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Macrobotanical Evidence of Diet and Plant Use at Wolf Village (42UT273), Utah Valley, Utah.

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A thesis submitted to the faculty of
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ABSTRACT

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Farming played a role in the subsistence base for the Fremont culture, but there is no consensus as to how significant that role was. Maize is consistently found in Fremont sites, but evidence of wild plant use is also abundant. The use of both domesticates and foraged plants by the Fremont, combined with the diversity of the landscape and sites that were inhabited by the Fremont, contributes to the diversity of theories on Fremont subsistence. This thesis examines evidence for plant usage at Wolf Village, a Fremont site in Utah Valley. Wolf Village is ideally situated for a Fremont farming village. Maize, beans, and wild plant remains were all recovered in the excavation process. In order to better understand the basis of Fremont subsistence there, further research is needed, however, into the economic importance of both the domesticates and the foraged plants, how the foraged foods may have contributed to the subsistence base, and whether the foraged plants were complimentary to a farming lifestyle. The information on plant use at Wolf Village should contribute to a better understanding of Fremont subsistence.

Keywords: Native Americans, Utah, Fremont, Wolf Village, diet and plant use

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1 Introduction

The Fremont culture disappeared from the horizon after a period of prolonged drought at approximately the same time period as the Pueblo people abandoned their northern territories on the Colorado Plateau and the southern portion of Utah and the Arizona strip. The Pueblo people left an artifact trail that could be traced, linking them to cultures that persist into modern times, and providing an ethnographic record that could be accessed to provide insight into their past and confirm a farming lifestyle as the basis of their subsistence. While the artifacts the Fremont left behind are distinctive and help define them as a culture, they do not provide clues as to where the Fremont went after abandoning their traditional territory, nor do they definitively answer questions on their subsistence base.

The Fremont people lived in the Eastern Great Basin from A.D. 400 to approximately A.D. 1300. They inhabited the region that is now the state of Utah as far south as the Colorado, Escalante, and Virgin rivers, along with portions of eastern Nevada, southern Idaho, and western Colorado. Half of the Fremont territory lies within the Great Basin and the other half is located within the Colorado Plateau. Elevations range from 3,000 ft. to over 12,000 ft. (Marwitt 1986). The area has a substantial amount of diversity in climate, rainfall amounts, vegetation and terrain. The diversity of the landscape they inhabited, and the presence of sites that include rock shelters, caves, and village sites located near marsh resources or perennial sources of water, combined with the presence of both domesticated plant remains and wild plant remains have contributed to the diversity of the theoretical viewpoints. Farming played a role in their subsistence, but to what extent? What portion of their diet and plant use could be attributed to foraging for wild plants?

Initially the Fremont people were viewed as farmers with ties to the southwest, because corn was consistently found in the archaeological sites. Differences in artifacts between the Fremont and the Pueblo people however, led researchers to define the Fremont as a separate cultural entity. The focus in Great Basin archaeology has changed over time, and different theories have been presented that reflect the different perspectives. Different theoretical viewpoints have portrayed the Fremont as a culture practicing a mixed farming/foraging strategy, as a culture with the ability to adapt their subsistence base to whatever environment they were occupying, and occupation of the region during this time period by both Fremont farmers and hunter/gatherer groups. Currently, the most commonly accepted model of Fremont subsistence is that of a mixed farming/foraging strategy.

The challenge with the definition of mixed farming/foraging is that a review of the subsistence base for any culture that inhabited the North American continent in the past would reveal that foraging was a common practice for all of them, including the farming cultures of the southwest. It is not enough to know that wild foods were incorporated into the diet of a particular culture. What is relevant is the economic importance of the plants they were using.

The question of Fremont subsistence can be resolved with further research, but the research needs to include a better understanding of the different plants used by the Fremont, both cultivated and wild. How many types of maize were grown? Was there evidence for beans and squash or other domesticates? What seasons were the wild plants they chose to incorporate into their subsistence base available in, and how did they contribute to the subsistence base? Were they medicinal or dietary? Were the foraged plants available in the local environment, or did they have to travel to obtain them?

It is hoped that the macrobotanical research done for Wolf Village will contribute to an understanding of Fremont subsistence. The focus of research for this thesis will be the subsistence base at Wolf Village, and whether the Fremont inhabitants of Wolf Village were dedicated farmers, incorporating wild plant foods into their subsistence base to provide variety, and supplement their diets at times when food reserves from farming may have been low.

It will be essential to determine the economic importance of the different plants recovered to answer this question. In order to determine this, the plants that are identified from the flotation analysis will be researched as to how they may have contributed to the subsistence base. Ethnographic literature will be consulted to gain insight into how each of the identified plants was used in the past by indigenous cultures. Ethnographic sources also provide information on the season the plant was used in. Comparative data will be consulted to determine whether or not the plants could have been found locally, or if travel was required to obtain them. The information on wild plants identified in the analysis process will be contrasted with the evidence obtained for a farming subsistence base. Part of the analysis will involve documenting how much corn was recovered, and where it was recovered from, as well as how many types of maize were found. Evidence of any other domesticated plants will also be included.

Wolf Village

Wolf Village, 42UT273, is located directly north of the mouth of Goshen Canyon on private land owned by the Wolf family (Figure 1). The Wolf family has collected artifacts from the site, so they were aware that it had been inhabited by Native Americans in the past. The site is located on low hills and ridges populated by both native and introduced grasses and plants, as well as juniper, sagebrush, greasewood, and rabbitbrush. This area is currently used for grazing cattle. The fields surrounding the site where the Fremont would have farmed, are now alfalfa fields.

In 1966, Leland Gilson (1968) conducted a survey of Goshen Valley to document sites, focusing on land adjacent to Currant and Kimball Creeks. He reported finding numerous sites along the Currant Creek drainage, the upper Kimball Creek drainage, and dune areas in the valley proper. Wolf Village was the largest of the sites recorded by Gilsen. Gilsen identified concentrations of

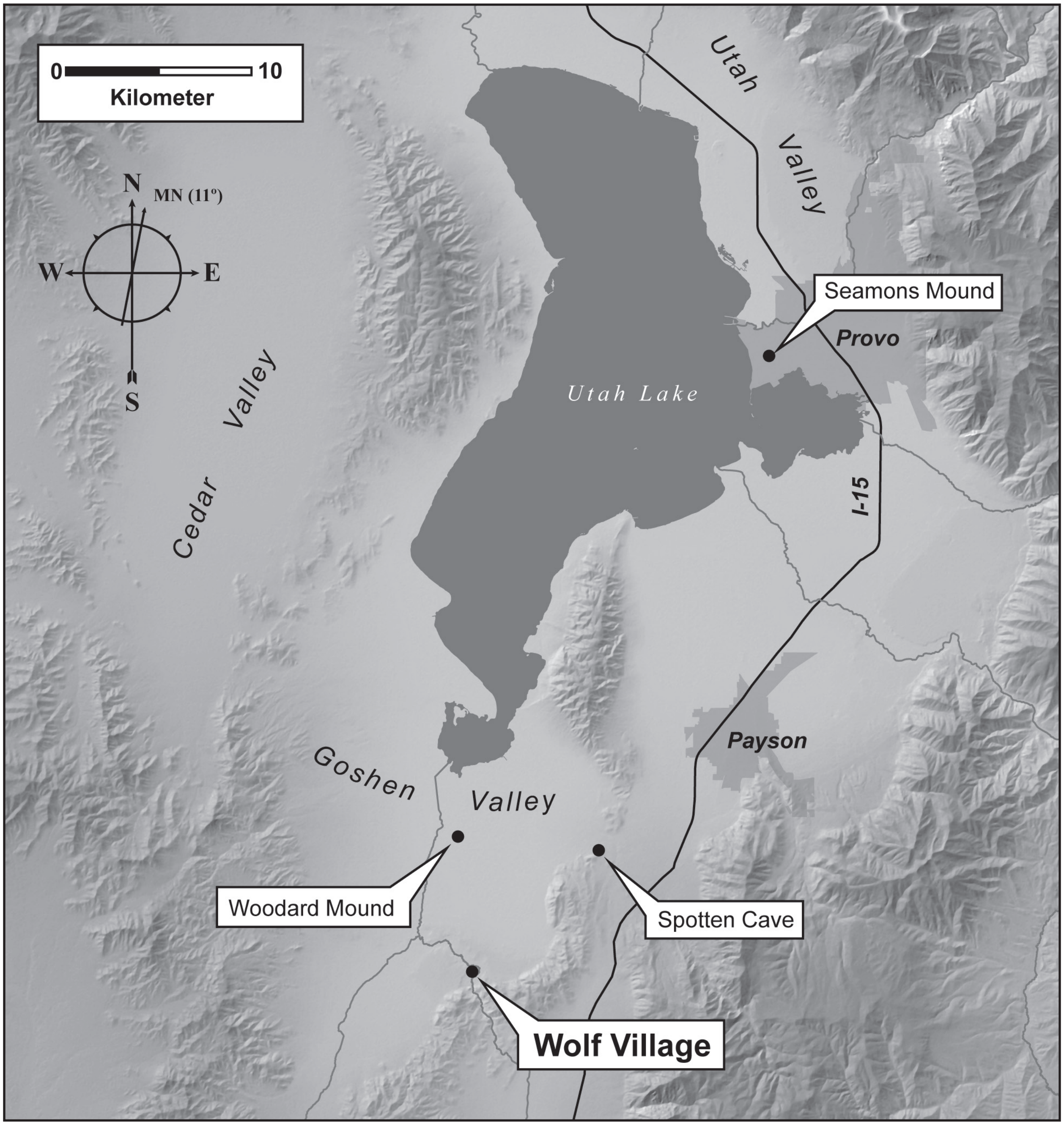

Figure 1. Location of Wolf Village in relation to other Fremont sites mentioned in the text.

artifacts and chunks of burned adobe that he interpreted as representing thirteen structures at the Wolf Village site.

The first archaeological excavations at Wolf Village took place in 2009 when the Brigham Young University archaeological field school excavated at both Seamons Mound in the Provo, Utah area, and at Wolf Village, under the direction of Joel C. Janetski. Subsequent excavations at Wolf Village by the field school were conducted under the direction of James R Allison in 2010 and 2011, and one more season of excavation is planned for 2012.

As of the end of the 2011 excavation season, two above ground adobe structures, and four pithouses have been fully excavated. The perimeters of an unusually large pit structure have been defined, with test trenches running through the center. This structure will be the focus of the 2012 excavation season. While testing for additional structures, three extramural pits were located and excavated. Figure 2 is a site map of Wolf Village showing the location of each of the structures and extramural pits that were excavated. Structures 1 and 6 are above ground adobe structures, Structure 2 is the unusually large pit structure, and Structures 3, 4, 5 and 7 are pithouses.

Soil chemistry analysis studies were conducted during the 2010 year by Laura Pyper, a graduate student from Brigham Young University in Soil Science, to define the site dimensions, locate areas of increased chemical concentrations, and evaluate those concentrations to determine correlations between the concentrations and possible activities (Pyper 2011). The results from this study will be used to help identify possible areas for future excavations. Soil samples were also taken from the modern fields surrounding the site. That research is still in process, but some of the samples that have been analyzed show evidence of a C4 signature in the fields, indicating areas where corn might have been grown by the inhabitants of Wolf Village (Richard Terry, personal conversation 2011).

Radiocarbon dates from the maize recovered during excavation at Wolf Village suggest all the excavated structures probably date to the A.D. 1000's, but also indicate some were in use as early as the late A.D. 600's, placing the site well within the Fremont culture time period. Dendrochronological samples will be sent to a tree ring lab for dating that may provide more information as to the length of time that Wolf Village was occupied. The Fremont inhabited the Eastern Great Basin from A.D. 400 to approximately A.D. 1300.

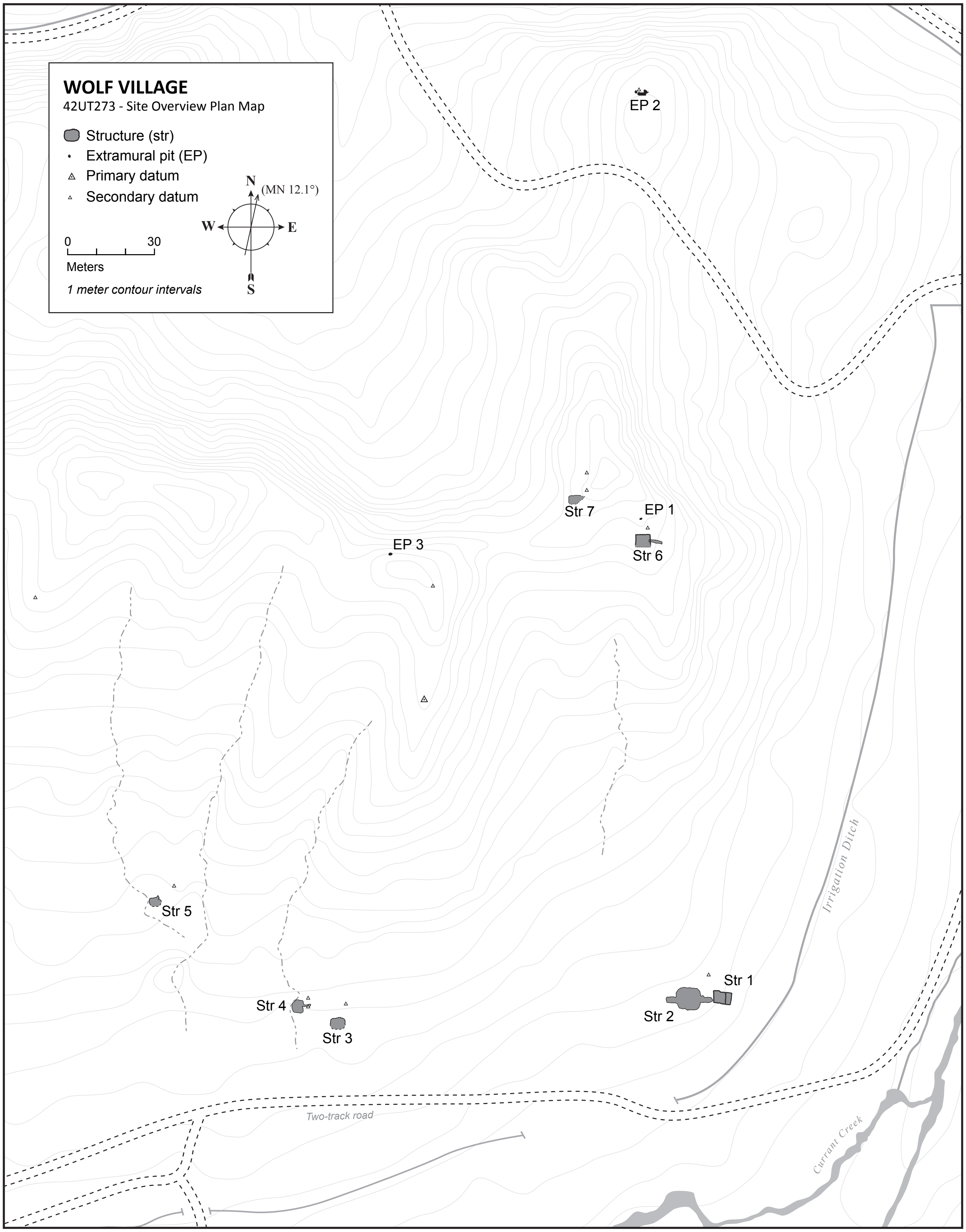

Figure 2. Plan map for Wolf Village showing the location of the different structures.

Wolf Village is an important site for multiple reasons. The large pit structure is unusual for a Fremont site and may have been a communal structure. Wolf Village is also the only well documented Fremont site in Utah County that has adobe surface structures. To date, very few Fremont village sites have been extensively excavated. Many of the Fremont village sites are located under modern towns and cities as the Fremont chose to locate their villages next to reliable water sources on land suitable for farming, just as the white settlers coming into the valleys did (Judd 1926, Malouf 1944). Consequently, much information has been lost for village sites. Five Finger Ridge is the only Fremont Village that has been fully excavated. The information gleaned from the archaeological excavations at Wolf Village can contribute to an understanding of Fremont village life.

Thesis organization

An understanding of the environment and what plants may have been found in the vicinity of Wolf Village will be important in answering subsistence questions. Information will be presented from two pollen studies that were done. One of the pollen reports comes from analysis done on groundstone from Wolf Village, and provides insight into what plants were in the area during the time the Fremont lived there. The other pollen report comes from an excavation site in the vicinity of Wolf Village with evidence of a long period of occupation. Several sources were researched to glean information on what plants were native to the area, and what the environment was like when early explorers and settlers first came into the valley.

A review of Fremont subsistence theories will follow, along with information on the role that culture plays in food choices. Culture is a part of what determines the food choices people are oriented towards, and a knowledge base of how to obtain, and process the preferred foods. This aspect of subsistence has not been addressed for the Fremont culture. The cultural aspect of Fremont subsistence is more difficult to get at, particularly when there are no ethnographic accounts to refer to, and no known living descendants. Evidence of cultural preference can be gleaned from the results of flotation analysis done for different sites, when the information is combined to see if there is a consistency in plant usage. In preparation for this thesis, the results from nineteen Fremont sites with flotation analysis results were compiled to gain insight into plant usage, and allow me to familiarize myself with those plants. Those results are included, along with phytolith analysis from a Fremont burial.

A description of the research design will be included, followed by the results of the analysis. The results will be presented by structure or excavation area first, then combined for the site, and a determination will be made as to whether or not the inhabitants of Wolf Village were relying on farming to provide the mainstay of their subsistence needs over a mixed farming/foraging strategy.

2 | Environment

When studying the subsistence strategy of a past culture, it is beneficial to understand what the environment was like during the time period being studied. Environment plays a large role in how different cultures structure their lifestyle, seasonal activities, subsistence, and daily activities. In an attempt to discover what the environment may have been like when the Fremont occupied Wolf Village, I have compiled information from several sources. I was unable to locate any pollen reports that would provide information on the Goshen environment from AD 840 to 1000, other than the results of a pollen study from groundstone found at Wolf Village, and a pollen study that was done at Spotten Cave, a nearby cave that was occupied for a substantial time period. The pollen reports from both sites will be described below. Reports made by early explorers and settlers that entered Utah Valley when it was still occupied by Native Americans contribute to a sense of what plants were found in the area, and what the condition of the region was. I have included tables listing the native plants that were identified from around Spotten Cave, along with information on native and introduced plants collected from the Wolf Village site. Information on the environment and native versus introduced plants from two environmental studies done for Utah Valley are also included.

The location of Wolf Village is well suited for a Fremont farming village. A perennial source of water flows through flat lands that could be used for cultivation. The site has a center section of low lying knolls and ridges where the habitation structures were located. The ridges and knolls provide a view of the area around them that would have allowed the inhabitants to see anyone approaching. Marsh resources are associated with Utah Lake, and may have been found closer to the site depending on whether they were experiencing wet or dry years. There were mountainous areas nearby where large game would have been available.

Climate

Goshen is located in an arid region. Much of the moist air from the Pacific Ocean must cross the Sierra Nevada's, and the Cascade Range before it reaches the Great Basin. As the moist air rises, much of it falls as precipitation. When the westerly air currents reach the Great Basin, they are relatively dry, and result in light precipitation over the area. The area around Goshen averages 10 to 15 inches of precipitation per year in historical times, making irrigation a necessity for most forms of agriculture. The chief source of moisture for the valleys comes from the snow that accumulates in the mountains in the winter, and enters the valleys as spring runoff, providing sufficient water for irrigation from the rivers and streams. Spring runoff normally peaks in April, May, or early June. Snowfall is moderately heavy in the mountains, but deep snow does not often remain long on the ground in the valleys. There are four and a half to five months of freeze-free growing time in the principal agricultural areas of the state. Summer months experience high temperatures, low rainfall, and high evaporation (Western Regional Climate Center 2011, Wakefield1933)

Reports from Early Explorers and Settlers

The earliest written accounts of the Utah Valley environment and plant life come from reports written by the early explorers who entered Utah Valley when it was occupied by Native Americans and from the first settlers who came in to the valley looking for fertile areas that would support colonization. Native plants still flourished at that time, and explorers and settlers often made mention of what plants were found in their reports or diaries. Escalante (1792) was the first white man who left a written record of what Utah Valley was like. He described wide meadows, abundant pastures, and marsh communities adjacent to the shores of Utah Lake. He also mentioned a prevalence of poplars, willow, flax, and hemp along the streams.

Kane (1831) described the beauty and fertility of Utah Valley as being unequaled as a stock raising country. He made particular mention of the lush grasses that were found in the area. Another pioneer exploration group camped at Kimball Creek. Kimball Creek flows into Currant Creek a couple of miles past the Wolf Village site. Bullock (1849) was in the party, and commented in his journal that the banks of Utah Lake were fringed with cane and tall grass for several rods.

The early settlers from Goshen Valley often made mention of the native plants that were in the areas that they settled, and traveled through. Jensen's (1957) history of Goshen Valley mentions numerous plants that were native to the area. Pinyon pine and cottonwood grew in canyons west and southwest of the town of Goshen. Cattail was abundant in the marshy areas. Other plants mentioned in Jensen's book included wild fruit available from the canyons such as currants, chokecherry, elderberry, and squawberry. Groundcherries were abundant throughout the fields. Other edible plants that were mentioned were wild spinach, wild lettuce, sheep sorrel, thistle, greasewood sprouts, pigweed, sego roots, wild mustard, and milkweed.

Steele (1960:1) includes an account of Phineas Cook, one of the founders of Goshen, and his perception of the Goshen valley as they crossed it for the first time. Cook described one of the meadows he observed as being "about five miles long and a mile wide, and was watered by a fairly large creek of water which entered the valley from the south and was fed by some springs and the melting snow on the high mountains in the distance." Steele stated that the explorers must have also been impressed with the rich, loamy black soil that was found in large areas throughout the valley. The description of the meadow area, may not be the exact location of Wolf Village, but is descriptive of the site's setting.

Spotten Cave

Spotten Cave is also located in Goshen Valley, three miles west of the modern town of Santaquin.

The cave was well know to the inhabitants of Goshen, and referred to as Indian Cave. James Mock excavated the cave as a graduate student at Brigham Young University. The excavations revealed that the cave had been occupied for an extensive time period, with inhabitants ranging from the Archaic people who inhabited the Great Basin from approximately 8000 B.C. to A.D. 400, the Fremont, ranging from about A.D. 400 to A.D. 1300, and Late Prehistoric Native Americans, who occupied the Great Basin after the Fremont up to the time of contact with European settlers. Artifacts and introduced plant remains from European settlers were found in the cave along with evidence of use by the earlier groups. Pollen studies from the cave show that pine was prevalent for the earlier levels of the cave, indicating the environment experienced a higher moisture level. Pine became insignificant as the moisture levels dropped and grasses became more prevalent. The last transition as evidenced by the pollen indicated that the cheno-ams became much more prevalent. (James Mock excavation notes, 2008 MS 043.02.02, Museum of Peoples and Cultures, Brigham Young University, Provo).

Tables 1, 2, and 3 list the different plants that were identified for the Spotten Cave area at the time it was excavated. The information was found in Mock's excavation notes (2008 MS 043.02.01, Museum of Peoples and Cultures, Brigham Young University, Provo).

Jess Bushman and Stan Welsh identified the plants at Spotten Cave and in the vicinity. Sam Rushforth identified additional plants from playa and other areas around Spotten Cave. The tables provide valuable information as to the native plant species were found in the area around Goshen that may have also been present a thousand years ago.

