10	7	0	0	0	5	2	2
5b	Cob_Fragment	0	0	0	0	3	0	0	0	4	3	2
5b	Cob_Fragment	0	0	0	10	7	0	0	0	5	2	2
5b	Husk	0	4	0	0	0	0	0	0	0	0	0
5b	Kernel_Fragment	0	0	0	0	0	5	3	0	0	0	0
9	Cob_Fragment	0	0	0	13	9	0	0	0	4	2	2

Appendix L:

Provenience Unit Designations and Volume

Provenience Unit	Volume (L)	Comments
1	13	
1a	1	
1b	0.3	
1c	1	
1d	0.22	
2	1.5	
3	1	
4a	0.2	Renamed 4N, portion taken out before redesignated
4b	0.5	Broken into 4SE and 4SW
4N	3	
4SE	3	
4SW	1	
5.1(5a1)	2	
5.2(5a2)	3	
5.3(5a3)	3	
5.4(5a4)	2	
5.5(5bN)	22	
5.6(5bS)	7	
6	3	
7	0.5	
7a	0.18	
7b	0.18	
7c	0.09	
8	0.2	
8a	0.18	
8b	0.06	
9	0.25	