Modern Vegetation Studies

Brotherson (1982) undertook a study for the Bureau of Reclamation to identify, map and describe the terrestrial vegetation that grows around Utah Lake. He documented both native plants and introduced or invasive plants and compared the plant communities that now exist around Utah

Table 1. Native Plants Identified in the Vicinity of Spotten Cave by Bushman and Welsh

Family name	Species/genus	Common name
Asclepias	*Asclepias speciosa*	Milkweed
Boraginaceae	*Hackelia micrantha*	Jessica's stickseed
Brassicaceae	*Camelina microcarpa*	False flax
Chenopodiaceae	*Atriplex canescens*	Fourwing saltbush
Asteraceae	*Artemisia cana? Pursh*	Sagebrush
	Artemisia ludoviciana	Sagebrush, Wormwood
	Artemisia tridentata	Big sagebrush
	Aster chilensis ssp. Ascendens	Aster
	Aster ericoides	Aster
	Chaenactis douglasii	Douglas' dusty-maiden
	Chrysothamnus nauseosus	Rabbitbrush
	Cirsium undulatum	Thistle
	Crepis sp. L.	Hawksbeard
	Grindelia squarrosa	Gumweed
	Gutierrezia sarothrae	Snakeweed
Cupressaceae	*Juniperus osteosperma*	Utah juniper
Cyperaceae	*Scirpus olneyi (americanus?)*	Bulrush
Leguminosa	*Astragalus eurekensis*	Milkvetch
	Astragalus utahensis	Milkvetch
Liliaceae	*Calochortus nuttallii*	Segolily
	Zygadenus paniculatis	Death camas
Malvaceae	*Sphaeralcea coccinea*	Globemallow
Poaceae	*Agropyron spicatum*	Bluebunch wheatgrass
	Erodium cicutarium	Storksbill
	Elymus elymoides	Squirrel tail
Rosaceae	*Purshia mexicana*	Cliffrose
Salicaceae	*Salix amygdaloides*	Peach leaf willow
Scrophulariaceae	*Castilleja chromosa*	Indian paintbrush

Table 2. Native Plants from the Vicinity of Spotten Cave identified by Rushforth

Family	Genus/species	Common Name
Asteraceae	*Townsendia sp.*	Townsendia
Cyperaceae	*Carex sp.*	Sedge
Lilliaceae	*Allium sp.*	Wild onion
Papaveraceae	*Argemone sp.*	Prickly poppy
Poaceae	*Hordeum jubatum*	Foxtail barley
Polemoniaceae	*Phlox longifolia*	Longleaf phlox

Table 3. Native plants from Playa in the Vicinity of Spotten Cave identified by Rushforth

Family	Genus/species	Common Plants
Asteraceae	*Brickellia scabra*	Rough brickelbush
	Iva axillaris sp.	Poverty weed
	Iva xanthifolia	Marsh-elder
	Lygodesmia grandiflora	Showy rushpink
	Tetradymia spinosa	Thorny horsebrush
Alismataceae	*Triglochin maritima*	Martime arrowgrass
Boraginaceae	*Cryptantha flavoculata?*	Yellow-eye cryptanth
Brassicaceae	*Rorippa nasturtium-aquaticum*	Watercress
Chenopodiaceae	*Atriplex confertifolia*	Shadscale
	Atriplex falcata	Jones' saltbush
	Bassia americana	Gray molly
	Salicornia virginica	Pickleweed
	Suaeda sp.	Seablite
Asteraceae	*Brickellia scabra*	Rough brickellbush
	Iva axillaris sp.	Poverty weed
	Iva xanthifolia	Marsh-elder
	Lygodesmia grandiflora	Showy rushpink
	Tetradymia spinosa	Thorny horsebrush
Cyperaceae	*Eleocharis sp.*	Spikerush
Loaceae	*Mentzelia laevicaulus*	Beautiful blazingstar
Poaceae	*Distichlis spicata*	Desert saltgrass
	Sporobolus airoides	Dropseed
Polemoniaceae	*Leptodactylon pungens*	Pungent slenderlobe
Polygonaceae	*Polygonum aviculare*	Knotweed
Primulaceae	*Glaux maritima*	Sea milkwort
Umbelliferaceae	*Berula erecta*	Cutleaf water-parsnip

Lake to those that would have been in the area prior to European settlement. Brotherson (1982:7–9) pointed out that several of the introduced plant species are now prevalent enough to affect the plant communities they have invaded. Cheatgrass, burbuttercup, halogetan, and russian thistle have been very successful in invading the sagebrush, greasewood, and shadscale communities. Cheatgrass, halogetan, and russian thistle are all found at the Wolf Village site as well as saltcedar, another invasive plant.

Wolf Village Plant Information

Preparation for this thesis included an effort to document the plant community that now exists at Wolf Village. Plants were collected from Wolf Village during the early summer months, the summer, and again in the fall. Stan Welsh identified the first set of plants that were collected. I identified the remaining plants after completing a plant identification class taught at Brigham Young University. Tables 4 and 5 are not all inclusive of what is currently growing, but list those that were identified and represent a good sampling of what is now at the site. At least four to five species of grasses now grow at the site including cheat grass and rye grass, both of which were introduced. Indian ricegrass is native and is currently found at the site, although it is sparse in comparison to the other grasses that cover the site. Other grasses were not identified.

While the environment may be very similar to what it was like during Fremont times as far as climate is concerned, the early accounts indicate that the plant communities have changed. Many of the native plants are still present, but not as abundantly as in the past, and introduced plants are now common. The cheat grass and rye grass seem to have all but replaced the native grasses. The native meadows are now under cultivation for alfalfa or other crops. Fortunately, we do have the early accounts to gain some insight into what it was like in the past. Past accounts paint a picture of lush grasses and abundant marsh resources.

Plant community

Plant community provides an idea of what ecosystem different plants grow in and will be a source of valuable information when determining what ecosystems the Fremont were foraging from. Welsh et al (2008) provides a description of plant communities that are found within the Great Basin. Plant communities found near Wolf Village, and the major plants that characterize these communities include:

Table 4. Native Species Collected from Wolf Village

Genus/species	Common Name
Allium textile	Textile onion
Artemisia tridentata	Big or Common sagebrush
Atriplex confertifolia	Shadscale saltbush
Bassia americana	Gray molly
Calochortus nuttallii	Segolily
Castilleja sp.	Indian paintbrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Grindelia squarrosa	Curly gumweed
Helianthus anuus	Common sunflower
Helianthella uniflora	One-headed sunflower
Juniperus osteoperma	Utah juniper
Machaeranthera canescens	Hoary aster
Opuntia polyacantha	Central prickly pear
Rhus aromatica trilobata	Skunkbush
Salix exigua sp.	Sandbar willow
Sarcobatus vermiculatus	Greasewood
Sphaeralcea coccinea	Common globemallow
Stipa hymenoides	Indian ricegrass

Table 5. Introduced or Cultivated Plants Collected from Wolf Village

Genus/species	Common Name
Anthemis cotula L	Mayweed
Bromus tectorum	Cheat grass
Chenopodium berlandieri	Netseed lambsquarter
Chorispora tenella	Blue mustard
Lepidium perfoliatum	Clasping pepperweed
Marrubium vulgare	White horehound
Populus alba	White poplar
Rubia tinctoria	Madder
Rosa woodsii	Wood's rose
Secale cereale	Cultivated rye
Sisymbrium altissimum	Tumbling mustard
Tamarix genesis	Salt-cedar
Taraxacum officinale	Dandelion
Tribulus terrestris L	Puncture vine

Salt desert shrub

Shadscale, mat saltbush, siltbush, greasewood, sweepweed, *ephedra sp.*, *Eriogonum corymbosum*, enceliopsis, zuckia, salt grass, arctic rush, and other salt tolerant species. Saline valleys, and geological strata, mainly at lower elevations are occupied by this community type, which is well developed over vast areas of both the eastern and the western portions of Utah.

Riparian communities

Cottonwood, birch, alder, box elder, red-osier dogwood, horsetail, willow, tamarix, Russian olive, Siberian Elm, *Forestiera*, rabbitbrush, greasewood, common reed, saltgrass, Nebraska sedge, and arctic rush. Riparian communities occur at practically all elevations in Utah, the composition varying with elevation.

Cool desert shrub

Big sagebrush, black sagebrush, winterfat, rabbitbrush, blue gamma, galleta, Indian ricegrass, and dropseed species. The Great Basin is characterized in some large part by this community, which extends from low to moderate elevations in mosaic form throughout the state.

Pinyon-juniper or juniper-pinyon

Pinyon pine, Utah juniper, big sagebrush, black sagebrush, *Ephedra* sp., corymbose buckwheat, mutton grass, and needle and thread. This vegetation type occurs over vast areas of the state.

Mountain brush

Gambel oak, bigtooth maple, serviceberry, mountain mahogany, and big sagebrush. Large areas area occupied by mountain brush, mainly on foothills, but also in shaded canyons at lower elevations in much of Utah (Welsh et al 2008 xix, xx).

The above plant communities include both native and introduced species. While there is no method of knowing exactly what was growing at Wolf Village or the surrounding area, we can determine whether the identified plants could have been present in the vicinity of Wolf Village or the surrounding area to examine the foraging patterns of the Wolf Village inhabitants. it may not be possible to know exactly what was growing at Wolf Village or the surrounding area during the time period it was occupied, information gleaned from the above sources do provide a clear picture of what the plant life probably consisted of. This information will be used to examine foraging patterns of the Wolf Village inhabitants.

3 Fremont Subsistence Strategies

Maize has been recovered from the majority of all Fremont sites that have been excavated, indicating that it was at least a standard inclusion in the Fremont diet. Beans and squash parts have also been recovered. In North America, the Fremont, and the people of the Southwest are the only indigenous groups west of the Great Plains that practiced horticulture. Other contemporaneous cultures practiced a hunter/gatherer life style. This led early researchers and archaeologists to conclude that the Fremont were an extension of the Pueblo culture. Further excavations and research defined the Fremont as a separate cultural entity. It is well accepted that the people of the Southwest relied on farming as the basis for their subsistence needs, but there are still debates about the role farming played in the subsistence base for the Fremont. They are most often portrayed as practicing a mixed farming/foraging strategy (e.g., Simms 1986; Bright and Loveland 1999) indicating that they did not have the same level of commitment to farming as Southwestern people did, but instead, adapted their subsistence to what was available to them depending on the environment they occupied and how favorable the year was for either farming or foraging.

Excavations have been carried out in rock shelters, caves, temporary encampments, and village sites, at higher elevations, and at lower elevations near water and marsh resources. Different theories have been proposed, but there is no consensus about what the basis of Fremont subsistence was. This lack of consensus is due in part to the scarcity of data on Fremont plant use.

Flotation samples were not gathered and processed until the early 1980's. Earlier excavation reports merely mentioned that maize was recovered, and mentioned any evidence of different plants recovered from screening or excavation. As flotation results have become available and more research is carried out, it will remain to be seen if there is a pattern in Fremont plant usage that will decide the question of subsistence. It is the goal of this thesis to add to the body of knowledge on Fremont subsistence by contributing information from selected flotation samples taken at Wolf Village, combined with a study of botanical remains recovered in excavation and screening, and consideration of how that information reflects the subsistence strategies at Wolf Village.

A brief review of the main theories addressing the Fremont and their subsistence base follows. The theories have changed as the focus of archaeology has changed and developed over time, and as new methods of research have become available. As my thesis is based on subsistence, the theories that I will cover will be those that address Fremont subsistence. The role that cultural choice plays in subsistence strategies has not been included in studies of Fremont subsistence, so a brief section on the role of cultural choice is included. Following that, a section containing comparative data gleaned from phytolith and starch analysis on dental tartar from a Fremont burial is presented, along with a compiled list of plants identified from other Fremont sites with flotation results. The comparative data from these reports will be compared to the information gleaned from the Wolf Village macrobotanicals.

Fremont Subsistence Models

In North America, the Fremont, and the people of the Southwest are the only indigenous groups west of the Great Plains that practiced farming. Other contemporaneous cultures practiced a hunter gatherer life style. This led early researchers and archaeologists to conclude that the Fremont were an extension of the Pueblo culture.

Noel Morss (1931) was one of the first archaeologists to define the Fremont as having a separate cultural identity from the Pueblo people. Since that time there has been debate over whether or not they can be defined as a cultural entity, what their origins are, and what the basis of their subsistence was (Madsen 1979a). Over time, the Fremont have been presented as either an extension of the Pueblo people to the south or as having had interaction with the Southwest (Allison 2010b; Fowler 1982), practicing a mixed farming/foraging strategy (Simms 1986; Bright and Loveland 1999; and Madsen 1979a), or relying on a subsistence base of regional variation based on local environmental parameters (Marwitt 1986; Madsen 1979a), and adaptive diversity (Simms 1986).

Neil Judd (1926:2) was one of the earlier archaeologists to excavate Fremont sites. He considered the inhabitants of the Great Basin to be Puebloan, partially based on the presence of maize in the sites he excavated. He spent time excavating in both the Southwest and the Great Basin area, specifically Paragonah, Willard, and Beaver. Julian Steward (1996) also believed the Fremont represented the northern periphery of the southwest Pueblo culture. This idea has been largely rejected based on the differences in artifacts found from the two cultures and the lack of stone in Fremont architecture. Jennings (1957) was responsible for defining the Desert Archaic Culture that lasted for ten thousand years in the Great Basin with an unchanging adaptation to a high desert environment. According to Jennings, the Fremont represented a brief anomaly to the Desert Archaic culture (Berry and Berry 2003).

The focus of archaeology in the eastern Great Basin for a time period changed to variation in subsistence strategies, architecture, and the location of sites. Marwitt (1986) divided the Great Basin Fremont into five geographic regions that he believes have been in existence since the beginning of the Fremont Culture. His regions are based on material culture trait distribution, subsistence, and settlement patterns. He proposed that the Parowan Fremont variant, centered on the Parowan Valley of southwestern Utah was based on maize horticulture, supplemented with game hunting and some foraging for wild plant foods. Settlement patterns for this area included larger settlements with pit houses and coursed adobe structures located on alluvial fans next to perennial streams. The Sevier Fremont regional variation of central-western Utah included Backhoe

Village and Hinckley Farm. Marwitt described the sites as small hamlets or open settlement sites near a canyon mouth and a dependable source of water. Subsistence would have been based on a mixed horticultural and foraging strategy with marsh resources being especially important and providing sufficient resources to allow sedentism rather than a reliance on horticulture. Wolf Village is located in the region that Marwitt proposed to be defined as the Sevier variant. The Great Salt Lake variant was based on hunting and foraging for wild foods, particularly from marsh environments. Sites were thought to have been more seasonal and included caves and rock shelters. The Uinta variant included an early withdrawal from that area and indicated an increase of faunal remains over botanicals. The San Rafael variant, east of the Wasatch Plateau, was represented by small rancherias with pit houses and associated storage structures, as well as evidence of fortified sites. Sedentary village life was made possible by horticulture, although wild resources remained important. One of the challenges with Marwitt's theory is whether or not defined borders really exist between his variants. The focus of archaeology in the Great Basin in the 1960's and 1970's was defining boundaries for regional areas. In the 1980's the focus moved to a stronger emphasis on subsistence studies.

Steven R. Simms (1986) is a proponent of adaptive diversity, based on settlement diversity and variability of subsistence adaptations to the environment or habitat that was being occupied. He believes that the Eastern Great Basin was occupied by a combination of farmers and foragers. He has proposed three different models. The first model was based on long term residential bases that were strategically located for farming. Possible villages and storage structures were present and the diet was maize based. The second model involved a variable strategy and was based on the marsh resources of the Great Salt Lake and the importance of foraging. Sites from this area would have included substantial farming bases as well as short term sites used for foraging. Rather than villages, any aggregation would have been hamlets or rancherias combined with short term sites with little or no investment in habitation structures. Residential groups may have broken into smaller groups or come back together depending on whether they were foraging or farming and switched to new sites for horticulture, and built new structures. The third model involved full time hunter/gatherers who practiced little or no farming, but interacted with horticulturalists. Simms theory is based on human behavioral ecology and assumes that natural selection plays an important role in peoples decisions, leading them to forage in an efficient manner to harvest as many calories as possible in exchange for the time and effort expended. While HBE theories have contributed to an understanding of the requirements and effort required to gather resources, they are limited in allowing for culturally determined food preferences. Bright and Loveland (1999) are also proponents of adaptive diversity. They contend that adaptive diversity is based on risk reduction and diet breadth choices.

The area around the Great Salt Lake has been portrayed as an area more important for marsh resources than for farming. Coltrain and Leavitt (2002) performed carbon isotope studies on burials from the Great Salt Lake Wetlands to address the questions of Fremont subsistence. The research indicated that reliance on maize varied, with subsistence strategies ranging from full time farming to full time hunting and gathering. They found little evidence of farming after A.D. 1150 from wetland burials, however the South Temple site still showed evidence of farming from that time period.

Madsen's (1979a) research at Backhoe Village near the modern town of Richfield, Utah led him to believe that marsh resources were large enough and productive enough to allow sedentism and support village life in that area of the Great Basin. Madsen based his subsistence model on cattail pollen found on ground stone and from floors of dwelling structures. He stated that there was little evidence of domesticates for Backhoe village. As a result of his studies, he proposed a "Sevier" Fremont subsistence strategy characterized by villages on alluvial fans near marsh or riverine ecosystems. Temporary encampments in the areas surrounding these villages would have facilitated the gathering of wild resources, both flora and fauna. Corn horticulture would have been used to supplement wild resources, rather than relied upon as the mainstay of the diet. Although Madsen proposed that Backhoe Village relied more on marsh resources than maize because of its location adjacent to marsh resources, carbon isotope studies and further evidence do not concur.

Berry and Berry (2003) looked at information from Backhoe Village that became available later on and compared the results to Madsen's work. Berry and Berry (2003:4) stated, "Maize macrofossils were omnipresent in flotation samples from these sites, and subsequent stable isotope analysis of skeletal material have established that these populations were maize dependent." *Typha* (cattail) is a C3 carbon path species and was clearly not a major component in the Fremont diet in comparison to maize. Berry and Berry also addressed one of the challenges of human behavioral ecology as being the assumption that it was possible for an situ transition from hunting and gathering to agricultural dependence whenever the appropriate caloric content calculus is achieved. Studies done by Angel (1984) and Cassidy (1980) indicate that there are changes in health as indigenous groups transition from a hunter/gatherer lifeway to a horticultural lifeway. As a general rule, horticulturalists have a more limited diet with a loss of diversity that foraging can provide.

Human behavioral ecology does not take into account that successful farming requires commitment. It takes time and effort for fields to be prepared and maintained. If they are abandoned temporarily so that the subsistence could switch to hunting and gathering, the fields would have fallen into a state of disrepair and required substantial effort to restore them to a suitable state for successful horticulture. This would seem a rather inefficient method of obtaining the sufficient caloric requirements. One of the tenets of HBE is that the Fremont or any indigenous group would weigh the costs and benefits of different economic choices as a basis for adaptive solutions.

Allison (2010b) and Berry and Berry (2003) consider the Fremont to have connections to the Southwest. Farming ended for both the Southwest and the Great Basin area around A.D. 1300. There is evidence for both regions of aggregation, social change, and then abandonment. There is evidence for severe drought in both the Southwest and the Great Basin that correspond with changes that occurred, and abandonment of both regions.

Berry and Berry (2003) conducted research on a NAGPRA affiliation study on human remains and associated funerary offerings from the Uinta Basin and the eastern Great Basin area of northwestern Utah. They state that an argument could be made for common origins for the Fremont and Anasazi people. They disagree that the Fremont evolved from an in situ Desert Archaic hunter gatherer base, but propose that there is overwhelming evidence of a south to north spread of maize agriculture. Berry and Berry (2003:2) see this as an expansion of prehistoric Southwestern farming. They place stress on “sedentary village life, not merely the failed attempts of maize expansion as seen in short-lived villages, cave sites, and caches.” The stable isotope evidence from their study provides strong evidence that maize was very important in an expansion from the Southern Basin and Range to the southern Colorado Plateau, the northern Colorado Plateau, and eventually the eastern Great Basin. They state that there was an absolute dependence on maize for sedentary village life. Berry and Berry (2003:124) point out that a dependency on maize does not preclude the use of wild resources to supplement the dependence on maize. The studies indicate that from A.D. 500 to 700 there was a rapid shift from a C3 foods diet to a C4 foods diet. From A.D. 700 to 1000, a stable C4 diet was evidenced. From A.D. 1000 forward the diet shifts back to a C3 diet. The studies agree with Coltrain and Leavitt’s work on the Great Salt Lake Burials except that Berry and Berry concluded that two groups following two distinct lifeways were present for that area. These two groups would have been present prior to A.D. 1000 indicating that there was a symbiotic relationship between sedentary Fremont famers and dispersed hunter-gatherers.

Allison (2010b) is of the opinion that the Fremont had strong connections to the southwest as the northernmost and westernmost extension of maize based horticulture in western North America. He stated that well-developed chronologies for the Fremont would be helpful in comparing the two cultures. Fowler and Jennings (1982:111) are also of the opinion that the Fremont were more than “country cousins” of the southwest people.

Maize has been found consistently in Fremont sites, whether or not the sites are rock shelters and caves, or village sites. This is one of the main factors that led early researchers to propose that the Fremont could be defined as an extension of the Pueblo culture to the south. Renee Barlow (2002) compiled dates for corn and corn cobs from the Eastern Great Basin that range from 100 B.C. to A.D. 500 providing evidence that corn was a source of food for at least some of the Fremont early on in their history. It is widely accepted that the Fremont practiced horticulture. The question is to what extent, and whether or not it was the mainstay of their subsistence. The research focus for this thesis is the subsistence strategy of the inhabitants of Wolf Village and if they were relying on farming as the main focus for their subsistence rather than a mixed farming/foraging strategy. It is expected that they would use wild plants to supplement farming, but if farming was their main focus, then it is also expected that most of the plants they used were those that were locally available, and could be gathered at times that were compatible with the time and effort required to successfully raise crops that would sustain them for the majority of the year.

If the Fremont did rely on maize horticulture as their mainstay of subsistence, there is no reason why they would not have supplemented their diet with foraged foods that grew in proximity to their villages and habitations to provide variety, flavor, valuable nutrients and diversity to their diet. Plants were also used for medicinal purposes, ritual uses, and utilitarian purposes. The plants chosen for use by a culture reflect identity. Nabhan (1985:6–7) has done extensive research on plants and their role in native societies. He states that when different cultures encourage its members to know plants intimately, they are making their cultural identity known. Nabhan discovered in his research that different cultures had different uses for plants and preferences as to which ones they used and those they chose to ignore. The plants remains recovered from the Wolf Village site should reflect what plants the Fremont chose to incorporate into their diet or use in other ways.

Preliminary examination of the maize recovered from Wolf Village indicates that three different corn varieties were present, flour, flint and dent, as well as at least two varieties of beans. The number of different varieties being grown suggests familiarity with different varieties that were available and could be seen as a dedication to farming rather than a casual use of farming interspersed with hunting and foraging as an alternative life style.

Farming requires commitment. Suitable ground has to be prepared, seed has to be saved and sowed, and then watered and tended until it reaches maturity. The architecture of different cultural groups also reflects subsistence choices. Although there are hunter-gatherer groups that lived in areas of resource abundance that allowed them to be sedentary and invest more effort into permanent architecture, most hunter-gatherer groups lived in shelters that could be easily deconstructed and reconstructed as they moved about on the landscape. The architecture of Wolf village consists of permanent structures, both pit houses and above ground adobe structures. Permanent architecture is usually a commitment to a sedentary life style more indicative of a horticultural society than a foraging society.

Farming as a Cultural Choice

Much of the research that has been done on Fremont subsistence has not taken into consideration the role of cultural choice and food preferences. The Fremont have been defined as a culture based on the consistency of different attributes of their artifacts such as their moccasins, figurines, small distinctive projectile points, etc. Subsistence, however, is still an area of debate. As mentioned previously in my proposal, many of the subsistence theories for the Fremont are based on human behavioral ecology or regional variability based on environmental parameters. These theories contribute to an understanding of what resources were relied upon by the Fremont, but they also exclude the role that culture plays in food preferences. Cervellon and Dube (2004:455) state that in the domain of food, "culture may be one of the most powerful determinants of attitudes and behaviors." Studies have shown that food choices are determined by both affective bases that are influenced by the sensations one derives from the taste and feel of food as well as the experience of sharing with friends or family, and consumption of the food, and the cognitive base that is determined by nutritional value, convenience, and health consequences. The cognitive base has been used extensively in Fremont subsistence theory, to the exclusion of the affective. Farb and Armellagos (1980) state: "the surest way of discovering a family's ethnic origins is to look into its kitchen. Long after dress, manners, and speech have become indistinguishable from those of the majority, the old food habits continue as the last vestiges of the previous culture. Rozin and Schiller (1980) have done studies that show that "food attitudes are formed early in childhood and are reinforced by a diversity of familial, social, and cultural influences, which makes food habits one of the most resilient of all habits in acculturation contexts."

Douglas and Gross (1981), summarized the importance of food in culture as follows, "Food categories encode social events . . . they express hierarchy, inclusion and exclusion, boundaries and transactions across boundaries."

The presence of maize in the majority of Fremont sites should be seen as evidence that the Fremont were culturally oriented towards a diet based on corn horticulture. Diet is also based on acquired knowledge in many respects. Not only do a people have to know what foods to grow and how to grow those foods, they have to know how to harvest, when to harvest, how to store and prepare the food. There is an entire skill set involved that has to be learned, taught, and passed from generation to generation.

Comparative Data

Information gleaned from other Fremont sites can be very useful in looking for patterns in subsistence. Phytolith analysis was done on dental tartar from a Fremont burial recovered from Seamon's Mound. Seamon's Mound is located 30 miles to the north of Wolf Village, in a similar environment. It is located on a delta estuary that drains into Utah Lake with marsh resources. Brotherson (1982:141) described the areas to the north and east of Utah Lake where Seamons Mound is located as being dominated by grass-sedge meadows. The plant community in this area had a great deal of diversity, and was dominated by wire grass, sedges, meadow fescue and spike-rush. The burial was determined to be a twelve year old male. The results of the analysis are listed in Table 6. The results reflect plants that were ingested.

Evidence of starch and phytolith from corn was particularly strong in the analysis results, indicating the individual ate a diet high in corn consumption. Pollen signatures were found for four different grasses. The Apiaceae family was also represented in the phytolith record, in the form of wild parsley which is native to Utah Valley. It is unusual to have evidence of the wild potato in this region. *Solanum Jamesii* is not native to central Utah. The furthest north it grows is in the San Juan, and Garfield counties of southern Utah (Welsh 2008:732). There is mention however, that evidence of *Solanum jamesii* was found in the macrobotanical evidence recovered from other Fremont sites, specifically the Radford Roost site (Talbot et al 1999) and the Crazy Bird Shelter site (Hauck and Hauck 2002). The wild potato would have been intentionally cultivated, or acquired in trade from Fremont or Pueblo people to the south. If they were cultivating it, it would be further evidence of dedication to farming. No evidence of the wild potato was recovered from Wolf Village.

In preparing for this thesis, I compiled the results from flotation studies that were done for nineteen Fremont sites that have been excavated. Flotation studies began in the early eighties and have contributed substantially to the knowledge of what plants the Fremont were foraging for. Before flotation studies were done, mention was made of plants recovered in screening, or from cave or rock shelters, consequently, a lot of information was lacking that prevented researchers from developing a more complete idea of Fremont plant useage. A compilation of the flotation analysis results is useful in establishing whether or not there was a pattern in plant usage by the

Table 6. Results of Phytolith and Starch Analysis for Dental Tartar from the Seamon's Mound Burial

Family	Genus, species	Common Name
Apiaceae	*Lomatium sp.*	Desert parsley
Poaceae	*Agropyon sp.*	Possibly Wheat grass
	Elymus sp.	Possibly Wild rye
	Hordeum sp.	Possibly Little Barley grass
	Stipa hymenoides	Indian ricegrass
	Zea mays	Corn
Solanaceae	*Solanum jamesii*	Wild potato

Fremont, and it allowed me to familiarize myself with the plants that were identified from other flotation studies. Table 7 shows the compiled list. The table shows a wide variety of plants used by the Fremont. The data is drawn from sites from different environments, making it difficult to say whether they were readily available or not.

Having comparative data to look at and become familiar with was very beneficial to my research as I was able to familiarize myself with what had already been gleaned. This information will not be used in this thesis to try and answer the question of Fremont subsistence beyond Wolf Village. However as additional studies are done, comparative data of this sort would be very valuable in providing further insight into how reliant the Fremont were on farming versus a mixed farming/ foraging strategy. Then perhaps the questions on Fremont subsistence can be resolved.

Table 7. Compiled List of Identified Plants from Flotation Analysis for Nineteen Fremont Sites

Family	Genus, species	Common name
Agavaceae	*Agave sp.*	Yucca
Amaranthaceae	*Amaranthus sp.*	Amaranth
	Amaranthus cf graecizans	Prostrate pigweed
	Amaranthus retroflexus	Redroot pigweed
Anacardiaceae	*Rhus trilobata*	Squawbush
Asclepiadaceae	*Asclepias sp.*	Milkweed
Asteraceae	*Ambrosia sp.*	Ragweed
	Artemesia dranculus	Tarragon sagewort
	Artemesia tridentata	Big sagebrush
	Gutierrez sp.	Snakeweed
	Helianthus sp.	Sunflower
	Helianthus annus	Common sunflower
	Helianthus anomalus	Western sunflower
	Heliomeris multiflora	Sunflower
	Helianthus petiolaris	Prairie sunflower
Boraginaceae	*Amsinkia sp.*	Fiddleneck
	Lithospermum sp.	Stoneseed
	Elegaenus sp.	Phacelia
	Cryptantha sp.	Cryptantha
Brassicaceae	*Arabis sp.*	Rockcress
	Descurainia sp.	Tansymustard
	Caulanthus type	Wild cabbage
	Lepidium type	Pepperweed (similar)
Cactaceae	*Opuntia polycantha*	Plains prickly pear
	Opuntia sp.	Prickly pear cactus
	Echinocactus sp	Hedgehog cactus
	Echinocactus sp.	Sclerocactus
Capparidaceae	*Cleome sp.*	Beeplant
Caprifoliaceae	*Sambucus caerulea*	Blue elderberry
Caryophyllaceae	*Silene sp.*	
Chenopodiaceae	*Allanrolfea occidentalis*	Iodine bush or pickleweed
	Atriplex truncata	Wedgescale saltbush
	Chenopodiunm sp.	Goosefoot
	Chenopodium album	Lambsquarter
	Corispermum sp.	Bugseed
	Suaeda sp.	Seepweed
Cucurbitaceae		Cucurbits
Clusiaceae	*Hypericum sp.*	St. John's wort
Cupressaceae	*Juniperus sp.*	Juniper
Cyperaceae	*Carex sp.*	Sedge

Table 7. Continued

Family	Genus, species	Common name
	Eleocharis sp.	Spikerush
	Scirpus sp.	Bulrush
Elaeagnaceae	*Shepherdia sp.*	Buffaloberry
Ericaceae	*Arctostaphylos sp.*	Manzanita
Euphorbiaceae	*Euphorbia sp.*	Spurge
Equisetaceae	*Equistum sp.*	
Fabaceae	*Astralgus cf. asclepiadoides*	Milkvetch
	Phaseolus sp.	Bean
Fagaceae	*Quercus gambeii*	Scrub oak
Geraniaceae	*Erodium sp.*	Storksbill
Hydrophyllaceae	*Phacelia sp.*	Phacelia
Juncaceae		
Laminaceae	*Salvia dorrii*	Sage
Loasaceae	*Mentzelia sp.*	Blazing star
Malvaceae	*Sphaeralcea sp.*	Globemallow
Onagraceae	*Epilobium sp.*	Willow weed
	Oenothera sp.	Evening primrose
Pinaceae	*Pinus edulis*	Pinyon pine
Polemoniaceae	*Gilia sp.*	Gilia
Polygonaceae	*Eriogonum sp.*	Wild buckwheat
Poaceae	*Agropyron sp.*	Wheat grass
	Bromus sp.	Brome grass
	Echinochloa crusgalli	Barnyard grass
	Elymus sp.	Wild rye
	Hordeum jubatum	Foxtail barley
	Muhlenbergia -type	Muhley grass
	Oryzopsis hymenoides	Indian rice grass
	Phragmites sp.	Common reed
	Sporabulus sp.	Dropseed
	Zea mays sp.	Corn
Polygonaceae	*Polygonum sp.*	Smartweed
	Rumex sp.	Dock
Portulacaceae	*Portulaca oleraceae*	Purslane
Ranunculaceae		
Rhamaceae	*Ceanothus fendlerii*	Buckthorn
Rosaceae	*Amelanchier sp.*	Serviceberry
	Cerocarpus montanus	Mtn. Mahogany
	Fragaria sp.	Strawberry
	Purshia sp.	Bitterbrush

Table 7. Continued

Family	Genus, species	Common name
	Prunus virginiana	Chokecherry
	Rhibes	Currant; gooseberry
	Rosa sp.	Rose
	Rubus sp.	Black or Raspberry
Santalaceae	*Capmandra umbellata*	Bastart toadflax
Saxifragaceae	*Ribes sp.*	Currant; gooseberry
Scrophulariaceae	*Linaria vulgaris*	Butter and eggs
	Verbascum sp.	Mullein
Solonaceae	*Solanum jamesii*	Wild potato
	Lycium pallidium	Wolfberry
	Nicotiana attenuata	Wild tobacco
	Physalis sp.	Ground cherry
Typhaceae	*Typhus sp.*	Cattail
Umbelliferae		Parsley
Verbenaceae		Verbena
Violaceae	*Violaceae sp.*	Viola

Allison 2002, Berry 1972, Billat 1985, Davis 1988, Dodd 1982, Gruebel 1998, Hauck and Hauck 2002, Hawkins and Dobra 1982, Jennings and Sammons-Lohse 1981, Madsen and Schmitt 2005, Martin 1983, Metcalf 1984, Montgomery and Montgomery 1993, Richens 1983, Seddon 2001,Talbot et al 1999, Talbot et al 2000, Talbot et al 2004

4 Methodology and Sampling

Paleoethnobotany is defined by Pearsall (2000:xix) as the "study of interrelationships between human populations and the plant world through the archaeological record." This is a field that has grown substantially in recent years, and has contributed to our understanding of how past cultures used plants for subsistence, medicinal purposes, and ritual use. Techniques from this field of study will be used to understand how the inhabitants of Wolf Village used the plants identified from the different methods of analysis.

Flotation Analysis

Soil samples for flotation analysis were collected routinely during the excavation process during all three years of excavation. It was not possible to process all of the soil samples and identify the recovered macrobotanicals in the time frame of this thesis. Twenty-six flotation samples were chosen from all of the structures that have been excavated to date, as well as from three additional excavation areas. The samples that were chosen for research were from hearths, storage features, or midden. Soil samples were selected from the hearths if samples were available. Pearsall (2000) pointed out that hearths alone do not provide a representative sample, as repeated use of the hearth will continue to char any macrobotanicals contained in it. Hearths are also periodically cleaned of ashes and debris, so should reflect latest use of plants for each structure. Storage areas should reflect what plants were collected and stored for long term use and provide a different perspective. Midden samples can provide insight into overall plant usage. Middens can also reflect spills that occurred next to hearths, or during the processing of plants. Structures used for midden after

Table 8. Soil Samples chosen for Flotation Analysis

Structure	Easting	Northing	Opening Depth	Closing Depth	Feature
Structure 1	599	396	0.88	1.07	Hearth
	597/598	395	1.53	1.73	Midden
	603	395			Midden
Structure 2	587	396	0.53	0.55	Midden
	587	397	0.59	0.71	Midden
	587	397	0.69	0.79	midden
	587	397	0.79	0.86	Midden
Structure 3	387	471	0.64		Hearth
Structure 4	456	393	0.25	0.425	Hearth
	456/457	393/394	0.86		Hearth
Structure 5	406	428	0.69	0.75	Hearth
	406	428	0.61	0.67	Hearth
Structure 6	578	554	1.4	1.44	Midden
	579	554	1.545		Midden
	575	554	0.77	0.99	Hearth
	575	554	0.77	0.99	Hearth
	576	555	0.54		Midden
	576	554	0.61	0.73	Midden
Structure 7	552/553	569	0.379	0.608	Midden
	552/553	569	0.241	0.237	Midden
Extramural Pit 1	574	563	0.425	0.425	Midden
	574	562	0.415	0.225	Midden
Extramural Pit 2	573	711	0.42		Midden
	576	710	0.34		Midden
Extramural Pit 3	488	549/550	0.23	0.58	Midden

abandonment may show patterns of deposition. At Wolf Village, trash was deposited in at least two structures after abandonment. The midden samples come from the fill of these structures. Table 8 is a list of samples chosen for analysis, their provenience and whether the sample was from hearth, storage area, or midden.

One liter of soil was processed for each flotation sample using a frothing flotation machine at the Museum of Peoples and Cultures. Undergraduate students Christine Edmunds, Shannon

Woods, Stephanie Abo, and Emily Crane assisted by running the samples through the flotation machine, and doing the initial sorting. After the samples were dried, they were size-sorted using geological sieves to assist in the identification process. The charred macrobotanical remains were then identified using a comparative collection at the museum, seeds from native plants gathered from the Wolf Village site, the use of seed identification manuals (Davis1993; Delorit1970; Martin and Barkley1961) and a website created by Colorado State University (Department of Crop and Soil Sciences 2011). Most of the remains were identified only to genus, although it was possible to identify a few of them to species. At least two different species of goosefoot were present, as well as at least two different species of wild mustard. It was not possible to identify which species either of the two represented, but because it was clear that two different kinds were represented they are presented that way on the tables. Counts for each structure, according to the area they represent, are included in chapter 5 in Tables 9 through 19, along with Table 20 with the combined totals for all macrobotanicals recovered from flotation analysis for the site.

Macrobotanicals from Screening

Macrobotanical remains were also recovered while screening the dirt from the excavation process. Corn, beans, and non-charred acorn casings were all found. Macrobotanicals used for roofing material, and other utilitarian purposes were not analyzed.

Maize analysis

The amount of maize recovered for Wolf village was substantial. Most of the maize that was recovered was very fragmentary. Only one cob was whole, and out of the numerous pieces of maize recovered, only 35 cob fragments, or 0.03 % of the maize recovered was whole enough to give a row count. Individual maize specimens often consisted of a cupule, small cob fragments with a few cupules, or whole or partial kernels.

Much corn analysis is directed towards tracing the migratory route of corn from Mexico to more northern regions, or assigning race to corn that is recovered. That is not the focus of this research. Instead, the focus is on issues important to the research question including how many varieties of corn were grown, and whether or not the types were present in similar quantities throughout different parts of the site.

Varying opinions about which measurements and attributes are the most useful in distinguishing different maize varieties in archaeological samples and published methods often require a large sample of cobs with the distinguishing attributes still intact. The best analyses would use noncharred corn from dry caves. Most of the methods require larger samples of well preserved maize than was available from Wolf Village.

Cutler was one of the more prominent researchers in corn analysis. His work involved tracing the route that the introduction of corn from Mexico into more northern regions followed, and identification of the different races of maize. Cutler (1942:72) points out some of the challenges involved with identification. Cutler states:

> In the recognition of race in Zea mays, it is therefore essential that we rely upon characters with a broad genetic background (such as cob shape and kernel size) rather than those that are indicators of but a single locus (as starchy vs. sweet or flint vs. flour). A natural classification of the races of Zea based upon characters like cob shape, kernel size, and tassel type will be incomplete, and one must expect disagreement, even among authorities.

Cutler suggests that the use of the root, branching of the primary axis, node number and internode length, leaves, male inflorescence or tassel are useful distinguishing characteristics.

In addition, he lists general differences in the cob shape, shape of the butt, how the kernels are arranged in rows, sulci between rows, regularity of the kernels, the amount of variation in size and shape from kernel to kernel, and the degree to which the kernels have been compressed by the husks, as useful in determining race. Most of these parts of the corn plant do not survive in the archaeological record however, unless they are found in dry cave sites. Two characteristics Cutler recommended for examining charred corn from archaeological sites are row number and rachis segment length.

King (1994) discusses methods of determining different races of corn from archaeological sites. He reviewes the problems that carbonization of the corn can create, and discusses kernel angle and row number, morphological variation, and regional variation. He believes that row number and rachis segment length are the characters most commonly used. Row number is one of the attributes least affected by exposure to heat (Huckell 2006).

Winter (1973) examined all of the collections of Fremont corn that were available and looked at reports from others who reported Fremont corn, noting that different cob attributes had been chosen by different researchers, with row number being the only attribute consistently reported.

The intent of the above information suggests the difficulty in determining what measurements and attributes will be the most useful for examining charred corn from archaeological sites, particularly when the majority of the corn is highly fragmented, and all that is recovered is cob fragments or kernels. Winter (1973:440) commented that thousands of pages have been published on maize classification by a number of authors who have used differing methodological and theoretical approaches and "In general, the literature concerning corn classification is both vague and confusing." I found this to be true, as I researched different methods for trying to determine what types of corn were present at Wolf Village. Given the condition of the corn that was recovered, measurements were taken whenever possible on rachis diameter, cupule width and length, and row number was recorded when possible. Whole kernels were measured to look for patterns of variation in size, and were assigned to dent, flint, or flour according to methods described by Cutler (1966:8-9, 43).

One of the challenges of using kernel measurements to look for patterns among varieties, is that the kernel will be shaped differently, depending on where it is located on the cob. If it is in the midsection, it is likely to be compressed because of limited space, whereas if it is located on the tip of the corn, it will have more room to fill out, and may take a very different shape. The different attributes of corn are also very subject to environmental factors. I did not find measurements on the corn kernels to be particularly useful. Figures 3 through 6 show no obvious patterns by corn type from width, length, and depth measurements taken on whole kernels classified as flour, flint, or dent.

Cutler (1966) provides a useful guide for determining the type of maize using distinctive traits observable on kernels. Dent corn is distinguishable by the dent that is formed on the cap of the kernel. This occurs because there is band of hard starch around the sides of the grain, but none at the cap. Consequently, when the soft starch matures and dries, the cap sinks to form the dent. Flint corn has a layer of hard starch surrounding the sides and the cap. Flour corn is filled with loosely packed starch grains, and lacks the hard starch region. Flour corn also tends to be crescent shaped.

Most of the results for corn that have been reported for Fremont sites do not address types of corn present, the reports simply state that corn was recovered and where it was recovered from. Two reports, Gruebel (1998) and Montgomery and Montgomery (1993) mention that the corn recovered was in a very fragmentary state.

Cutler (1966:8) stated, “Most corn grown anywhere in prehistoric times was flint corn.” Winter (1973:444) found that mixed amounts of eight row corn, a Chapalote series and hybrid variants represented two thirds of the corn he examined for Fremont sites. Fremont Dent corn accounted for the other third of the collections. Winter researched Fremont dent corn to determine whether it was a late introduction of Mexican Dent maize, or whether an internal evolution took place in Utah from non-dented corn, concluding that an evolution took place in Utah. In order for this to have happened, a primitive form of flint or popcorn had to have been present, along with a form of flour corn. To demonstrate an in situ evolution, an evolutionary sequence, showing the blending of those forms resulting in the Fremont dent corn, needed to be evidenced. Winter found that both of these conditions existed for Clyde’s Cavern.

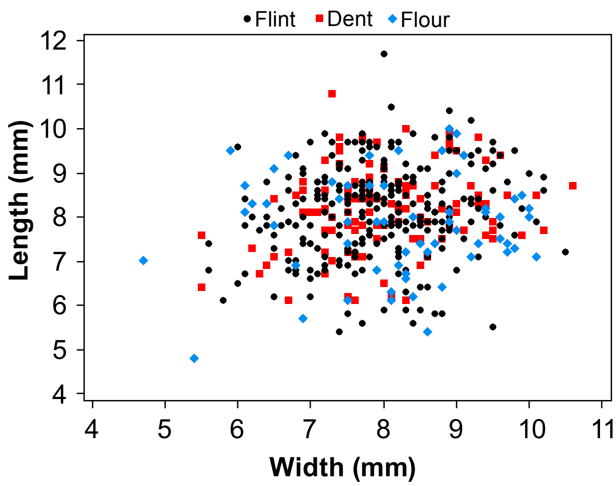

Figure 3. Scatterplot of kernel width and length measurements to determine maize type indicating there is no correlation between the measurements and maize type.

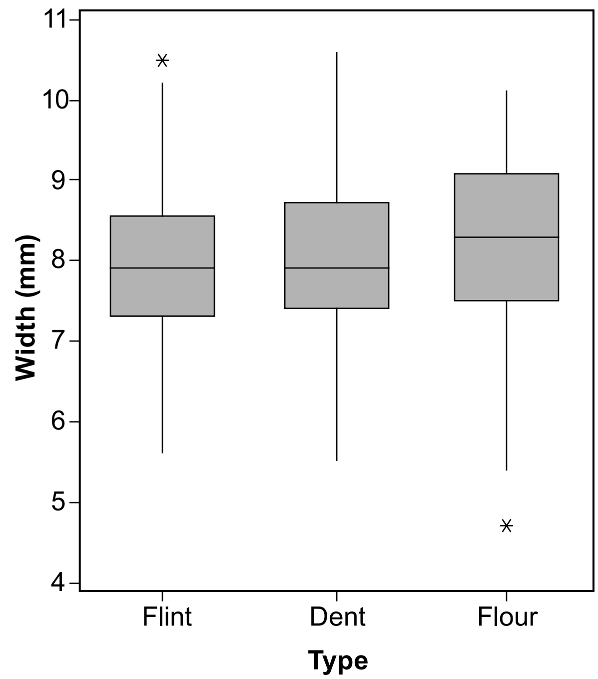

Figure 4. Boxplot for width to determine maize type indicating there is no correlation between width measurements and maize type.

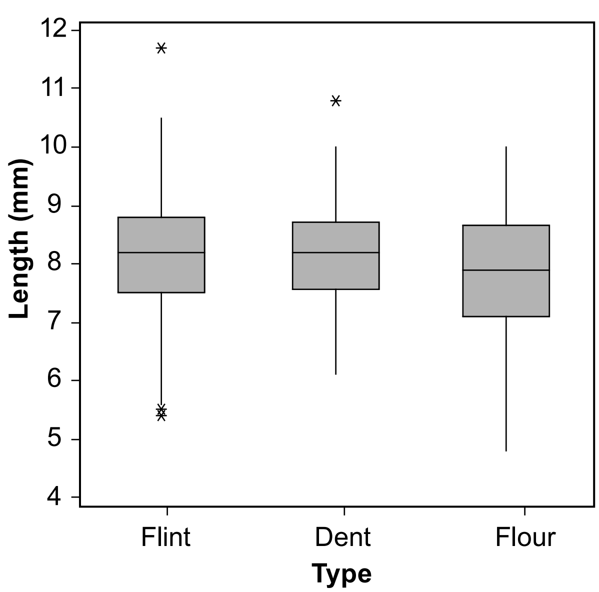

Figure 5. Boxplot for length to determine maize type indicating there is no correlation between length measurements and maize type.

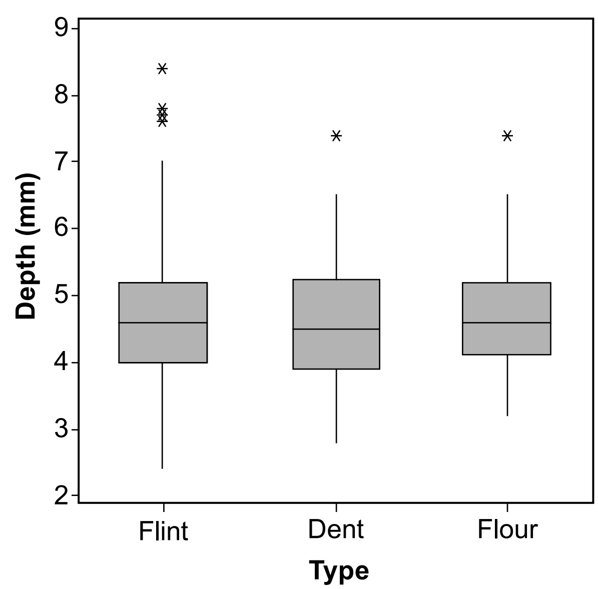

Figure 6. Boxplot for depth to determine maize type indicating there is no correlation between depth measurements and maize type.

Fremont dent corn is described as having large, well dented kernels, and a wide butt with 14 rows. As a side note, Winter (1973:445) concluded that there was a cultural exchange of plant material being exchanged between the Pueblo people and the Fremont, particularly the Fremont in the east central area. That area had high frequencies of eight row corn, while northern and northeast Utah did not, although he does state that those numbers could have been influenced by a number of factors.

The second challenge was to determine how to present the information gleaned from the corn analysis. Two methods commonly used are count and presence. Count is useful to see how much corn was recovered but has to take into consideration the condition of the corn and how very fragmented it was. The presence of corn is useful, particularly when determining if all the types of corn identified are found consistently in all structures and stratum. A combination of count, percentages, and ubiquity will be used in presenting the results.

Beans

The information that can be gleaned from charred beans is fairly limited because many of the identifying features of beans are lost when they are charred. The size of the bean was the most useful attribute in this study, but was still limited for identification purposes. There is a lot of variation in bean size within the different species and varieties. Two species of beans are found for the southwest (Hawkins and Dobra 1982). The first, Phaseolus vulgaris is referred to as the common or kidney bean and thrives in soils that are neutral or slightly alkaline. It is an intermediate size bean with a fair amount of variation within the different varieties. The second, Phaseolus acutifolius or the tepary bean is a much smaller bean that is well adapted to arid conditions.

The shape of the hilum can be an indicator of the different species but it is also variable within the species. The tepary bean usually has a round hilum, but also has a lot of variation. Phaseolus vulgaris usually has an elongated hilum. This attribute was not useful for the beans recovered for Wolf Village, as the hilum was not distinctive enough to determine which species the beans represented.

Pollen analysis

Pollen analysis was done on five pieces of groundstone recovered during excavation. The five pieces were chosen based on shape and condition. All of the samples were manos. None of the typical Utah style metates used by the Fremont have been recovered at this site to date and much of the groundstone that was recovered was fragmented and not well shaped. An effort was made to find samples from as many structures as possible although funding limited the amount of groundstone that could be analyzed. Those that were selected were submitted to the PaleoResearch Institute in Colorado.

Two manos were submitted for Structure 2. Both were one handed manos. One was recovered from the midden of the north/south test trench that runs through the middle of the structure. The other one was found in the rooffall layer containing burnt beams, and adobe chunks. A two handed mano was submitted from Structure 4. It was found on the floor of the structure. Two manos were submitted from Structure 6. Both were very well formed, two handed manos found in the fill of the vent shaft. The vent shaft extends under the adobe wall and opens into the structure. The manos came from the portion of the vent shaft that is inside the structure.

5 | Botanical Data from Wolf Village

The results from the analysis will be presented by structure first, then combined for the overall site. The results from flotation analysis will be presented in tables for each structure, and any unusual occurrences noted in the text. Any beans that were recovered from each structure will be noted, followed by the results from maize analysis. Counts and percentages of the different types of maize kernels that were identifiable will be presented for each structure. It will be important to look at the consistency of maize throughout the site, and whether or not maize was found in each of the structures or excavation areas tested. The total count will be given, but it should be noted that the total count includes kernels and cob fragments that could not be identified because of their partial or fragmentary state. Figures are included representing the distribution of maize within the structures. Pollen results will also be reported for each structure that had manos submitted for analysis.

The results from flotation analysis and maize analysis will then be combined and discussed for the site as a whole. Because the focus of this research is whether the inhabitants of Wolf Village were relying on farming as the basis of their subsistence over a mixed farming/foraging strategy, it will be important to look at the consistency of maize presence and amounts, compared to the number and variety of wild plants recovered and information on their use. The identified native plants are presented for the site in Table 26 and information provided as to whether or not they are dietary or medicinal, when they are available, and whether they are from marshy areas, montane areas, or whether the inhabitants could have found them in close proximity to the site. A brief synopsis of ethnographic use by Native Americans for those plants follows. A comparison is also made to the list of plants that was compiled from flotation analysis for other Fremont sites to see if the plants used at Wolf Village are consistent with other reports.

Results by Structure

Structure 1

Structure 1 is an above ground, two-room coursed adobe structure, with a large square domestic room (Room 1) and a smaller, second room (Room 2) to the east of the main room. Room 1 has a fire hearth and a storage pit. Room 2 does not contain a hearth or any other features that would indicate that it was used as a living area, and it is more likely that it was used as storage area. The overall structure measures 6 x 4 m. Room 1 measures 4 x 4 m, while Room 2 is 4 x 2 m. Radiocarbon dates were obtained from maize recovered from the structure: 970 ± 40 B.P., with a calibrated date of A.D. 1000–1160; and a 960 ± 40 B.P., or a calibrated date of A.D. 1010-1170. No pollen analysis was done for this structure.

Flotation samples for Structure 1 were selected from the hearth, midden within the main room, and midden from the second room. The flotation results from Structure 1 are shown in Tables 9, 10, and 11.

A total of fifteen charred beans were recovered from throughout Structure 1. Of the fifteen beans recovered, ten were found while screening the fill of Room 2. Four beans were recovered while screening the fill of a possible subfloor feature in Room 1, and one bean was recovered from the floor zone of Room 1 in the same grid as the hearth.

A substantial amount of maize was recovered from Structure 1. The maize consisted of fragmentary cobs and whole or partial kernels, totaling 680 pieces. Dent, flint, and flour corn were all present. Dent corn represented twenty six percent of the identified kernels with a count of 112, while fifty-six percent of the identified kernels, or a count of 248, were flint corn. Eighty kernels

Table 9. Flotation Results from the Hearth of Structure 1

Family	Genus	Species	Common Name	Part	Count
Brassicaceae	*Brassica*		Mustard	Seed	1
				Seed	1
Euphorbiaceae	*Euphorbia*	*Cf Prostrata*	Creeping spurge	Seed	1
Papaveraceae	*Papaver*		Prickly poppy	Seed	1
Poaceae			Grass	Caryopsis	1
Rosaceae	*Ameliancher*		Serviceberry	Achene	1

Table 10. Flotation Results from the Midden of Structure 1

Family	Genus	Species	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	1
		Cf gigantospermum		Seed	1
Euphorbiaceae	*Euphorbia*		Spurge	Seed	1
Poaceae	*Cf Panicum*		Grass	Caryopsis	1
	Stipa	*hymenoides*	Indian ricegrass	Lemma	11
Polygonaceae	*Cf Eriogonum*		Wild buckwheat	Achene	1
Portulacaceae	*Portulaca*		Purslane	Seed	3

Table 11. Flotation Results from the Second Room of Stucture 1

Family	Genus	Species	Common Name	Part	Count
Asteraeae	*Helianthus*		Sunflower	Achene	1
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	15
Cyperaceae	*Scirpus*		Bulrush	Seed	1
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	Lemma	5
Rosaceae	*Ameliancher*		Serviceberry	Achene	2
	Prunus	*virginiana*	Chokecherry	Pit frag.	1

of flour corn were also recovered, and accounted for eighteen percent of the total. Thirteen cobs were sufficiently whole to show a row count, and included eight, ten, and twelve row corn. Figure 7 is included showing how maize was distributed throughout the structure and by different strata.

The distribution of maize on and near the floor zone is noteworthy. Thirty-eight charred kernels or cob fragments were recovered from the floor zone in the grid just south of the hearth. The stratum above that also has a particularly high concentration of 305 maize cob fragments and

Figure 7. Plan map for Structure 1 showing the provenience of maize from screening, progressing from the floor zone to the upper fill below duff layer. The color key indicates the count for maize found in each grid in increments of ten.

kernels in an adjacent square to the west. It is difficult to recreate what happened in the past, or why the kernels are distributed the way they are. Both grids are between a storage area and the hearth, areas where maize would have been stored and processed. The maize recovered from the floor zone may have been the result of a spill during processing. This structure did not show evidence of being burned after it was abandoned, consequently, a scenario of maize that was spilled at the time of abandonment and then charred as the structure burned does not fit. If the trash was deposited in the structure after abandonment, the maize could simply represent a depositional pattern for midden in the structure, which may explain the presence of such a large number for charred maize.

Structure 1 is the only structure that has been excavated at Wolf Village with two rooms. Macrobotanical remains from the flotation sample, beans, and maize were all found in Room 2. This evidence, combined with the lack of a hearth or other evidence that it was used for living space, indicate that Room 2 was most likely a storage room. The other interesting aspect of this structure is that the amount of maize recovered compared to the other structures is significantly higher. More beans were also recovered from this structure than anywhere else on the site. Although when comparing this structure to other structures that were excavated, one has to take into account the eroded condition of some of the other structures that were excavated, and the fact that Structure 2 has not been fully excavated yet. This structure still stands out as having more macrobotanical remains recovered from it than any of the other structures.

Structure 2

Structure 2 is an oversized pit structure measuring 71 m^2. The structure may have been accessed by a roofed tunnel leading into it from the east. There is also an antechamber or second tunnel attached to the west side of the structure. Structure 2 has not yet been fully excavated. Test trenches were excavated in east/west and north/south directions through the middle of the structure

Table 12. Flotation Results from the Midden of Structure 2

Family	Genus	Species	Common Name	Part	Count
Brassicaceae	*Brassica*		Mustard	Seed	3
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	13
				Seed	3
Cyperaceae	*Scirpus*		Bulrush	Achene	2
Plantaginaceae	*Plantago*		Plantain	Seed	1
Poaceae	*Cf Panicum*		Panic grass	Lemma	1
	Stipa	*hymenoides*	Indian ricegrass	Lemma	10
	Zea mays		Corn	Cob frag.	46
Rosaceae	*Prunus*	*virginiana*	Chokecherry	Pit frag.	1
Solonaceae	*Physalis*		Groundcherry	Seed	1

and grids were excavated revealing the perimeters of the structure. Structure 2 may represent central community space. Communal structures were also found at Nephi Mounds, Five Finger Ridge, and Baker Village. Radiocarbon dates from this structure range from 1010±40 B.P., with a calibrated date of A.D. 980–1050 to 950±40 B.P. with a calibrated date of A.D. 1010–1170. Plans for excavation of this structure are included in the goals for the 2012 field school.

Soil samples for flotation analysis for this structure were chosen from the midden of the structure, and are presented in Table 12.

Two manos recovered from this structure were submitted for pollen analysis. The first mano was found in the upper fill of the north/south test trench that runs through the center of the structure. The mano had elevated levels of Cheno-am pollen, suggesting that this particular mano was used for grinding goosefoot or amaranth seeds. A Trichuris parasite egg was also recovered from this mano, indicating that the inhabitants of Wolf Village suffered from an infestation of whipworm. Transmission of the parasite would most likely have occurred because of a lack of sanitary practices. Pollen from other plants found in the local environment were also present and included pine, juniper, fir, greasewood, sagebrush, sunflower, grasses, wild buckwheat, and cattail (Cummings 2011).

The second mano was recovered from rooffall, indicating that it may have been utilized or left on the roof, rather than inside the structure. The results from this mano vary greatly from the first mano, indicating that this mano was used for grinding maize. It also had elevated levels of *Polygonum* bistort type pollen. Bistort grows in montane, moist environments, so would have been transported to the site. Pollen signatures from the environment include box elder, juniper, pine, sunflower, marsh elder type, chicory, *ephedra*, legumes, grasses, and a member of the rose family. Greasewood, *artemesia,* and cheno-am pollen were also present. Small levels of cattail pollen were present, but not in sufficient quantities to indicate that the mano was used to grind cattail (Cummings 2011).

One bean was recovered during screening in the fill of the tunnel leading into Structure 2 from the east. Two non-charred acorn shell fragments were also recovered from midden near the perimeter of the structure.

All maize recovered from Structure 2 was charred, and included both flint, dent and flour corn. Flint corn represented 79 percent of the corn recovered with a count of 22 kernels. Two dent corn kernels represented seven percent of the maize recovered, and four flour corn kernels represented fourteen percent of the maize. Cob fragments with eight, ten, twelve, and fourteen row count were recovered. The total maize count, which includes unidentified cob fragments and kernels for this structure was 28 kernels and 112 cob fragments. Figure 8 shows how the corn was distributed throughout the structure and in the different strata.

Structure 3

Structure 3 is a sub-rectangular pit structure with a hearth, measuring 4.5 x 3.5 m or 22 m². The only radiocarbon dates for this structure is 970±40 B.P. which corresponds to a calibrated date of A.D. 1000 to 1160. The structure was severely eroded, and the floor in the northwestern area was lower than in the remainder of the structure. The difference in floor levels raises questions about whether or

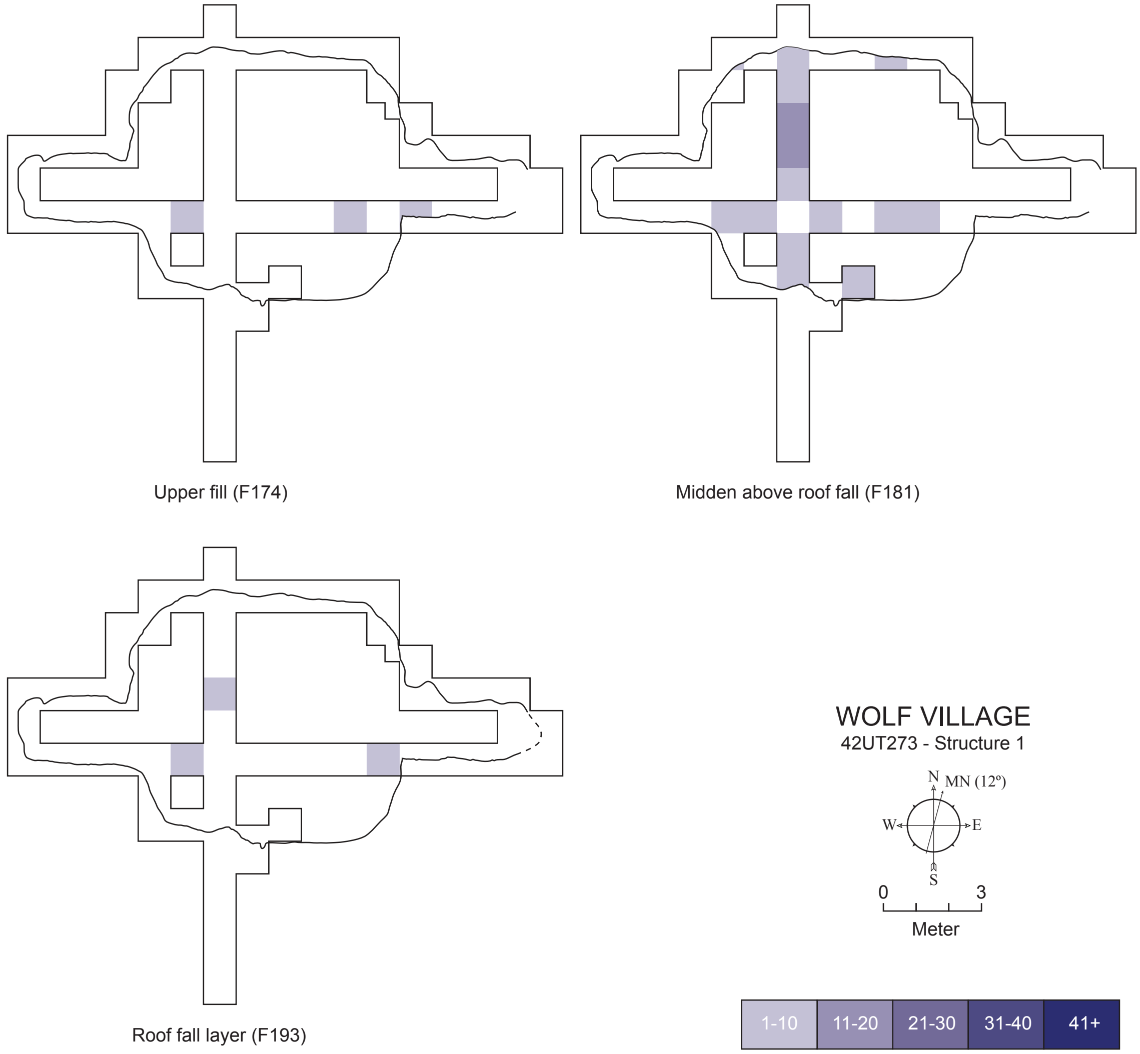

Figure 8. Plan map for Structure 2 showing provenience of maize from screening the midden of the structure by strata. The color key indicates the count for maize found in each grid in increments of ten.

not a later structure was superimposed over an earlier structure, and whether there may have been two hearths present. An area with red soil coloration was thought to have been a hearth during the initial excavation, but further excavations found that it was not a hearth, although the structure floor was oxidized in this area, probably as a result of the fire that destroyed the structure. Flotation samples were processed from the known hearth, and the area initially thought to be a hearth, although that sample contains material from the structure floor rather than a hearth. Table 13 has the results for the known hearth. Table 14 has the results for the area that may have been an earlier hearth.

Table 13. Flotation Results from the Hearth of Structure 3

Family	Genus	Species	Common Name	Part	Count
Boraginaceae	*Amsinkia*		Fiddleneck	Seed	1
Cyperaceae	*Scirpus*		Bulrush	Achene	1
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	Lemma	25
	Zea mays		Corn	Kernel	1
				Cob frag.	1
Polygonaceae	*Polygonum*	*Cf lapathifolium*	Willow weed	Achene	1
Rosaceae	*Rhubus*		Wild raspberry	Achene	1

Table 14. Flotation Results from the Floor Zone of Structure 3

Family	Genus	Speicies	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	20
Fabaceae	*Phaseolus*		Bean	Seed	1
Malvaceae	*Sphaeralcea*		Globemallow	Seed	1
Poaceae			Grass	Caryopsis	3
	Zea mays		Corn	Cob frag	5

The flotation sample from the area initially thought to be a hearth did contain macrobotanical remains. Chenopodium plants produce seeds prolifically, so it could be argued that those seeds were present as a result of seed rain. Maize fragments and a bean are also present however. Figure 9 represents the distribution of maize in the fill of the structure, and from the floor zone.

The only bean recovered from this structure was from flotation. Thirty-three maize fragments or kernels were recovered. Of the maize recovered, only two flour corn kernels were identifiable to type. No pollen analysis was done for this structure.

Structure 4

Structure 4 is a small pit structure measuring 4.5 x 3.5 m or 22 m². A ventilation shaft is attached at the east side with three openings into the structure. The southern and western edges are eroded, consequently, the shape was difficult to determine. Because the northern edge is straight, the shape is thought to be sub-rectangular or D-shaped.

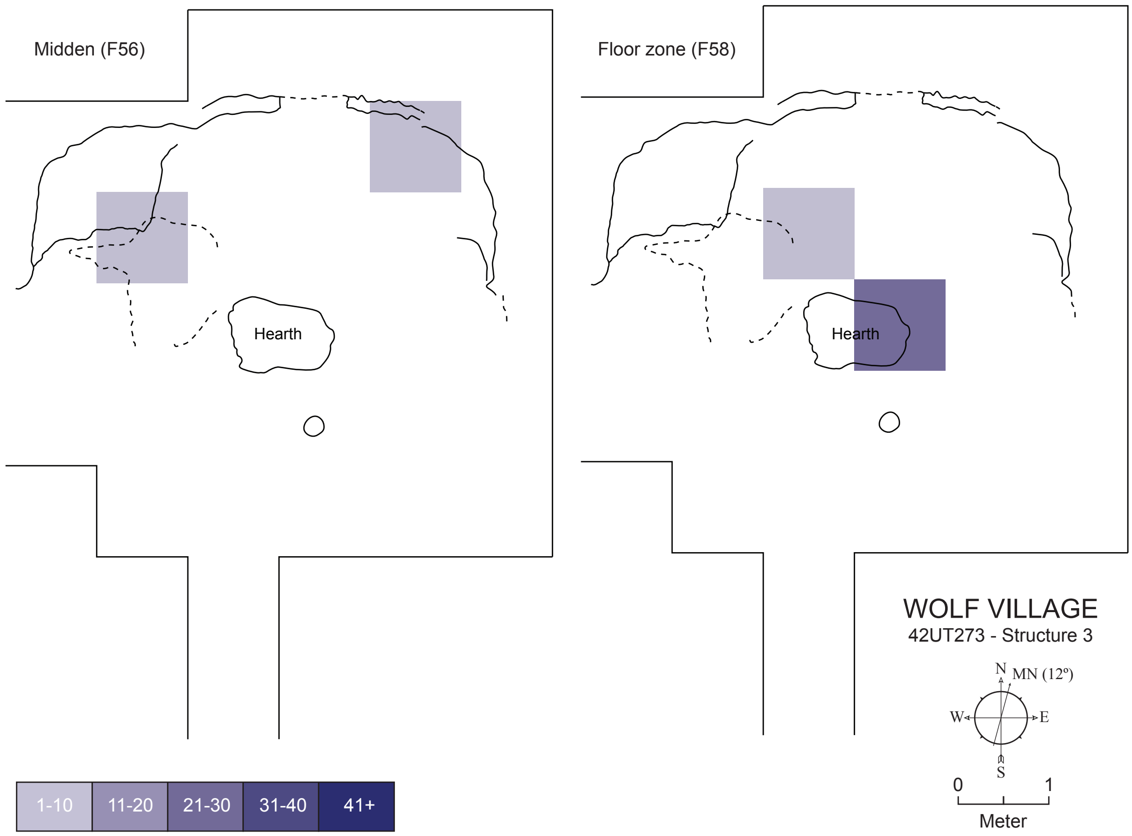

Figure 9. Plan map for Structure 3 showing the provenience of maize from the floor zone and from the midden of the structure. The color key indicates the count of maize found in each grid in increments of ten.

Table 15. Flotation Results from the Hearth of Structure 4

Family	Genus	Species	Common Name	Part	Count
Amaranthaceae				Seed	2
Asteraceae	*Cf Cirsium*		Thistle	Achene	1
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	4
Poaceae	*Cf Panicum*		Panic grass	Caryopsis	1
			Grass	Caryopsis	1
	Zea mays		Corn	Cob frag.	6
				Kernel	1

The flotation samples for this structure were from the hearth. The results are in Table 15. No beans were recovered from this structure. Twenty whole or partial kernels or cob fragments were recovered. Of those, two kernels were identifiable as flour corn and three kernels were identifiable

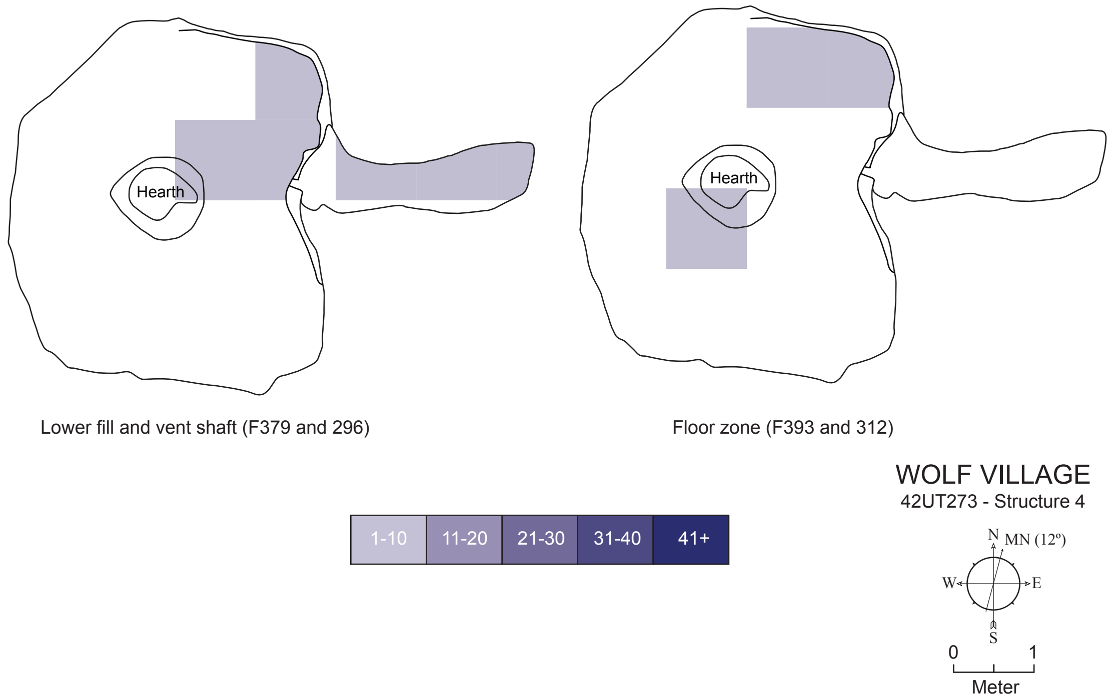

Figure 10. Plan map for Structure 4 showing the provenience of maize from the floor zone of the structure and lower fill of the vent shaft and structure. The color key indicates the count of maize found in each grid in increments of ten.

as flint corn. Cob fragments included two fourteen-row cobs, and one ten-row cob. Figure 10 represents the distribution of maize within the structure.

Pollen analysis was done on one mano from this structure. It was a two-handed mano used primarily for grinding goosefoot or amaranth. It may also have been used to grind cattail. The environmental signature for this mano shows presence of juniper, pine, sagebrush, sunflower, greasewood, *ephedra*, legumes, and cattail.

The proximity of the structure to the surface and the degree of erosion probably contributed to the smaller number of macrobotanical remains recovered from screening for this structure.

Structure 5

Structure 5 is a sub-rectangular pit structure with a clay rimmed hearth. The southern half of the structure was highly eroded; the preserved portion of the structure floor measured 3 x 4 m

Table 16. Flotation Results from the Hearth of Structure 5

Family	Genus	Species	Common Name	Part	Count
Brassicaceae	*Lepidium*		Pepperweed	Seed	1
Capparaceae	*Cleome*		Beeplant	Seed	1
Papaveraceae	*Argemone*		Prickly poppy	Seed	1
Polygonaceae	*Rumex*		Dock	Achene	1
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	Lemma	1
	Zea mays		Corn	Cupule	1

during excavation, but originally the structure was probably larger, measuring approximately 4 x 4 m. Soil samples used for flotation analysis were from the hearth and results from them are found in Table 16.

No beans were recovered from this structure, and partial kernels from the flotation sample were the only maize recovered. Pollen analysis was not done from this structure. Erosion and proximity to the surface are probably contributing factors to the small number of macrobotanicals recovered. Figure 11 is a plan map for Structure 5.

Structure 6

Structure 6 is an above-ground adobe structure with a ventilation shaft attached to the east, a hearth, and support posts on the exterior of the structure angling in sharply towards the structure. The structure measures 4 x 5 m or 20 m^2. Radiocarbon dates for the structure range from a date of 930±40 B.P. or A.D. 1020 to 1210 and 910±40 B.P., A.D. 1030 to 1220.

Soil samples were processed from the hearth, the lower fill in the vent shaft, and midden from within the main structure fill. The results are presented in Table 17 for the hearth, Table 18 for the midden from the structure, and Table 19 for the midden fill in the vent shaft.

Table 17 shows that 153 lemmas from Indian ricegrass were recovered from the soil samples. The soils samples were taken from the midden of the grid located immediately to the east of the hearth. According to Castetter (1935) the lemma of Indian rice grass is indurate or hard, requiring

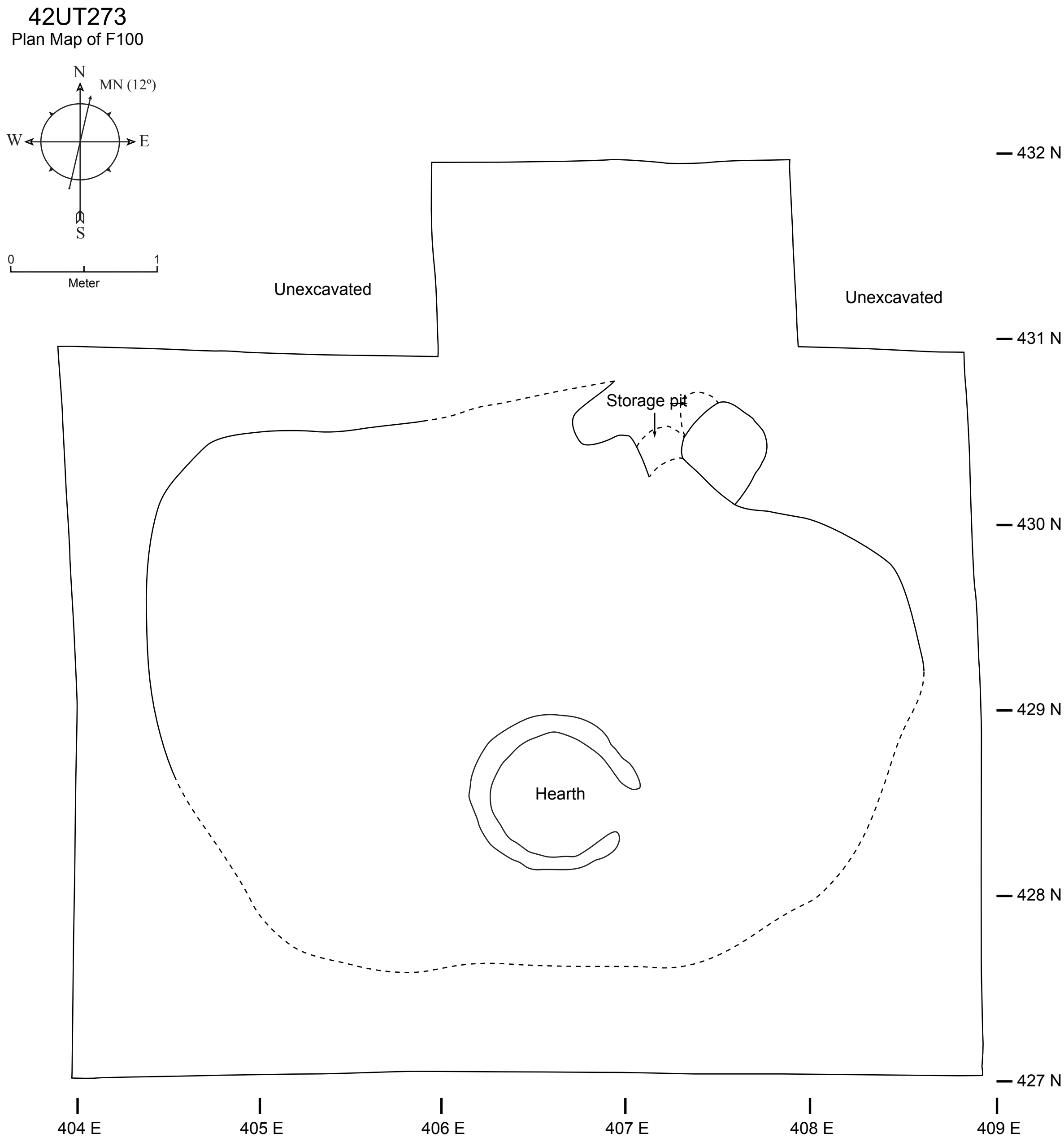

Figure 11. Plan map for Structure 5.

heat treatment to separate it from the caryopsis. The hearth is an area that one would expect to see evidence of parching or the cooking process. A more probable explanation for the lemmas is that the structure and the vent shaft were used as midden after it burned, and the lemmas represent trash that was deposited as part of the midden.

Table 17. Flotation Results from the Midden of Structure 6

Family	Genus	Species	Common Name	Part	Count
Asteraceae	*Helianthus*		Sunflower	Achene	4
Brassicaceae	*Brassica*		Mustard	Seed	2
				Seed	3
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	3
				Seed	13
	Suaeda		Swampweed	Seed	1
Plantaginaceae	*Plantago*		Plantain	Seed	1
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	Lemma	153
	Zea mays		Corn	Cob Frag	6
			Flour corn	Kernel	1
Rosaceae	*Ameliancher*		Serviceberry	Achene	4
Typhaceae	*Typha*		Cattail	Seed	4

Table 18. Flotation Results from the Hearth of Structure 6

Family	Genus	Species	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*			Seed	2
			Goosefoot	Seed	3
Cyperaceae	*Scirpus*		Bulrush	Achene	1
Polygonaceae	*Polygonum*		Willow weed	Achene	1
Poaceae	*Cf Panicum*		Panic grass	Caryopsis	2
	Zea mays		Corn	Kernel	1

Table 19. Flotation Results from the Midden of the Vent Shaft of Structure 6

Family	Genus	Species	Common Name	Part	Count
Amaranthaceae	*Amaranth*			Seed	1
Capparaceae	*Cleome*		Beeplant	Seed	1
Caryophyllaceae	*Cf Silene*			Seed	17
Chenopodiaceae	*Chenopodium*			Seed	1
	Suaeda		Willow weed	Seed	2
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	Lemma	9
	Zea mays		Corn	Cob frag.	1
Rosaceae	*Ameliancher*		Serviceberry	Achene	1

Two beans were recovered during the screening of this structure. 151 pieces of charred maize were recovered. Dent corn accounted for 22 percent of identifiable kernels with a count of 5, flint corn accounted for 65 percent or 15 kernels, and flour corn accounted for thirteen percent of the identified kernels or a count of 3. Fragments of one eight-row corncob, three ten-row corncobs, and two twelve-row corncobs were recovered. Figure 12 represents the distribution of corn within the structure.

Pollen analysis was done on two manos recovered from this structure. Both manos were found in the fill of the vent shaft near where it connects to the structure. The pollen signature of the first mano indicated that it was used primarily for grinding Cheno-am. Seeds from the mustard and grass families were also ground. A single eccentric starch recovered indicates that roots were also ground, although cattail was ruled out. The environmental pollen signature for this mano included alder, juniper, pine, greasewood, sunflower, wild mustard, chicory, legumes, plantain, grass, and cattail.

The pollen record for the second mano indicates that it was used primarily for grinding cattail. Maize was most likely ground also, along with some grass seeds. The environmental pollen signature for this mano included *artemesia*, juniper, pine, *asteraceae, sarcobatus*, grasses, greasewood, and *typha* (Cummings 2011).

Structure 7

Structure 7 was difficult to interpret, but may have been a pit structure. Distinctive features included a preserved floor and roof-fall. A circular feature appeared to be a hearth, however further excavation revealed a bell shaped storage pit beneath the thermal feature. The hearth may have been placed above the bell shaped storage pit after it was no longer used and filled in. Flotation samples were processed from the bell shaped storage pit and from midden from the structure. Soil samples were chosen for flotation analysis from the hearth and from the fill of the storage pit

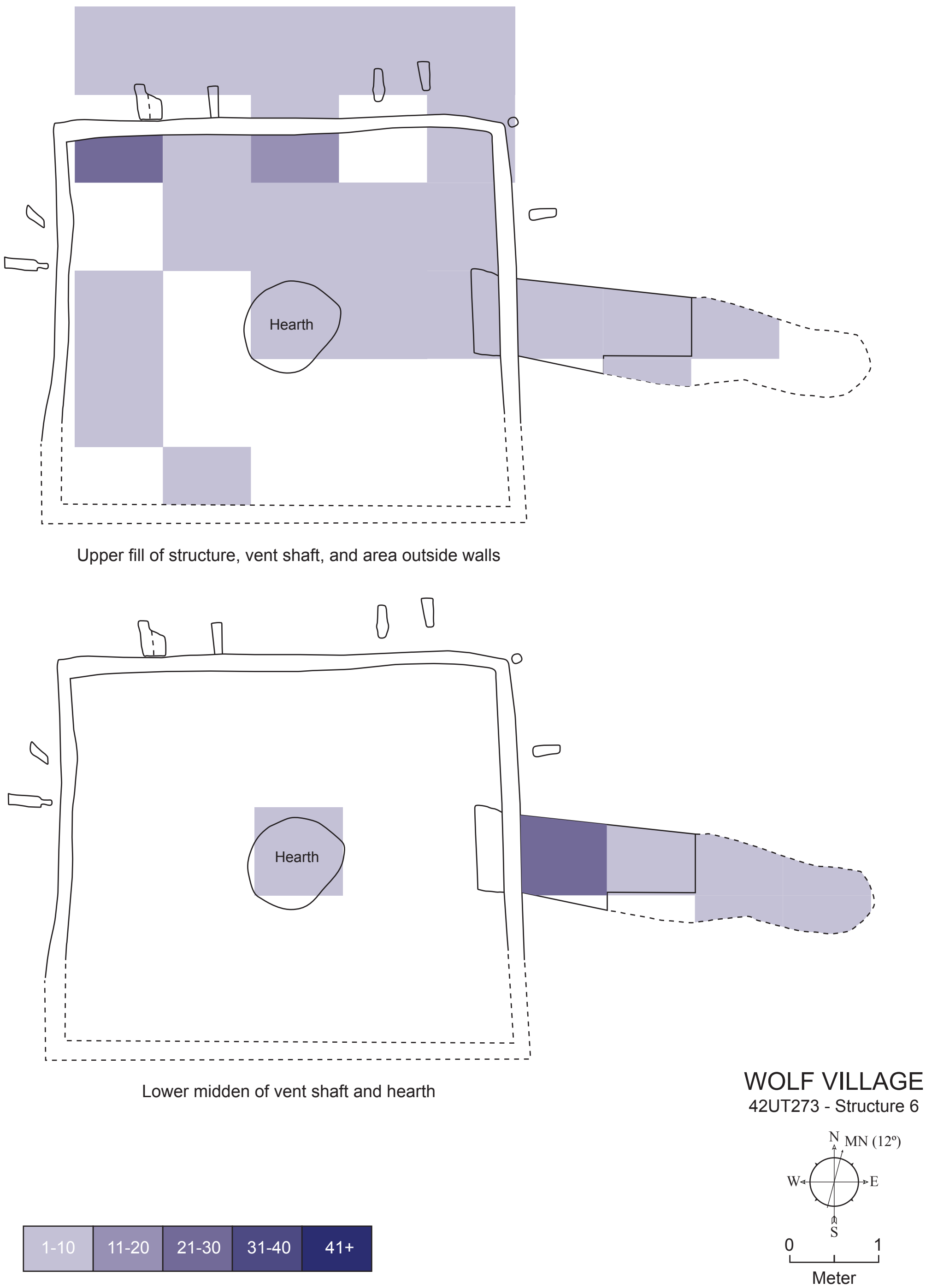

Figure 12. Plan map for Structure 6 showing the provenience of maize from the floor zone of the structure and the lower midden of the vent shaft, and the midden of the structure and the upper midden of the vent shaft. The color key indicates the count of maize found in each grid in increments of ten.

Table 20. Flotation Results from the Midden of Structure 7

Family	Genus	Species	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	2
Polygonaceae	*Polygonum*		Willow weed	Achene	2
Poaceae	*Zea mays*		Corn	Kernel	1

Table 21. Flotation Results for the Storage Pit in Structure 7

Family	Genus	Species	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*		Goosefoot	Seed	3
	Cheno-Am			Seed	4
Poaceae	*Cf Panicum*		Panic grass	Lemma	1
	Stipa	hymenoides	Indian ricegrass	Lemma	14

below the hearth. The flotation results for the midden of the structure are found in Table 20, and the results for the fill of the storage pit are found in Table 21.

Pollen analysis was not done for this structure. No beans were recovered, but 87 whole or partial kernels or cob fragments were recovered from screening and flotation. Flint kernels accounted for sixty seven percent of identifiable kernels, or a count of thirty eight. Dent kernels came in at twenty one percent, or a count of twelve, while flour kernels accounted for twelve percent, or a count of seven. None of the cob fragments that were recovered were whole enough to obtain row counts. Figure 13 represents distribution of maize within the structure.

Twenty seven non-charred acorn shell fragments were recovered for this structure, along with one charred hackberry pit. The only other structure that acorn fragments were recovered from was Structure 2. They were scattered throughout the structure at different depths, and were heavily accreted with dirt. Gambel Oak is native to the area, but usually grows in the foothills. This leads to the question of whether or not the shell fragments could have survived in the archaeological record for such a long time period, or if they are a modern introduction.

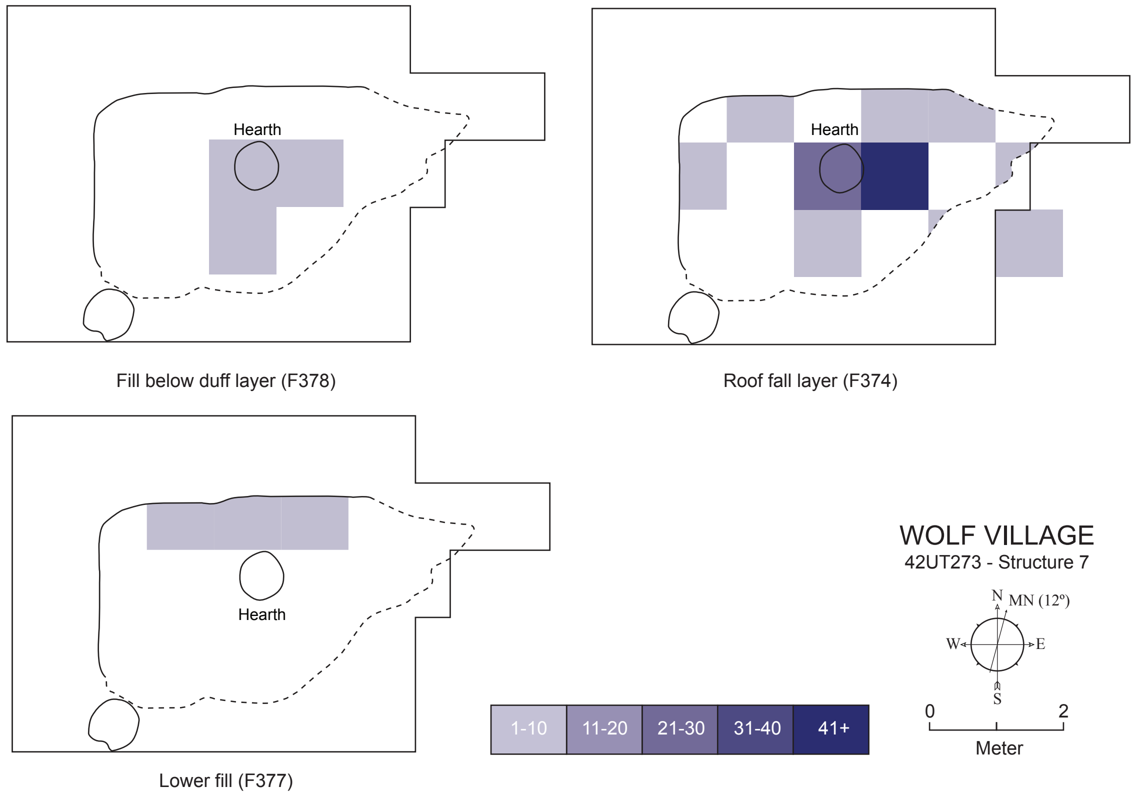

Figure 13. Plan map for Structure 7 showing the provenience of maize from the lower fill, roof fall layer, and the fill below duff layer. The color key indicates the count of maize found in each grid in increments of ten.

Extramural Pit 1

Excavation Area 5 includes an extramural pit 5 m north of Structure 6. This area was originally tested to see if there was any evidence of a granary, and to answer questions about the artifact density in Structure 6 (specifically whether artifacts high in the fill of Structure 6 could have been washed in from areas upslope to the north). It was determined that the high number of artifacts were coming from Structure 6 rather than washing in from the test area, which is located uphill from the structure, but a thermal feature was found while testing the area. Flotation analysis was done from a soil sample taken from the fill of the thermal feature but no macrobotanical remains were recovered.

Table 22. Flotation Results from Extramural Pit 2

Family	Genus	Species	Common Name	Part	Count
Brassicaceae	*Brassica*			Seed	6
Capparaceae	*Cleome*		Beeplant	Seed	1
Chenopodiaceae	*Chenopodium*			Seed	17
			Goosefoot	Seed	4
Cupressaceae	*Juniperus*		Juniper	Scale Leaf	1
Plantaginaceae	*Plantago*		Plantain	Seed	2
Poaceae	*Cf Panicum*		Panic grass	Caryopsis	7
	Zea mays		Corn	Cob frag.	97
				Kernel	3
Portulacaceae	*Portulaca*			Seed	6
Typhaceae	*Typha*		Cattail	Seed	2

Extramural pit 2

Excavation Area 7 includes an oblong, oval depression oriented east/west that is associated with two extramural pits on either end. The excavation area is located to the north of Structure 6. The function of the pits is unknown, however, numerous artifacts were recovered from them as well as a substantial amount of bone. The artifacts included stone tools, projectile points, ceramics, groundstone, and a pendant. Soil samples were taken from the pits at either end of the depression (Table 22).

The six portulaca seeds, six of the chenopodium, one mustard seed, and one grass caryopsis were recovered from the pit on the east end of the depression. The rest of the results are from the pit at the western end. The count for cob fragments and whole or partial kernels was 130, with two kernels that were identifiable as dent corn, and one kernel that was identifiable as flour corn.

This pit may have been used for trash. This is also supported by the recovery of 1302 bones or bone fragments from the western pit. The recovered bones included swan, mallard, mule deer, antelope and mountain sheep. Figure 14 is a plan map for Extramural Pit 2.

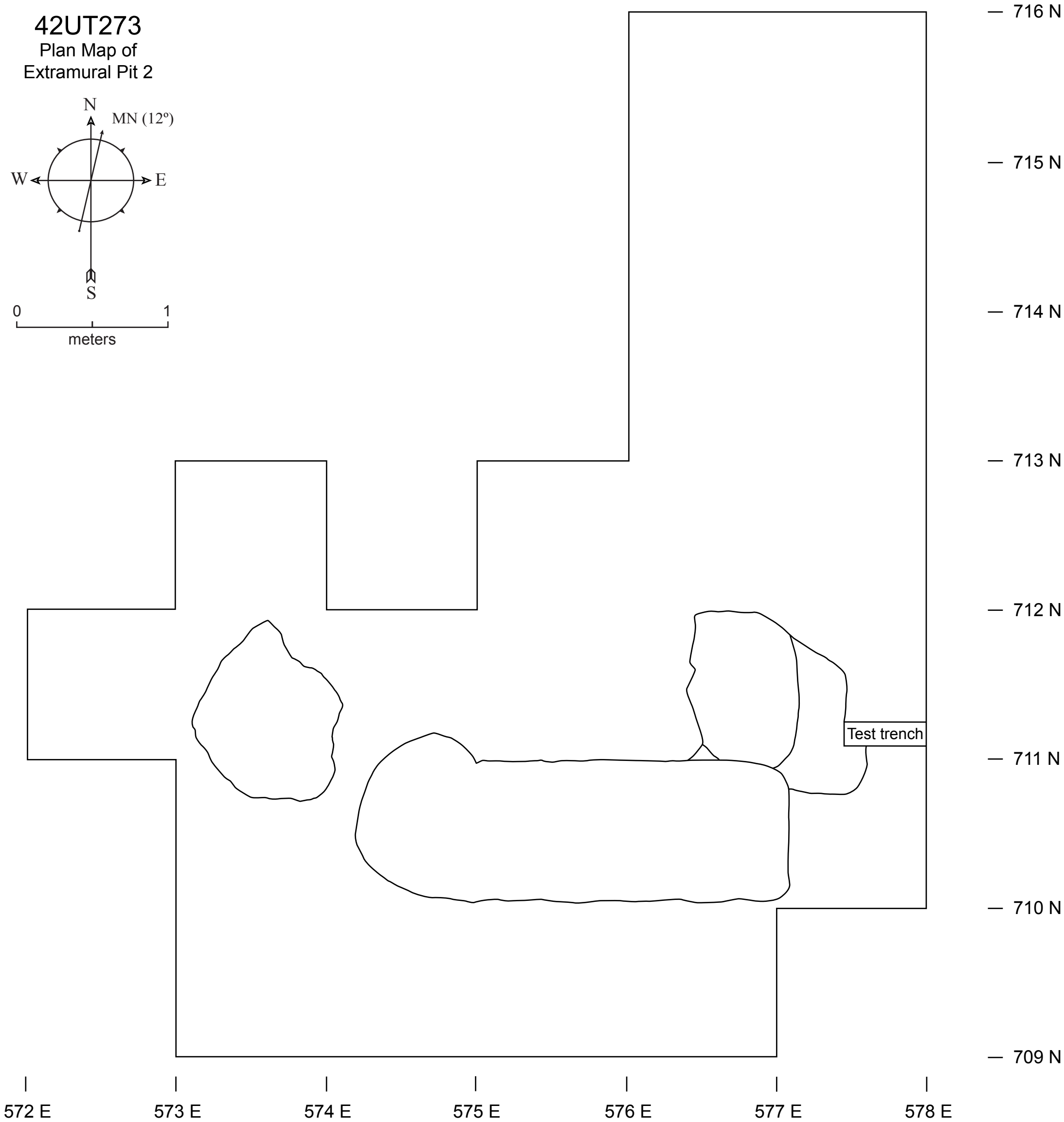

Figure 14. Plan map of Extramural Pit 2 showing the trench with pits on either side. The pit to the west of the trench contained numerous bones and macrobotanicals.

Extramural Pit 3

Extramural Pit 3 is located on top of the ridge, north of the primary datum, and west of Structure 6. It extends into a small saddle to the west with a relatively steep slope to the north. Testing was done in this area because of abundant ground artifacts and stick-impressed burnt adobe. Auger testing was done to look for evidence of a possible structure but did not produce any definitive evidence. Test pits were placed in areas where abundant charcoal was found in the auger testing.

Table 23. Flotation Results from the Midden of Extramural Pit 3

Family	Genus	Species	Common Name	Part	Count
Chenopodiaceae	*Chenopodium*			Seed	3
			Goosefoot	Seed	3
Brassicaceae	*Brassica*		Mustard	Seed	2
Fabaceae	*Legume*		Bean	Seed	1
Poaceae	*Cf Panicum*		Panic grass	Caryopsis	3
				Lemma	21
	Stipa	*hymenoides*	Indian ricegrass	Lemma	188
	Zea mays		Corn	Cob frag.	53
				Kernel	1

As a result, one thermal feature was found to the northwest of the concentration of artifacts. There is no evidence that the thermal feature was located within a structure. Soil samples were taken from the thermal feature and processed. The results are in Table 23. This strong presence of 188 lemmas from Indian ricegrass contributes to the interpretation of this extramural pit as a thermal feature of some kind. Maize is also abundant. Only one flour corn kernel was whole enough to be identified, but 66 cob fragments and whole or partial kernels were recovered from this excavation area. One bean was also recovered. No pollen studies were done.

Combined Results

The combined results provide insight into plant use for the entire site, and allow comparisons between the different structures and excavation areas. I will begin with maize analysis.

A large quantity of maize was recovered from Wolf Village. The only area it was not recovered from was the extramural pit in Excavation Area 5. Strong evidence of maize was found for the rest of the structures and excavation areas within the site. Figure 15 shows the maize count by type for each of the structures and excavation areas. Structure 1 stands out significantly from the others. Structures 2, 6, and 7 appear to have comparable amounts, while Structures 3, 4, and 5 have low counts. The structures with low counts were highly eroded, with little fill left

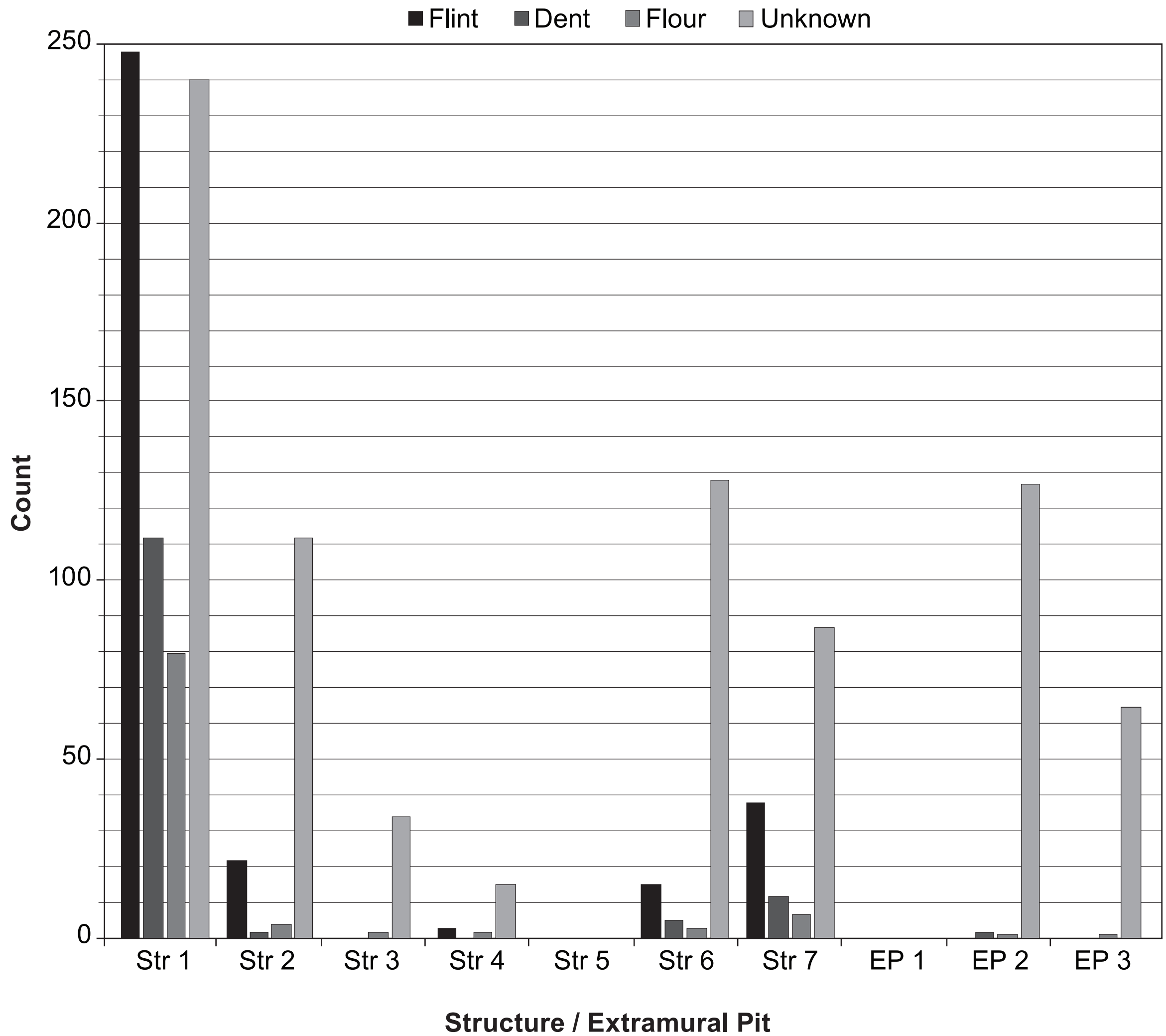

Figure 15. Corn count by type for all seven structures, and the extramural pits.

in them. Consequently, much of the botanical record was probably lost for these structures, but may have shown more significant amounts before the erosion took place. The graph also shows how fragmented the recovered corn was. The unknown bars represent corn that could not be identified due to its fragmented state. The total corn count for the site was 559 kernels, and 808 cob fragments. Even though the corn was in a fragmented state, the evidence for reliance on corn is strong. Photos of flint, dent, and flour corn identified from Wolf Village are in Figures 16, 17, and 18. Figure 19 shows a sampling of cobs recovered from Wolf Village with different row counts. Table 24 shows the distribution of of row count for cobs by structure.

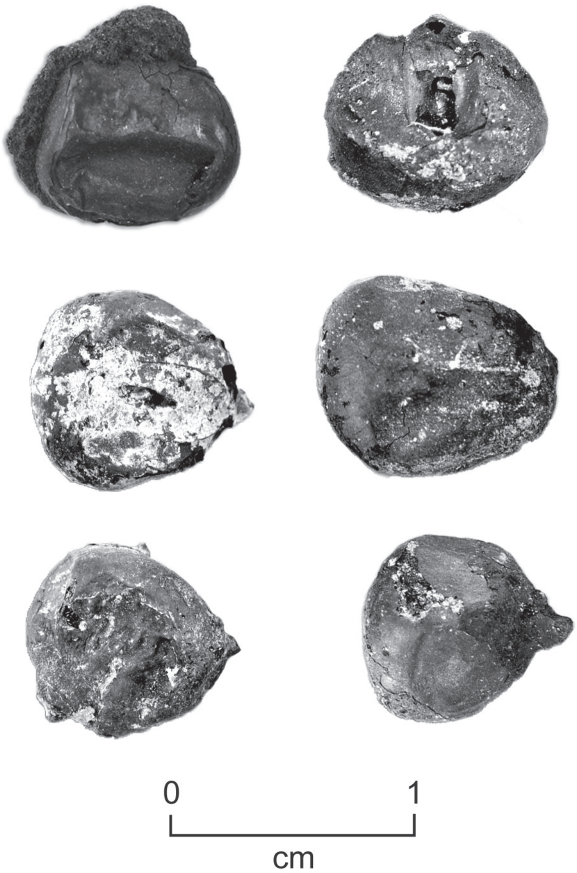

Figure 16. Flint corn found at Wolf Village.

Figure 17. Dent corn found at Wolf Village.

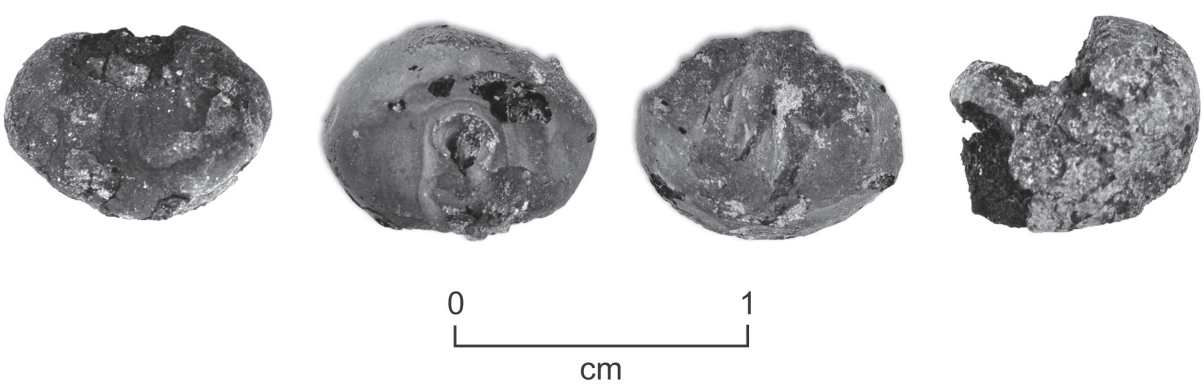

Figure 18. Photo of Flour corn found at Wolf Village.

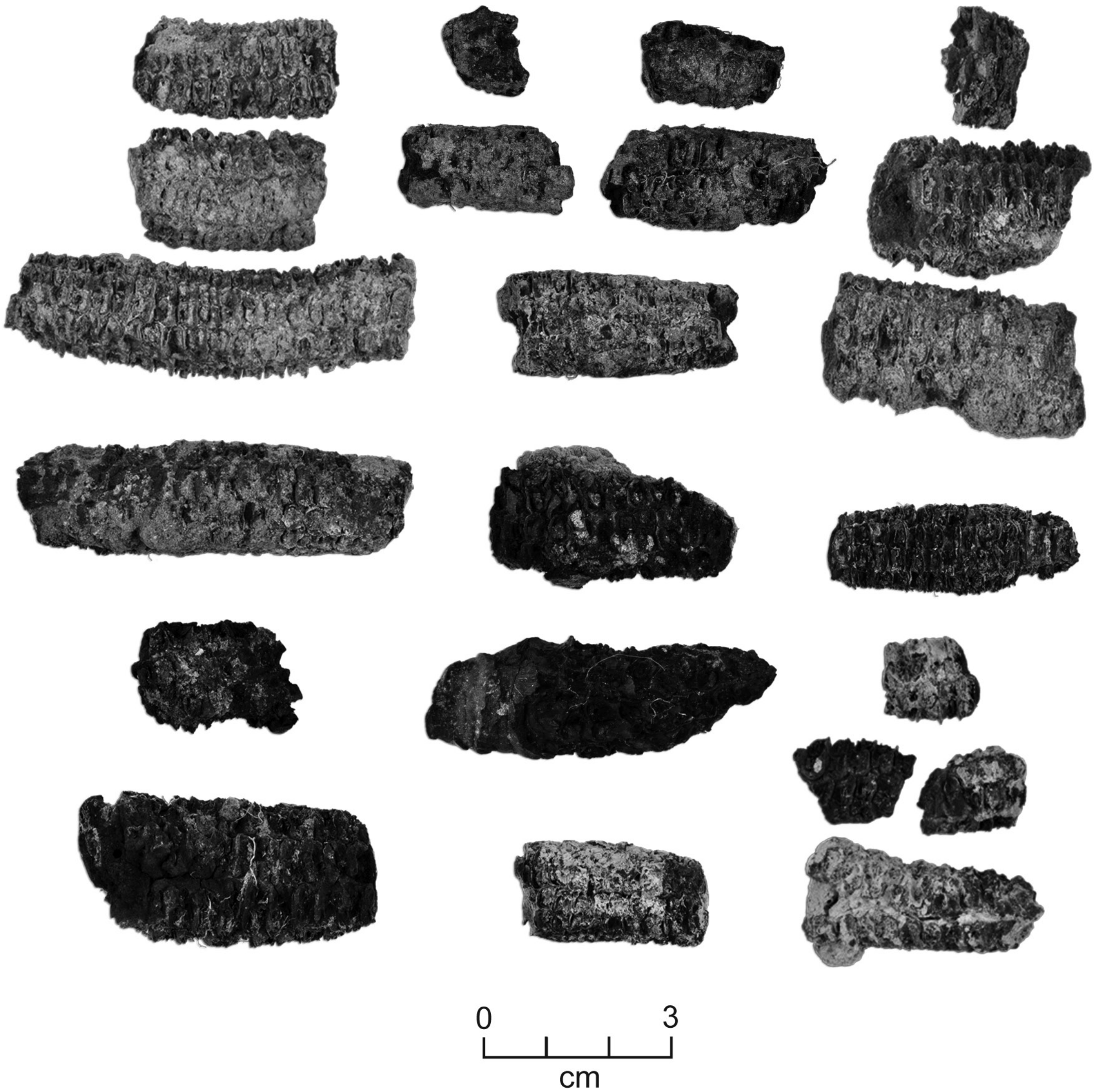

Figure 19. Sampling of row count for cob fragments found at Wolf Village.

As mentioned previously, both Winter (1973) and Cutler (1966) listed flint corn as being the type most commonly recovered. This was the case for Wolf Village. Figure 20 represents percentages for the different types of corn recovered. The results are consistent for all of the structures represented, although Structure 2 had a higher percentage of flour corn. The percentages for flint corn were the highest, with dent coming in second, and flour last. The quantities and presence of three different types of corn recovered for Wolf Village contributes to the argument that the inhabitants of Wolf Village were relying on farming as a basis of subsistence, rather than

Table 24. Row Count for Cobs by Structure. Row Count is Determined by Counting the Number of Cupules around the Rachis, and Multiplying by Two, as each Cupule contains Two Kernels

Row Count	Str 1	Str 2	Str 3	Str 4	Str 5	Str 6	Str 7	Total
8 Row	6	1				1		8
10 Row	4	4		1	3	1		13
12 Row	3	4	1		2	1		11
14 Row		1		2				3
Total	13	10	1	3	5	3		35

the more casual approach a mixed farming/foraging strategy would indicate.

The different types of corn are used in different ways, and ripen at different times. An ethnographic account was recorded of a Hidatsa Woman who grew up in a traditional Native American lifestyle. She was born around 1839 in what is now North Dakota, and became an expert gardener. Her account includes a description and uses of the some of the corn they grew. She does not use any of the names for maize that are now in use, but refers to them as hard and soft white, hard and soft yellow, and gummy corn. She described green corn as being available around the first week of August. It was boiled or dried for future use. Green corn lasted for ten days, then became too hard to boil. Fresh green corn could also be put in a mortar and pounded, then boiled, and served plain or with beans and fats. The green ears could be roasted, and corn bread could be made from pounded kernels. Hard corn was often boiled with beans and squash. The maize was parched first, and then pounded with fat in a mortar before it was added to the pot. Hard corn could also be parched, then boiled alone for a type of mush. Soft maize was very versatile, and could be parched and pounded into a meal to be used for boiled corn balls, mush, or made into a form of hominy. Maize was often parched as a whole ear, and could also be parched using sand. Buffalo Bird Woman stated that she could tell when she ate food containing corn, what type of maize had been used for a particular dish, as they all had characteristics that distinguished them from each other (Wilson1987). Buffalo Bird Woman's account emphasizes cultural familiarity with a

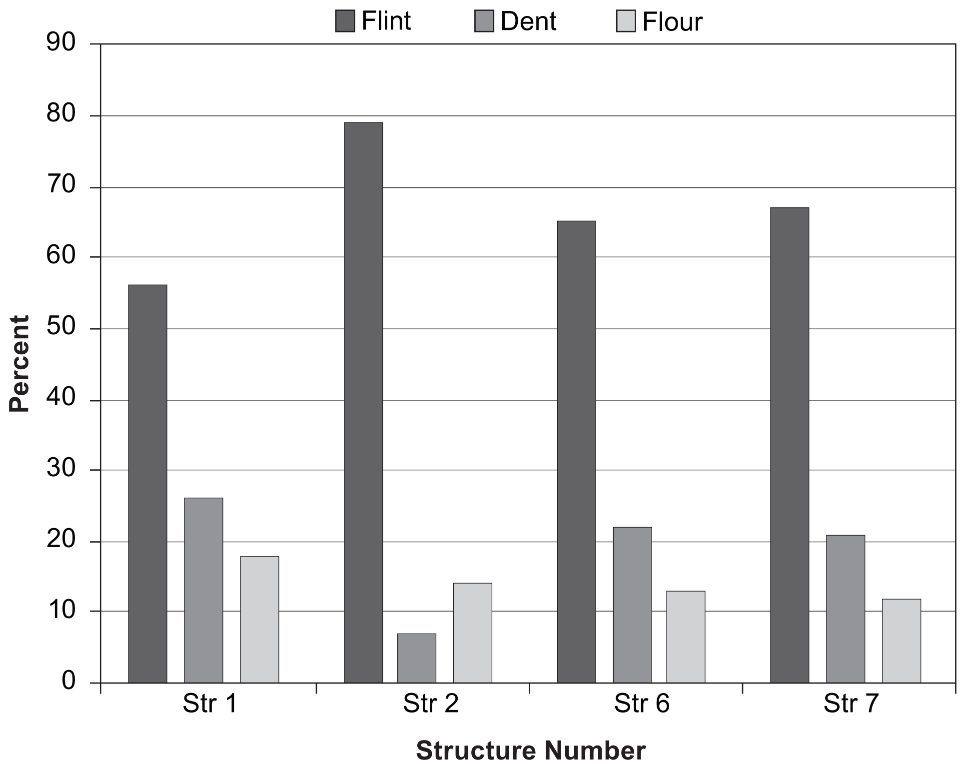

Figure 20. Percentage of corn type for structures with a count over ten.

variety of maize types and the manner in which each type should be prepared. Native American farmers often planted different varieties of corn that ripened at different times, and could be used in different food preparations according to whether they were hard or soft, starchy or not.

It is assumed that if the inhabitants of Wolf Village were growing three different types of corn, they also had different methods for processing and preparing the different varieties that would have reflected Fremont culture. I also bring up the fact that the use of beans and squash in addition to maize by Native American farmers seems to be quite universal. Not only were beans found at Wolf Village, at least two types of beans were recovered. One type of bean compares favorably to *Phaseolus vulgaris* or the common bean. The other type of bean is quite small and could possibly be *Phaseolus acutifolius* or the tepary bean, but in its charred state, there are not enough attributes to definitively identify it. Figure 21 is a photo of the beans found at the site. While evidence of squash has not been recovered from Wolf Village, it was found at Spotten Cave in the Fremont level.

Figure 21. Photo of different varieties of beans found at Wolf Village .

Identified Plants from Flotation Analysis

The plants that were identified from flotation analysis have been combined into one table (Table 25) to reflect plant usage for the site as a whole. Indian Rice grass had the highest count of 417 and was evidenced by charred lemmas that were recovered. Some of the lemmas were fragmented, so caution has to be used in establishing exactly how much Indian ricegrass is represented. Nevertheless, it has a strong presence. Corn fragments came in with the second highest count at 191. Again, the corn is fragmented, but still shows a strong presence. When the results of flotation analysis are combined with recovered corn from screening the count jumps to the 1367 reported for the site. Two different types of goosefoot were recovered. They were only identifiable to genus, but it was obvious that they came from different species. When the count

Table 25. Compiled list of Plants identified from Flotation Analysis for Wolf Village with Count for the Site, and Ubiquity or the Percent of Soil Samples the Plant was identified from. The Ubiquity for Corn is represented by the Cobs, Kernels were found in Samples with Cob Fragments

Family	Genus	Species	Common Name	Count	Ubiquity
Amaranthaceae	*Amaranth*			3	11
Asteraceae	*Helianthus*		Sunflower	5	8
	Cirsium		Thistle	2	8
Boraginaceae	*Amsinkia*		Fiddleneck	1	4
Brassicaceae	*Brassica*		Mustard	10	27
				4	11
	Lepidium		Pepperweed	5	4
Capparaceae	*Cleome*		Beeplant	3	8
Caryophyllaceae	*Silene*			17	4
Chenopodiaceae	*Chenopodium*		Goosefoot	55	42
			Goosefoot	15	35
	Cheno-Am			42	4
	Suaeda			3	8
Cupressaceae	*Juniperus*	*juniper*		1	4
Cyperaceae	*Scirpus*		Bulrush	5	19
Euphorbiaceae	*Euphorbia*	*Cf prostrata*	Creeping spurge	1	4
			Spurge	1	4
Fabaceae	*Phaseolus*		Bean	1	4
Malvaceae	*Sphaeralcea*		Globemallow	1	4
Papaveraceae	*Argemone*		Prickly poppy	2	8
Plantaginaceae	*Plantago*		Plantain	4	11
Polygonaceae	*Eriognum*		Wild buckwheat	1	4
	Polygonum	*Cf lapathifolium*	Willow weed	42	11
	Rumex		Dock	1	4
Poaceae	*Stipa*	*hymenoides*	Indian ricegrass	417	42
	Panicum		Panic grass	37	31
	Cf Sporobolus		Dropseed	1	4
	Zea mays		Corn -cob frag	191	73
			Corn- kernel	10	19
Portulacaceae	*Portulaca*		Purslane	9	8
Rosaceae	*Ameliancher*		Serviceberry	8	15
	Prunus	*virginiana*	Chokecherry	2	8
	Rhubus		Wild raspberry	1	4
Solonaceae	*Solanum*	*Cf Physalis*	Ground-cherry	1	4
Typhaceae	*Typha*		Cattail	6	8

for the three different species is combined, goosefoot comes in third with a count of 112. The numbers drop off from there, with some plants showing a stronger presence than others. Ubiquity is as useful for the results of the flotation analysis as count, particularly when looking at the identified plants with low counts. Ubiquity is figured according to how many flotation samples each macrobotanical was found in. When the macrobotanicals are figured according to ubiquity, corn has a seventy-five percent ubiquity, Indian ricegrass had a forty-two percent ubiquity, panic grass had a thirty-one percent ubiquity, and the two goosefoot species had ubiquities of forty-two percent and thirty-two percent.

As it is important to my research question to understand how each plant is used and in what season, I have researched different ethnographic accounts to glean information. There are ethnographic accounts for the Fremont, but it is assumed that different plant parts, such as leaves or seeds have similar uses to different cultures. Cummings (2011:2) states that "it is a commonly accepted practice in archaeology to reference ethnographically documented plant uses as indicators of possible or even probable plant uses in prehistoric times." Table 26 is a list of the plants identified from flotation analysis for the site, indicating what season of the year the plant can be used in, and whether or not the plant is dietary or medicinal. Columns also indicate if the plant could have been found in the vicinity of Wolf Village, or if they would have been gathered from marsh or montane areas. A determination of whether or not to list it for Wolf Village was arrived at by checking to see if that particular plant had been identified from the lists of native plants found in the area of Wolf Village or Spotten Cave, (see Tables 1 through 5 in the section on environment). Welsh et al (2008) was consulted for information on the plants not found in the tables to determine what habitat and county the plant was native to, to determine if the plant could have been found near Wolf Village. Early accounts from pioneers and explorers included were also taken into account.

Table 26. Ethnographic Use of Plants Identified for Wolf Village, with Season of Use, Whether the Plant is Dietary or Medicinal, and Habitat

Plant	Spring	Summer	Fall	Dietary	Medicinal	Stress	Site	Marsh	Montane
Amaranth		*	*	*			*		
Beeplant	*	*		*		*	*		
Bulrush	*	*	*	*				*	
Cattail	*	*	*	*				*	
Chenopodium	*	*	*	*	*		*		
Chokecherry		*		*	*				*
Dock	*	*	*	*			*		
Fiddleneck	*					*	*		
Ground-cherry		*		*			*		
Juniper			*	*	*	*	*		
Plantain	*			*		*	*		
Prickly poppy							*		
Purslane	*	*	*	*	*		*		
Seepweed	*	*		*				*	
Serviceberry			*	*	*				*
Silene					*		*		
Spurge					*		*		
Sunflower			*	*	*		*		
Wild buckwheat	*	*		*	*		*		
Mustard	*	*	*	*	*		*		
Wild raspberry		*		*	*				*
Willow weed				*				*	

Ethnographic Plant Use

Marsh Resources

Scirpus sp. (Bulrush)

Harrington (1967:212) stated that bulrush was used extensively by Native Americans. The young shoots were gathered and eaten in the spring. Pollen was collected and mixed with other meals to make bread, mush, or pancakes. Seeds could be gathered later in the season, ground and used in the same way the pollen was. Rootstocks could also be boiled to make sweet syrup in the fall. Different parts of the plant were also used for mats, baskets, and roof thatch.

Typha sp. (Cattail)

Cattail was used extensively for food and other purposes. It has been referred to as an outdoor pantry. Different parts of the plant were harvested and used most of the year. Young shoots were eaten in the spring. The flower spikes were boiled and eaten like roasting ears. The pollen can be collected and mixed with other flours for breads and mush. The rootstalks have a high starch content, and can also be used later in the fall. Native Americans ate the tiny seeds after burning off the bristles (Harrington 1967:222–224).

Suaeda sp. (Seepweed)

The greens were collected and eaten in April. The seeds could be gathered and ground into a meal to be mixed with cornmeal. The Pima referred to it as black saltbush, distinguishing it from the *Atriplex* species. The use of this plant in the diet was considered to be part of 'older' diets that were no longer used. In the past, the Pima roasted seepweed with cholla cactus to give it a salty flavor (Rea 1997:154-155).

Epilobium sp. (Willow weed)

Willow weed is an aquatic species. Rea (1997:88) commented that willow weed is native to marshy areas and usually found in abundance, but it appeared to be a plant used anciently. It had been recorded at the turn of the century, but none of the people he interviewed could remember how it was used.

Montane Plants

Polygonum sp. (Bistort)

Bistort was not found in the flotation analysis, but was evidenced from pollen, so it is included here to provide a complete picture of the montane plants that were identified. Bistort grows in moist meadows and swamps at high elevations. Native Americans were rather fond of the rootstock. The young leaves could be used as a pot herb (Harrington 1967:196-197).

Prunus sp. (Chokecherry)

Chokecherry grows on shady hillsides and along streams in pinyon/ juniper plant communities. The Apache considered it a staple. The fruits were dried for later use, as well as cooked fresh and added to other foods. The cyanide in the seed can be neutralized by cooking and grinding. The wood is flexible and ideal for bows. The bark was used medicinally for coughs, abdominal cramps, and fever (Dunmire and Tierney 1997:139-140).

Ameliancher sp. (Serviceberry)

Serviceberry grows on wooded slopes. It was a favorite item of ancestral Pueblo people and the Hopi. It has been referred to as the Indian apple. The fruit can be eaten raw or cooked and can be dried for future use. It can also be used an as emetic for stomachaches, and nausea. The wood is hard and heavy, making it useful for a number of implements (Dunmire and Tierney 1997:159-160).

Rubus sp. (Wild raspberry)

Wild raspberry grows abundantly in the Rocky Mountains and is found at medium to high elevations, up to 10,000 feet. Native Americans ate the berries fresh or dried them for future use. The leaves can be boiled to make a tea (Harrington1967:275).

Plants native to the Wolf Village vicinity

Amaranthus sp. (Pigweed)

The early leaves of the amaranth plant could be used as a potherb in the early summer. Several cultures parched and ground the seeds of the pigweed. Amaranth plants produce many seeds making them easy to harvest. The seeds from a single plant can number in the tens of thousands. The seeds are nutritious, providing protein, lysine, Vitamins A and C, as well as iron and calcium. Amaranth plants thrive in disturbed soils. The Ute Indians ground the seeds for flour to make cakes and mush (Dunmire and Tierney 1997:205-207). Nabhan (1985:98) studied the use of amaranth among the Papago. It was used extensively in salads, boiled or fried as greens, and mixed with other foods. The Papago relied on amaranth to round out their diets before the harvest was ready.

Cleome sp. (Beeplant)

Beeplant was used by Native Americans for food, medicine and as a dye for painting pottery. The leaves of the young beeplant could be used as potherbs in stews, while the seeds could be ground for mush or bread. A tea made from the leaves was used for stomach aches (Wheeler 1994:4). Beeplant was also used by the Navajo to stave off famine. Famine foods were defined by the authors as those that were available before maize ripened (Huss-Ashmore and Johnston 1994:70). The Rocky Mountain beeplant prefers disturbed or fertilized soils. Dunmire and Tierney (1997:74) point out that goosefoot, pigweed, and beeplant are wild plants that can become established or encouraged on cultivated or disturbed areas around habitation sites. The greens from these plants would have been available after early summer rains. Beeplant is a source of iron, which is sometimes lacking in diets that relied heavily on corn. It also provides calcium and Vitamin A.

Chenopodium sp. (Goosefoot)

Goosefoot grows well in disturbed areas. Rea (1997:71) stated that the Gila Pima cultivated the chenopods. The seeds were ground into meal and added to other flours. The tender leaves can be eaten in the spring. The Zuni use the plant medicinally as a tea. The Navajo used the plant to make a liniment, while the Acoma and Laguna use it as an emetic (Wheeler 1994:11). Two different species of Goosefoot were identified from Wolf Village.

Rumex sp. (Dock)

The Hopi encourage weedy annuals including dock in their otherwise carefully tended gardens as they produce greens that can be eaten in the spring. Dock is also used by the Hopi for a dye (Dunmire and Tierney 1997:37, 96). The seeds could be ground and used for breads. It is known as Indian tobacco. Dock produces abundant seeds. The plant often protrudes above snow cover providing a potential source of seeds in the winter (Harrington 1967:90).

Amsinkia sp. (Fiddleneck)

Fiddleneck is listed as a spring stress food. Rea (1997:213) describes the fiddleneck as springing up on the floodplains after the winter moisture. The plant is bristly and most likely would not have been eaten except as a stress food.

Physalis sp. (Ground-cherry)

Ground-cherry is considered to be a garden indicator plant. Pueblo people encouraged or intentionally introduced ground-cherry into their gardens. The plant has the ability to adapt to the environment and continue to thrive long after the fields have been abandoned. The fruits can be eaten fresh or cooked (Dunmire and Tierney 1997:62–64). The berries can also be dried and ground into meal for bread. Seeds of the ground-cherry are found in almost every fecal sample of the ancient Mesa Verde inhabitants (Harrington 1967:252) Seeds of the ground-cherry were found in fecal samples from the Fremont level of Spotten Cave. Early settlers in the Goshen Valley described ground-cherry as prolific.

Juniperus sp. (Juniper)

The juniper was used extensively by Native Americans. Juniper berries were eaten, particularly during times of famine. Juniper ashes were added to cornmeal by the Navajo when making cornbread. The plant is also used medicinally. Sweathouses were made from Juniper wood. Twigs and leaves were mixed with other plants and used for colds, headaches, stomachaches, nausea, acne, and spider bites. The Hopi gave women in labor a tea of juniper sprigs (Dunmire and Tierney 1997:126-128).

Plantago sp. (Plantain)

Plantain was used medicinally both internally and externally. Internally it was used to check diarrhea, and to soothe, cool and heal (Hutchens 1969:276). The Pima used it for diarrhea by placing the seeds in a container of water and letting it sit for a short time. The mixture jells. It was used in ancient times by the Pima as a famine food in the spring (Rea 997:118). The young leaves can also be eaten in the early spring or in a tea (Harrington 1967:86).

Lepidium sp. (Pepperweed)

Pepperweed produces hundreds of seedpod fruits. The seeds were used extensively by the ancestral Pueblo people. Evidence of the seed is often found in coprolites from the Four Corners region. It is also used medicinally for headaches, dizziness, and gastrointestinal disorders (Dunmire and Tierney1997:219-221).

Argemone sp. (Prickly poppy)

Prickly poppy was used medicinally by the Shoshone and the Paiute for burns and sores. It was also used for toothache and for an eye salve (Texas Archaeological Research Laboratory 2011).

Portulaca sp. (Purslane)

Native purslane was used extensively by the Pueblo people. It was considered an important food for both the seeds and the green parts of the plant that can be eaten fresh. They remain tender throughout the summer after other greens become tough. Purslane can also be dried for later use. The seeds were used for mush and breads after being ground. Purslane is very nutritious, and provides Vitamins A, C, and several B vitamins as well as calcium, iron, and protein. The plant has also been used medicinally as an antiseptic wash, or for diarrhea (Dunmire and Tierney1997:210).

Silene sp.

Very little information was available on Silene. Elpel (1967:68) states that Silene can be eaten as a pot herb, although some species are dry and woody. *Silene stellata* and *Silene virginica h*ave been used to expel worms.

Euphorbia sp. (Spurge)

Spurge is considered a medicinal plant. It was used as a laxative, but it best known for snakebite (Rea 1997:226).

Helianthus sp. (Sunflower)

The sunflower is considered to be a major food source for many of the ancient people. The seeds were ground into a meal for cakes, bread, and dumplings. The oil from the seed was important. The Hopi use the oil to grease the griddle when making piki bread. Sunflower pith was used by the Navajo to remove warts, and the seed hulls can be boiled to make a red dye (Wheeler 1994). Some of the Southwestern Native Americans ground the seeds and mixed them with ground corn to make a drink known as Pinole. Sunflowers have also been used for treating pre-natal infections

(Dunmire and Tierney1994:). The sunflower was the first seed planted in the spring by the Hidatsa around the edges of the fields (Wilson1987:16).

Eriogonum sp. (Buckwheat)

Buckwheat has both dietary and medicinal uses. The Hopi used the leaves as potherbs and the achene for making bread after it was ground. The Navajo used it extensively for internal injuries, backache, side ache, venereal disease, and other internal injuries. The Navajo also consider it a life medicine. Plant parts were eaten to cleanse the body before certain ceremonies (Dunmire and Tierney 1994:204).

Brassica sp. (Mustard)

The plants in the mustard family generally have a pungent flavor, and can be used both as food and as a flavoring. The greens of the mustard plant could be eaten when young. The plants provide calcium, potassium, B vitamins, beta carotene, vitamin C and fiber (Brill1994:247-249). The Pima used the mustard plant as follows. The seed was roasted, ground and then mixed with water to make a drink. A cold drink of raw seeds was also made. It was reported that a seed placed in an irritated eye would aid in removing the irritant by incorporating it into the mucous that gathers in the corner of the eye (Rea 223–224).

Summary for plants identified from flotation analysis

The different uses of the plants provide clues as to how the Fremont may have used the plants and how they contributed to the subsistence base. It is interesting to note that the accounts include information that Native American farmers from the past encouraged amaranth, goosefoot, beeplant, dock, ground-cherry, and the sunflower to grow in or around their fields. It could be said that a symbiotic relationship between the native weedy plants and the cultivated plants developed that provided a broader subsistence base than corn and beans could provide. These plants could have been found in the environment naturally, but were important enough in providing variety, nutrients, and early greens and seeds before the corn and beans were available, that different cultures either encouraged them to grow in the fields, or intentionally planted them along with the corn and beans. Many of the plants recovered were used medicinally as well as in the diet, although prickly poppy, spurge, and silene were listed as medicinal only.

Marsh resources would have contributed to the diversity of the diet and provided food from early spring to late fall. Marshes are currently located within three to six miles of Wolf Village, and may have been found closer to the site during wet years, or years with greater rainfall or snowmelt. Serviceberry, chokecherry, and wild raspberry all grow abundantly in the mountains. Foraging trips would have been required to collect those as well as the bistort. Perhaps they were collected during hunting trips into the mountains. Evidence has been found for mountain sheep at Wolf village, and hunting them would require travel to the mountainous regions.

An examination of the different ethnographic uses of the plants, and the areas from which each of the plants identified is found, contributes substantially to an understanding of the subsistence base of the Wolf Village inhabitants and will be discussed in the next chapter.

6 Summary and Conclusions

When defining the subsistence base of a past culture, it is not enough to know that the people of the past were foraging for wild foods. It is critical to examine what plants were incorporated into the subsistence base, what season they were available in, and what contribution those plants might have made to the diet.

The Fremont people are often depicted as practicing a mixed farming/foraging strategy, rather than dedicated farmers. The evidence from flotation analysis, and the macrobotanical remains recovered from screening, indicates there is a strong possibility that farming was the economic basis for subsistence at Wolf Village. Evidence of maize was ubiquitous throughout the site, with the exception of Extramural Pit 1 which did not contain any macrobotanicals. Foraging definitely played a role in the subsistence base. The ethnographic accounts of plant use provided insight as to how the native plants may have contributed to the subsistence base at Wolf Village, but it is still difficult to determine the economic importance of those foraged plants to the Fremont. Were they supplementary to the cultivated foods, or did they play a larger role in the subsistence base?

The identified wild plants fall into several categories that suggest their use as supplements to a maize-based horticultural economy. These include weedy plants that likely grew in agricultural fields, plants whose documented ethnographic uses were as famine foods, plants that were used primarily in the spring or early summer before maize would have been available for harvest, and medicinal plants. Most of the plants could have been found near the site, and those that weren't, such as berries, are unlikely to have contributed many calories.

Several of the wild plants fall into the category of weedy plants that have been encouraged by farming cultures of the past to grow in or around the fields to provide a broader subsistence base in the form of variety, nutrients, and early greens and seeds that were available before the maize was ready for harvest. These include the dock, amaranth, beeplant, goosefoot, sunflower, and ground-cherry plants.

Silene, fiddleneck, and swampweed were all considered famine foods in the ethnographic information. Plants that can be referred to as stress foods or famine foods played an important role in the subsistence of any indigenous society. Minnis (1991) defined stress foods as those that are edible and available when more frequently consumed rations are not available. Food shortages can occur as a result of drought or other environmental factors, such as too much or too little rain during the growing season. There is also a hunger season, or a time when the preferred food supplies are running low and the most economically important foods are not ripe for foraging, or the crops are not ready for harvesting. This is the time period that stress season foods play an important role in the subsistence strategy of indigenous societies. They provide sustenance during a critical time period. Farmers are reliant on crops that are usually harvested for a one or two month period in the fall. Enough food has to be grown, processed, and prepared for storage to last an entire year. Stress foods would be particularly important in the spring and into the early summer, as that would be the time when stored food supplies would be running low or gone.

Several of the plants that were identified from the flotation analysis may have provided seasonal sustenance during those time periods. Many of them provided greens in the early spring, and several produced seeds that ripened before the time of harvest. Dock, amaranth, beeplant, and goosefoot are referred to as providing food at a time of the year that food resources may have been low in the form of early greens and seeds that could be gathered in the early spring and summer. Cattail and bulrush may have been particularly important in the spring as they provided not only greens, but the young shoots could be eaten, and as the season progressed, the spike from the flower stalk could be harvested and eaten in the same manner as roasting ears (Harrington 1967). The cattail plant has parts that are edible from spring into the fall, contributing to the subsistence base both in spring, when food reserves might have been low, and later for variation in the diet.

Another important source of food for many Native Americans was Indian ricegrass (Doebley 1984). It grew in abundance before the introduction of cattle and other domesticated animals in the west and is a cool season grass that ripens in the early summer before other foraged or cultivated foods are ready. *Sporobolus* spp. and *Panicum* spp.were also harvested by several groups, but not to the extent that Indian ricegrass was. All three of the grasses ripen in the early summer, have a large grain, and were easy to process. Grasses were found in abundance in Utah Valley at the time the white explorers and settlers came in, and there was evidence of grass use at Wolf Village.

Four of the plants identified are native to mountainous areas. Use of the Serviceberry, chokecherry, and wild raspberry were indicated from flotation analysis. Bistort is also found at higher elevations and was identified from pollen analysis. This group of plants probably added variety and flavor to the diet, but would have required travel. They may have been collected on hunting trips into the mountains for mountain sheep or mule deer. Prickly poppy and spurge were used ethnographically as medicinal plants, with no record of dietary use. Several of the other plants were used for both medicinal and dietary purposes.

A resource that is abundant in the valley, but does not show much evidence of use, is the acorn. The Gambel oak is native to the foothills at an elevation of 5000 to 8000 feet. Acorn shell fragments may not preserve well, as charring is not required to remove the shell and the acorn is not parched before being ground into flour for breads or mush. The acorn from the oaks that are native to the area are smaller than the acorns that were relied on for subsistence by many California Native American groups, but they are also sweet and do not require leaching to remove the tannin, unlike the larger California acorns (Dunmire and Tierney1997). Southwestern people did incorporate the acorn into their diet (Wheeler 1994). The Gambel oak grows prolifically in the foothills in

Utah, and could have contributed substantially to the subsistence base, but there is not any definite evidence for use. Several shell fragments were found in Structure 7, two fragments were found in Stucture 2, but as they are not charred, it is not known if they were modern introductions, or if they were associated with the structures.

Results from the groundstone analysis do not add to the conclusion one way or the other. The results do indicate that different manos were used for different types of plants, for instance three of the manos showed evidence for grinding seeds of the cheno-ams, with little or no evidence for grinding corn. The other manos show evidence of corn processing along with some cattail.

Foraging was common practice for both hunter/gatherer cultures, and for farming cultures of the past but the economic importance of the foraged food is different for farmers than for hunter-gatherers. Doebley (1984) compared the diets of the Hopi, a farming society, and the Paiute, who rely on a hunter/gatherer subsistence base. "Though the main food supply for the Hopi comes from agriculture, there are some wild plants which provide an important means of sustenance. Chief among these are several wild grasses." His findings for the Paiute were that "while many different plants furnished seeds that were used, by far the greater portion came from the grasses and members of the Chenopodiaceae." Both cultures exploited the grasses that grew abundantly, both foraged, but cultivated crops provided the main source of plant food for the Hopi and foraged foods provided the main source of plant food for the Paiute.

A determination of the economic contribution that domesticates and wild foods provided to the subsistence base is essential to come to a consensus on whether or not the Fremont were dedicated farmers, or whether they should continue to be referred to as practicing a mixed farming/foraging strategy. Carbon isotopes studies were done by Coltrain (1993) for Fremont and Pueblo burials to compare the degree of maize reliance between the two groups. Coltrain's (1993:52) research showed that a C4 diet compromised 73 to 85 percent of the diet for all sites that were included in the study. Backhoe Village is a Fremont village that was included in the study. The carbon isotope studies for Backhoe Village show that C4 foods comprised 85 percent of the diet. Maize is a C4 food. Backhoe Village was initially reported as showing a much heavier reliance on marsh and wild resources than on maize, with cattail providing the necessary economic base that allowed sedentism (Madsen and Lindsey 1977:87).

Backhoe Village compares with Wolf Village in that they are both village sites located near marsh resources, and both have evidence of domesticates and wild foods. Two studies have been done from different areas of Backhoe Village. A review of the macrobotanicals reported for Backhoe Village by Seddon (2001) show that corn had a 29 percent ubiquity from flotation samples, and cheno-ams had an 11 percent ubiquity. A review of the macrobotanicals that were reported for Backhoe Village by Madsen and Lindsey (1977) show 8 percent ubiquity for *helianthus spp.*, yucca, and *asteraceae* and 42 percent ubiquity for maize from the flotation analysis. Wolf Village had a ubiquity of 75 percent for maize, and a ubiquity of 42 percent for Indian ricegrass and goosefoot (chenopodiaceae) from the flotation samples. Ubiquity for maize is much higher at Wolf Village. Burials have not been found at Wolf Village that would allow carbon isotope studies, but if corn compromised 85 percent of the diet at Backhoe Village with a ubiquity of 42 percent for maize, logic would indicate that the inhabitants of Wolf Village were as reliant on maize as the inhabitants of Backhoe Village. There is a broader representation of wild foods than Backhoe Village had (Table 25) indicating that wild or foraged foods were still important to the inhabitants of Wolf Village.

Insight into how the wild plants may have contributed to the subsistence base at Wolf Village combined with the consistent presence of three types of corn throughout the site point to a subsistence strategy based on farming. The recovery of two varieties of beans, and evidence of squash from Spotten Cave further add to the conclusion. The majority of the wild plants that were identified could have been gathered in the vicinity of Wolf Village, and are commonly used by other farming societies to provide sustenance at a time of the year when food supplies may have been running low. The wild plants would have contributed needed nutrients and variety, without pulling the inhabitants away from the requirements of successful farming. While the evidence for farming is strong, it is not conclusive. Arguments can still be made either way. As mentioned previously, both farming and hunter/gatherer societies used foraged plants. The deciding factor is the economic importance of the cultivated or foraged plants and how they contributed to the subsistence base. The fact that the Fremont foraged for wild foods does not preclude them from being defined as a farming society. Farming is the subsistence base for the Pima. A few of the elderly Pima from the Gila River Valley can still recognize 260 plants and how they are used from the environment they live in (Rea1997:xv). Knowledge of both cultivated and foraged plants is passed from generation to generation and plays a role in defining who different cultures are and what their subsistence is based on.

Although this thesis does not go beyond the scope of Wolf Village, all of the plants identified from the flotation analysis for Wolf Village, except the thistle, prickly poppy, and plantain (all of which are found in the vicinity of Wolf Village), were found in previous flotation analysis from other Fremont sites (Table 7) or in Tables 1 through 4 of native plants identified in the vicinity of Wolf Village. This would suggest that there was a consistency in wild plant use by the Fremont.

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Appendix A

POLLEN ANALYSIS OF SAMPLES FROM WOLF VILLAGE,
GOSHEN CANYON, UTAH

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INTRODUCTION

Wolf Village, 42UT273, is a Fremont site located north of the mouth of Goshen Canyon in Utah County, Utah. Radiocarbon dates on corn from this site range from AD 840 to 1000. Investigating the subsistence base at this site includes examining groundstone for the recovery of pollen. Evidence for grinding agricultural products and native plants will be discussed.

METHODS

Groundstone Washes for Pollen and Starch

The use of groundstone in processing plants and animals may leave evidence on the artifact surface that include concentrations of pollen and starch. This evidence may be recovered by washing the ground surfaces.

First, all visible dirt was removed using tap water and gentle hand pressure to remove any modern contaminants. A small portion of each ground surface was tested with dilute (10%) hydrochloric acid (HCl) to detect the presence of any calcium carbonates. If present, these carbonates were removed with additional dilute HCl. Then, the ground surfaces were washed with a 0.5% Triton X-100 solution to recover any pollen and starch grains. The surface was scrubbed with an ultrasonic toothbrush and rinsed thoroughly with reverse osmosis deionized (RODI) water. Each sample was then sieved through 250-micron mesh to eliminate any large particles that might have been released during the washing process. After centrifuging, the samples were dried under vacuum, then mixed with sodium polytungstate (density 1.8) and centrifuged to separate the pollen and starch, which will float, from the silica, which will not. The samples were treated with hydrofluoric (HF) acid to remove silica, then acetylated for 3–5 minutes to remove any extraneous organic matter. The samples were rinsed several times with RODI water, then stained with basic fuchsin. A light microscope was used to count the pollen at a magnification of 500x. The pollen preservation in these samples varied from good to poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

The pollen diagrams were produced using Tilia 2.0 and TGView 2.0.2. A plus (+) on the pollen diagram indicates that the pollen type was observed outside the regular count while scanning the remainder of the microscope slide. Total pollen concentrations were calculated in Tilia using the measurement in cm^2 of the ground/use surface washed, the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per cm^2 of use surface. "Indeterminate" pollen includes pollen grains that are folded, mutilated, or otherwise distorted beyond recognition. These grains were included in the total pollen count, as they are part of the pollen record. The estimated microscopic charcoal abundance was calculated by recording individual microscopic pieces of charcoal during a portion of the pollen count, then allowing the computer to extrapolate from those observations to the quantity of charcoal present in the total count. This number is presented on the pollen diagram.

The pollen analysis also included examination for starch granules and, if they were present, their assignment to general categories. Starch granules are a plant's mechanism for storing carbohydrates. Starches are found in numerous seeds, as well as in starchy roots and tubers. The primary categories of starches include the following: with or without visible hila, hilum centric or eccentric, hila patterns (dot, cracked, elongated), and shape of starch (angular, ellipse, circular, eccentric). Some of these starch categories are typical of specific plants, while others are more common and tend to occur in many different types of plants.

ETHNOBOTANIC REVIEW

It is a commonly accepted practice in archaeological studies to reference ethnographically documented plant uses as indicators of possible or even probable plant uses in prehistoric times. The ethnobotanic literature provides evidence for the exploitation of numerous plants in historic times, both by broad categories and by specific example. The presence of numerous sources of evidence for exploitation of a given resource can suggest widespread utilization and strengthens the possibility that the same or similar resources were used in prehistoric times. Ethnographic sources both inside and outside the study area have been consulted to permit a more exhaustive review of potential uses for each plant. Ethnographic sources document that the historic use of some plants was a carryover from the past. A plant with medicinal qualities is likely to have been discovered in prehistoric times, with is use persisting into historic times. There is, however, likely to have been a loss of knowledge concerning the utilization of plant resources as cultures moved from subsistence to agricultural economies and/or were introduced to European foods during the historic period. The ethnobotanic literature serves only as a guide indicating that the potential for use existed in prehistoric times, not as conclusive evidence that the resources were if fact used. Pollen and macrofloral remains, when compared with the material culture (artifacts and features) recovered by the archaeologists, can become indicators of use. Plants represented by pollen and starch will be discussed in the following paragraphs in order to provide an ethnobotanic background for discussing the remains.

Native Plants

Brassicaceae (Mustard family)

The Brassicaceae (mustard family) is a large family consisting of annual to perennial herbs or, rarely, small shrubs. Several members of the Brassicaceae (mustard family), such as *Capsella* (shepherd's purse), *Descurainia* (tansy-mustard), and *Lepidium* (pepperweed), are noted to have been exploited for their greens and seeds. The young plants can be eaten raw or cooked as potherbs. Tilford (1997:158) notes that "the raw or cooked greens of young plants are highly nutritious, containing considerable amounts of trace minerals and vitamins A, B, and C." The parched and ground seeds were used to make a flour, thicken soup, and to make pinole. Brassicaceae seeds begin to ripen in early summer and some species are available into the fall. Seeds of this family also are known to stimulate production of digestive juices in the stomach and aid in digestion. *Capsella* is useful for stopping internal or external bleeding (Fernald 1950; Harrington 1967; Hickey and King 1981:150; Kirk 1975; Sweet 1976:56; Tilford 1997:158).

Cheno-ams

Cheno-ams are a group of plants that include *Amaranthus* (pigweed) and members of the Chenopodiaceae (goosefoot) family, such as *Atriplex* (saltbush), *Chenopodium* (goosefoot), *Cycloloma atriplicifolium* (winged pigweed), *Monolepis* (povertyweed, patata), *Sarcobatus* (greasewood), and *Suaeda* (seepweed). These plants are weedy annuals or perennials, often growing in disturbed areas such as cultivated fields and site vicinities. Plants were exploited for both their greens and seeds, which are very nutritious. Young shoots and stems can be eaten fresh or cooked as greens, either alone or with other foods. The greens are most tender in the spring when young but can be used at any time. The small seeds can be eaten raw, but most often they were ground into a meal and used to make a variety of mushes and cakes. The seeds usually are noted to have been parched prior to grinding. Various parts of Cheno-am plants are noted to have been gathered from early spring (greens) through the fall (seeds) (Harrington 1967:55-62, 69-71, 80-82, 234-236; 1972:68-71, 82-84; Kirk 1975:56-63; Sweet 1976:48; Tilford 1997:14-15, 88-89).

***Amaranthus* (Amaranth, Pigweed)**

Amaranthus leaves were an important source of protein, iron, and vitamin C and are reported to have an asparagus-like flavor. *Amaranthus* poultices were used to reduce swellings and to soothe aching teeth. A leaf tea was used to stop bleeding, as well as to treat dysentery, ulcers, diarrhea, mouth sores, sore throats, and hoarseness (Angier 1978:33-34; Harris 1972:58; Kirk 1975:63; Krochmal and Krochmal 1973:34-35; Tilford 1997:14).

***Atriplex* (Saltbush)**

Atriplex (saltbush) occurs as both an annual herb and perennial shrub. The leaves and young shoots have a salty taste and can be used as a potherb or seasoning. A poultice of the chewed plant was applied to ant, bee, and wasp sting swellings. *A. canescens* (four-wing saltbush) was used for stomach pain or as an emetic. Dried leaves were used as a snuff for nose trouble, and a poultice of the warm, pulverized root was applied to toothaches (Moerman 1986:85-86; Weiner 1972:75). *Atriplex* seeds are very nutritious and were ground into a meal, mixed with water and drunk as a beverage, or mixed with some other meal and used as flour. The seeds do not ripen until mid-fall and can remain on the shrubs throughout the winter into the next growing season. *Atriplex* is found widely scattered throughout the western United States in waste places and fields, growing in arid, alkaline, or saline soils (Kirk 1975:59; Muenscher 1987:180).

***Chenopodium* (Goosefoot)**

Chenopodium seeds were important resources for Fremont groups (Madsen 1989). *Chenopodium* is a weedy annual capable of producing large quantities of seeds that can be harvested in the late summer and fall. The red fleshy fruit clusters of *Chenopodium capitatum* (strawberry blite) were eaten raw or cooked. *Chenopodium* leaves are rich in vitamin C and were eaten to treat stomachaches and to prevent scurvy. Leaf poultices were applied to burns, and a tea made from the whole plant was used to treat diarrhea. *Chenopodium* is commonly found in cultivated fields, waste places, open woods or thickets, and on stony hills. It is an opportunistic weed, often establishing itself rapidly in disturbed areas (Fernald 1950:592-596; Kirk 1975:56-57; Martin 1972:44-45; Sweet 1976:48).

***Sarcobatus* (Greasewood)**

Sarcobatus (greasewood) is a highly branched, somewhat spiny shrub most often found in alkaline or saline soil in the more arid areas of the western United States. The young twigs can be cut into short pieces, boiled for several hours until tender, then eaten (Kirk 1975:62; Medsger 1966:142; Mozingo 1987:80-86). Greasewood, saltbush, and willow or cottonwood were used to construct a brush pole structure similar to a wickiup at Topaz Slough, a Fremont site in the Sevier Desert dating to about 900 years ago (Madsen 1989:58-60).

***Monolepis* (Poverty weed)**

Monolepis is an annual, slightly succulent herb. The leaves and stems can be eaten as a potherb, and the seeds can be ground and used as a meal. The roots also can be eaten raw or cooked. This plant is found on moist or dry, often saline, ground throughout the West, often in disturbed areas (Dorn 1992:135; Kirk 1975:59).

***Suaeda* (Seepweed)**

Suaeda (seepweed) greens are noted to have been collected in April with cholla buds, dried, and stored for later use. Greens were packed around cholla buds when they were roasted. The seeds were also ground into meal and frequently mixed with cornmeal. The Hopi applied the dried leaves to sores (Greenhouse et al. 1981:238; Kearney and Peebles 1960:263).

Poaceae (Grass Family)

Members of the Poaceae (grass) family have been widely used as a food resource, including *Agropyron* (wheatgrass), *Hordeum* (little barley grass), *Elymus* (ryegrass), *Eragrostis* (lovegrass), *Achnatherum* (ricegrass), *Poa* (bluegrass), *Sporobolus* (dropseed), and others. Grass grains could be eaten raw but usually were parched and ground into a meal to make various mushes and cakes. Several species of grass contain hairs (awns) that were singed off by exposing the seeds to flame. Young shoots and leaves were cooked as greens. Roots were eaten raw, roasted, or dried and ground into a flour. Grass also is reported to have been used as a floor covering, tinder, basketry material, and to make brushes and brooms. Grass seeds ripen from spring to fall, depending on the species, providing a long-term available resource (Chamberlin 1964:372; Fowler 1986:76-77; Harrington 1967:322; Kirk 1975:177-190; Liljeblad and Fowler 1986:416-417).

***Polygonum* (Smartweed, Knotweed)**

Polygonum (smartweed, knotweed) is a large genus of annual or perennial plants characterized by the angular joints of their stems that look like knots tied in the stem at the base of each alternate leaf. The seeds of *Polygonum* were parched and ground into a meal. The leaves of some species were collected in the spring and used raw in salads or cooked as potherbs. Some species' leaves are peppery and make a good seasoning. Young stems also can be eaten like asparagus. *P. bistortoides* and *P. viviparum* have starchy roots that are edible raw and boiled, but are best when roasted. The whole plant was poulticed for pain, and rubbed on poison ivy rashes and horses's backs to keep the flies away. A tea made from the entire plant of *P. pennsylvanicum* was used for diarrhea. A tea made from the leaves of *P. persicaria* was used for heart troubles, stomachaches, and as a foot soak for rheumatic pains of the legs and feet. *Polygonum* plants are found in a variety of habitats throughout the West, including disturbed, moist, dry, saline, rocky, sunny, and shady soils (Albee et al. 1988:491-494; Foster and Duke 1990:160; Harrington 1967:196; Kirk 1975:56; Tilford 1997:18-19).

***Typha* (Cattail)**

Typha (cattail) is a perennial marsh or aquatic plant with creeping rhizomes. This plant is a rich source of nutrients. Native American groups used various parts of the cattail plant throughout the year. In the spring, young shoots were peeled and the inner portion eaten raw or cooked as potherbs. During the summer, young flowers stalks were taken out of their sheaths and cooked. Flowers were eaten alone or added as a flavoring or thickening for other foods. Pollen-producing flowers and the pollen itself were collected and used as flour, either alone or mixed with other meal. In the fall, the rootstalks were collected, the outer peel removed, and the white inner cores of almost pure starch were eaten raw, boiled, baked, or dried and ground into flour. Cattail roots were richer in starch during the fall. Cattail starch flour is noted to be similar in quantities of fats, proteins, and carbohydrates to flour from rice and corn. The seed-like fruits also were collected and eaten in the fall. Native groups processed these "seeds" by burning off the bristles. The seeds were then parched and could be more easily rubbed off the spike. The slightly astringent flower heads were sometimes used to relieve diarrhea and other digestive disorders. Cattail down was used as dressing for wounds and padding in cradle boards. The leaves and stems were used for weaving mats. Cattails are found in marshy habitats in or near swamps, ponds, sloughs, and edges of streams (Harrington 1967:220-224; Kirk 1975:171; Sweet 1976:8; Tilford 1997:28-29).

<u>Cultigens</u>

Zea mays (Maize, Corn)

Zea mays (maize, corn) has been an important New World cultigen, originating from a wild grass called teosinte. At the time of European contact, Heiser (1990:89) notes, "maize was the most widely grown plant in the Americas, extending from southern Canada to southern South America, growing at sea level in some places and at elevations higher than eleven thousand feet in others." Maize has long been a staple of the Southwest inhabitants, and charred maize is found in almost every cliffhouse in the Southwest (Stevenson 1915:73). Maize is by far the most common remain in Anasazi coprolitic material from Basketmaker III to Pueblo times (Clary 1983; Minnis n.d.; Moore 1978; Stiger 1977; Williams-Dean 1986; Williams-Dean and Vaughn M. Bryant 1975). Maize can show great variability in kernel color, size, and shape; in ear size and shape; and in maturation time. Five types of maize exist, characterized by a different endosperm composition. Pop and flint corn have a hard starch and a high protein content. Flour corn has a soft starch and little protein. Dent corn has a localized deposit of soft starch on top of a hard starch that leaves a depression or dent in the top of the dried kernels. Sweet corn stores more sugar than starch. Innumerable ways of preparing maize exist. Green corn was eaten raw or boiled. Mature ears were eaten roasted or wrapped in corn husks and boiled. The kernels were popped, parched, boiled, or ground and made into a meal. Kernels also were soaked in *Juniperus* (juniper) wood ashes and made into hominy. Cornmeal can be colored with *Atriplex* (saltbush) ashes. Black corn is used as a dye for basketry and textiles and as a body paint. Maize can be husked immediately upon harvesting. Clean husks were saved for smoking and other uses, such as wrapping food. Corn also was sometimes shelled prior to storage. Ears were allowed to dry on the roof, and ristras of maize were hung inside from the roof (Heiser 1990:89-98; Mangelsdorf 1974; McGee 1984:240-242; Stevenson 1915:73-76).

PARASITE REVIEW

<u>*Trichuris trichiura* (Whipworm)</u>

Trichuris trichiura (whipworm) resembles a buggy whip and can average 40 millimeters (nearly 16 inches) in length for the female. Unlike *Ascaris* (roundworm), which lives free and unattached in the small intestine, whipworm lives primarily in the cecum, where it attaches itself to the intestinal wall. In heavy infestations, however, they may be found along the entire colon including the rectum. Whipworms are longer lived than roundworms, living for several years and producing eggs for discharge in the feces. The eggs develop into an infective larval stage within the eggshell in three to six weeks. Adverse conditions can delay development for several months or even years. Once the embryos are ingested, the larvae hatch in the jejunum, penetrating the intestinal villus, where it will develop for three to ten days. The adolescent worm moves into the cecum, where it develops into an adult. Ninety days are required between ingestion and production of a gravid female (Beck and Davies 1976:84-86).

Infections are common in areas of high humidity and hard clay soils, which hold moisture. Dense shade and a warm climate are both necessities. Infection is usually heaviest among children, since hand to mouth contact in areas of soil pollution is a common vector in spreading these parasites. Whipworm eggs are less resistant to environmental changes, so infection might be more spotty than *Ascaris* (roundworm), with which it often co-occurs (Beck and Davies 1976:84-86).

Light infestations with whipworm might produce no symptoms. Abdominal pain sometimes mimicking appendicitis, vomiting, constipation, fever, distension and flatulence, headache, backache, anorexia, and weight loss have all been associated with infestation by this parasite. If the infection is heavy, bloody diarrhea and emaciation can result. Prolapse of the rectum can also occur with heavy worm burdens. Fatalities are rare even in malnourished and neglected children. Whipworm is more difficult to treat than roundworm, since the worms are embedded in the intestine (Beck and Davies 1976:84-86).

DISCUSSION

Wolf Village was a Fremont site occupied between approximately AD 840 and 1000. The site is situated near Current Creek, a perennial stream near the mouth of Goshen Canyon. This village contained 13 structures, seven of which are dispersed across the landscape (Dahle, personal communication, August, 2011). Five manos recovered from three structures were selected for pollen analysis (Table 1). Two manos, labeled 3771A and 3771B, were recovered from a vent shaft associated with an adobe structure (F. 145). This area also contained a deer mandible, a figurine, and several figurine fragments. Two manos, represented by samples 5710 and 7907, were recovered from a 10-meter structure excavated during the spring of 2011. Finally, sample 6467 was associated with a pithouse.

Structure 6

Two manos were removed from a vent shaft associated with an aboveground adobe structure (Structure 6) located toward the north end of the site. These manos are represented by samples 3771A and 3771B. The pollen signatures for these two manos were very different from one another.

Sample 3771A yielded a pollen record dominated by Cheno-am pollen, with *Artemisia* pollen as the sub-dominant type. In addition, small quantities of *Alnus*, *Juniperus*, *Pinus*, High-spine Asteraceae, Liguliflorae, Brassicaceae, *Sarcobatus*, Fabaceae, *Plantago*, Poaceae, and *Typha* were observed, representing alder, juniper, pine, various members of the sunflower family including the chicory tribe, members of the mustard family, greasewood, legumes, plantain, grasses, and cattail. Pollen preservation was good, as is exhibited by the very small quantity of indeterminate pollen recorded for this sample. This pollen signature suggests very strongly that Cheno-am seeds were ground using this mano. In addition, it is possible that seeds from a member of the mustard family, and grass seeds also were ground. Recovery of a single eccentric starch from this sample suggests that roots also were ground using this mano. Cattails do not produce this type of starch, so they may be excluded from the interpretation of grinding roots with this mano. A moderately large quantity of microscopic charcoal was noted in this sample, suggesting the possibility that this charcoal was introduced either through use of this tool near a hearth, or possibly from its burial in the vent shaft. This sample yielded approximately 70 pollen per square centimeter of ground surface.

Sample 3771B was dominated by *Artemisia* pollen, which is likely an environmental signature. Small quantities of *Juniperus*, *Pinus*, High-spine Asteraceae, *Sarcobatus*, and Poaceae pollen represent plants growing as part of the local vegetation community that included juniper, pine, members of the sunflower family, greasewood, and grasses. The elevated *Typha latifolia*-type pollen recorded in this sample strongly suggests grinding cattail with this mano. Further, it is more likely that cattail pollen was shaken from the spike of the plant prior to maturation of the seeds. When cattails pollinate they produce very large quantities of pollen which may be shaken loose from the characteristic brown, fuzzy spikes on the plants. As the seeds mature, it is likely that some pollen is also retained and may travel with the harvested seeds. Immature spikes containing pollen also might have been collected. This sample exhibits a much larger quantity of *Typha* pollen than did the other sample collected from this vent shaft or any of the other manos examined from this site, making an interpretation of processing cattail pollen very likely for this mano. A small quantity of *Zea mays* pollen was observed while scanning this slide, indicating that maize also was ground using this mano. The quantity of Poaceae pollen was very similar to that noted for the other mano recovered from this vent shaft, suggesting that this mano also was used to grind grass seeds. This mano contained a smaller percentage of microscopic charcoal than did the other mano recovered from this vent shaft. A total pollen concentration of more than 110 pollen per square centimeter of ground surface was tallied.

Structure 2

A 10-m structure (Structure 2) located at the south end of the site on flatter terrain than Structure 6 was excavated during the spring of 2011. This structure yielded two manos that were submitted for pollen analysis. The structure has not been completely excavated although it was located to the west of the structure that may have provided access. Sample 5710 represents a mano that was recovered from fill below the duff layer. This sample yielded a moderately large quantity of Cheno-am pollen, accompanied by aggregates, as well as moderate quantities of *Pinus* and *Sarcobatus* pollen, and small quantities of *Juniperus*, *Abies*, *Artemisia*, Low-spine Asteraceae, High-spine Asteraceae, Poaceae, *Eriogonum*, and *Typha latifolia*-type pollen. These pollen represent local plants that included at least pine, greasewood, juniper, fir (growing in the mountains), sagebrush, various members of the sunflower family, grasses, wild buckwheat, and cattails growing in a nearby riparian habitat. The elevated quantity of Cheno-am pollen likely represents grinding goosefoot and/or amaranth seeds using this mano. The elevated *Sarcobatus* pollen suggests that this mano was used in a location close to heavy growth of greasewood. It is unlikely that any portion of the greasewood plant would have been processed. This sample contained a *Trichuris* parasite egg, indicating an infestation of this population by whipworm. The most likely explanation for recovery of this treacherous egg on a mano wash is a difference in sanitary practices. It is highly unlikely that people of this era washed their hands on a regular basis. Transmission of parasite eggs is likely the result of failure to wash hands after using the bathroom and before cooking or processing foods. While it is somewhat surprising to find this parasite egg on a groundstone tool, it simply represents infestation of this population by whipworm. This mano wash contained a relatively small quantity of microscopic charcoal and yielded a total pollen concentration of slightly more than 300 pollen per square centimeter of ground stone surface.

Sample 7907 represents another mano recovered from the rooffall of this 10-m structure. Its association in this position within the excavation suggests that it was used on the roof, rather than inside the structure. The pollen signature for this sample was significantly different than that for sample 5710. A larger quantity of *Artemisia* and smaller quantity of Cheno-am pollen was observed, suggesting a greater contribution of the environment to this pollen signature. Moderate to moderately small quantities of High-spine Asteraceae and *Sarcobatus* pollen represent various members of the sunflower family and greasewood, which would have been expected as part of the local vegetation community. The presence of small quantities of *Acer negundo*, *Juniperus*, *Pinus*, Low-spine Asteraceae, Liguliflorae, *Ephedra nevadensis*-type, Fabaceae, Poaceae, and Rosaceae pollen document local growth of boxelder, juniper, pine, members of the sunflower family that include marsh elder type and members of the chicory tribe, ephedra, legumes, grasses, and a member of the rose family. The elevated quantity of *Polygonum* bistort-type pollen suggests that someone transported bistort from a montane or montane foothills vegetation community to the site. Bistort prefers moist ground, and does not grow in dry areas. Since this pollen is so rare in the archaeobotanic record, it is highly likely that its presence on this mano represents grinding bistort roots or perhaps including bistort leaves with other foods being ground. This plant flowers from late spring until mid- to late summer. The quantity of Typha pollen recovered from this sample is not sufficient to interpret positively the use of this mano for grinding cattail. It is, however, suggested. Recovery of *Zea mays* pollen while scanning this sample indicates that maize was ground, probably on the roof of the structure. The presence of grass seed starch can probably be attributed to grinding maize, since this type of starch is fairly ubiquitous in many types of grass, including some of the cultivated grasses such as maize. This sample yielded a large quantity of microscopic charcoal, suggesting that it was exposed to fire. The total pollen concentration of only slightly more than 70 pollen per square centimeter of ground surface is relatively low.

Structure 4

Sample 6467 represents a mano recovered from a pithouse (Structure 4) located in the southwest portion of the site. The pollen signature from this mano was heavily dominated by Cheno-am pollen, indicating grinding goosefoot or possibly amaranth seeds. Recovery of small quantities of *Juniperus*, *Pinus*, *Artemisia*,High-spine Asteraceae, *Sarcobatus*, *Ephedra nevadensis*-type, Fabaceae, and *Typha* pollen from this sample indicates the availability of juniper, pine, sagebrush, various members of the sunflower family, greasewood, ephedra, legumes, and cattails. Weak evidence was noted for the possibility of grinding cattail products that included pollen. Very little microscopic charcoal was noted in this sample, which yielded a total pollen concentration of more than 200 pollen per square centimeter of ground surface. This mano appears to have been used primarily to grind goosefoot or possibly amaranth seeds.

SUMMARY AND CONCLUSIONS

The examination of five manos for pollen evidence of plant processing has yielded evidence for processing native goosefoot or possibly amaranth seeds on three of these manos, represented by samples 3771A, 5710, and 6467. It is interesting to note that this distribution of evidence includes one mano from each of the structures examined. Evidence for grinding maize was recovered from the two manos that did not exhibit strong evidence for grinding goosefoot or amaranth seeds. This suggests specialization of tools. Evidence for grinding cattails that included pollen, was observed primarily on the mano represented by sample 3771B, although it is also possible that manos represented by samples 3771A and 7907 also were used for grinding cattails. If any of these manos were used to grind native grass seeds, it was likely to have been the two models recovered from the vent shaft, represented by samples 3771A and 3771B, and possibly the mano recovered from the roof fall of the 10 meter structure, represented by sample 7907. This mano, recovered from the roof fall, also yielded a moderately large quantity of pollen from bistort, suggesting that roots from this montane plant were ground. Only the mano represented by sample 3771A yielded Brassicaceae pollen, suggesting the possibility that seeds from a member of the mustard family were ground. An eccentric starch recovered from this same sample suggests the probability that roots that have not been identified further were ground. This study provides ample evidence of grinding seeds, pollen, and roots from native plants and only minimal evidence of grinding agricultural products, which includes maize. It is possible that tool use specialization is represented by the recovery of *Zea mays* pollen only from samples that yielded small quantities of Cheno-am pollen. The recovery of a parasite egg from one of the manos recovered from the 10-meter structure indicates that the population of Fremont people living at Wolf Village suffered from intestinal parasites that included whipworm.

TABLE 1. PROVENIENCE DATA FOR SAMPLES FROM SITE 42UT273, WOLF VILLAGE, UTAH

FS No.	Feature No.	Unit	Level	Depth	Provenience/ Description	Analysis
3771A	F220 in F145 in F3	577E 554N			Groundstone from an above ground adobe structure	Pollen
3771B						Pollen
5710	F171 in F328 in F4	587E 391N	2	0.53-0.58 mbd	Groundstone from a 10-meter structure not yet fully excavated	Pollen
7907	F193 in F196 in F4	687E 396N	9	.88-.93 mbd	Groundstone from a 10-meter structure not yet fully excavated	Pollen
6467	F293 in F292 in F5	457E 393N		0.76 mbd	Groundstone from a pithouse	Pollen

FTIR = Fourier Transform Infrared Spectroscopy

TABLE 2. POLLEN TYPES OBSERVED IN SAMPLES FROM SITE 42UT273, WOLF VILLAGE, UTAH

Scientific Name	Common Name
ARBOREAL POLLEN:	
Acer	Maple
Alnus	Alder
Juniperus	Juniper
Juniperus monosperma	One-seeded juniper
Pinaceae:	Pine family
Abies	Fir
Pinus	Pine
NON-ARBOREAL POLLEN:	
Asteraceae:	Sunflower family
Artemisia	Sagebrush
Low-spine	Includes ragweed, cocklebur, sumpweed
High-spine	Includes aster, rabbitbrush, snakeweed, sunflower, etc.
Liguliflorae	Chicory tribe; includes dandelion and chicory
Brassicaceae	Mustard or cabbage family
Cheno-am	Includes the goosefoot family and amaranth
Sarcobatus	Greasewood

TABLE 2. CONTINIUED

Scientific Name	Common Name
Ephedra nevadensis-type (includes *E. clokeyi, E. coryi, E. funera, E. viridis, E. californica, E. nevadensis,* and *E. aspera*)	Ephedra, Jointfir, Mormon tea
Fabaceae	Bean or Legume family
Plantago	Plantain
Poaceae	Grass family
Polygonaceae:	Knotweed/Smartweed family
Eriogonum	Wild buckwheat
Polygonum bistortoides-type	American bistort
Rosaceae	Rose family
Typha latifolia-type	Cattail
CULTIGENS:	
Zea mays	Maize, Corn
Indeterminate	Too badly deteriorated to identify
STARCHES:	
Eccentric hilum	Root starch
Grass seed starch	Produced by a member of the grass family
PARASITES:	
Trichuris	Whipworm
Charcoal	Microscopic charcoal

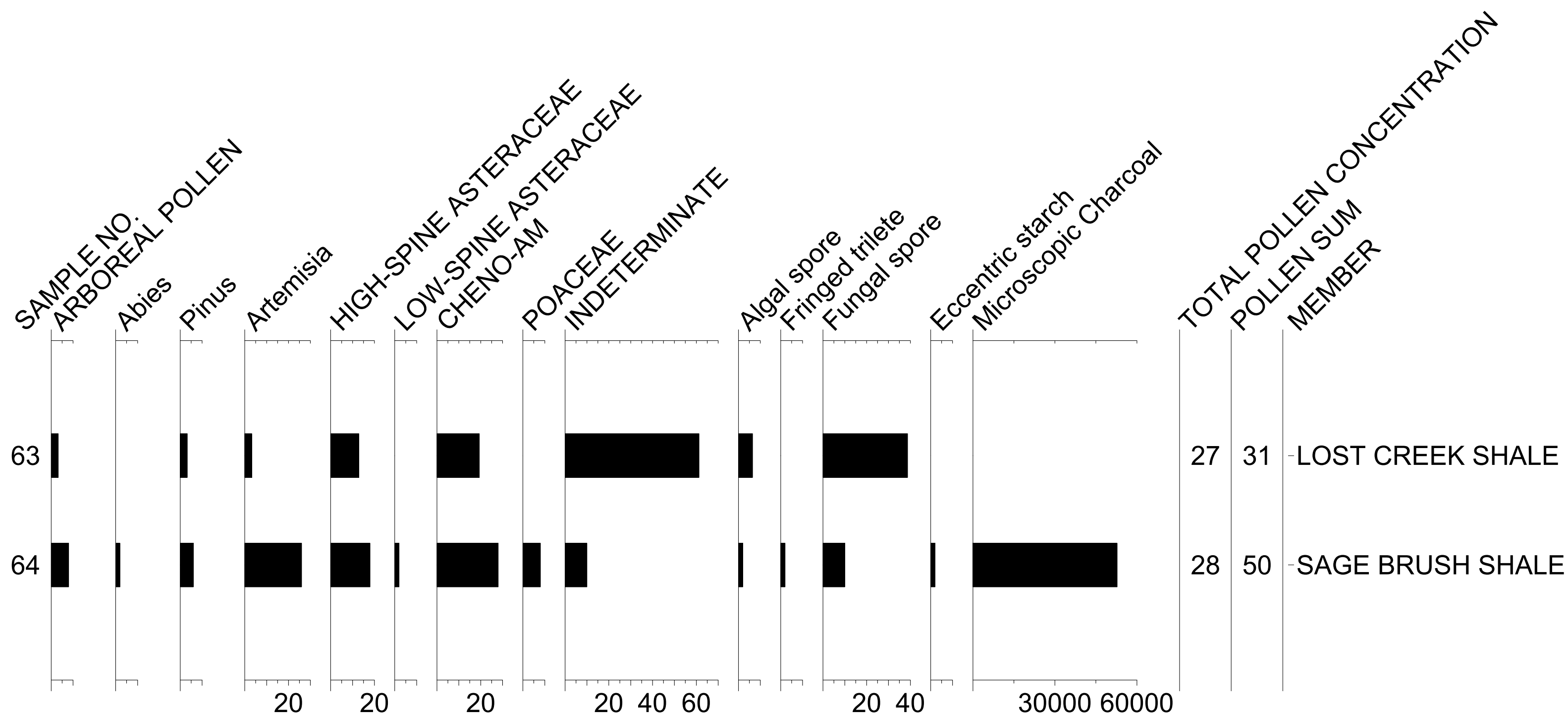

FIGURE 1. POLLEN DIAGRAM FOR SAMPLES FROM A CORE OF THE BATTLE SPRING FORMATION, WY

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