AN ARCHAEOBOTANICAL INVESTIGATION OF SHIELDS PUEBLO'S (5MT3807) PUEBLO II PERIOD

by

Chelsea Lynn Wyatt Dunk
H.B.Sc. Lakehead University 2000
M.M.C. Sir Sandford Fleming College 2001

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

In the Department
of
Archaeology

SIMON FRASER UNIVERSITY

Spring 2006

APPROVAL

Name: Chelsea Lynn Wyatt Dunk

Degree: Master of Arts

Title of Thesis: An Archaeobotanical Investigation of Shields Pueblo's (5MT3807) Pueblo II Period

Examining Committee:

Chair: Dr. R. Jamieson
Assistant Professor, Department of Archaeology

Dr. A. C. D'Andrea
Senior Supervisor
Associate Professor, Department of Archaeology

Dr. J. Driver
Supervisor
Professor, Department of Archaeology

Dr. S. Peacock
Associate Professor, Archaeology & Ethnobotany,
University of British Columbia, Okanagan
External Examiner

Date Defended February 17, 2006

SIMON FRASER UNIVERSITY library

DECLARATION OF PARTIAL COPYRIGHT LICENCE

The author, whose copyright is declared on the title page of this work, has granted to Simon Fraser University the right to lend this thesis, project or extended essay to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users.

The author has further granted permission to Simon Fraser University to keep or make a digital copy for use in its circulating collection, and, without changing the content, to translate the thesis/project or extended essays, if technically possible, to any medium or format for the purpose of preservation of the digital work.

The author has further agreed that permission for multiple copying of this work for scholarly purposes may be granted by either the author or the Dean of Graduate Studies.

It is understood that copying or publication of this work for financial gain shall not be allowed without the author's written permission.

Permission for public performance, or limited permission for private scholarly use, of any multimedia materials forming part of this work, may have been granted by the author. This information may be found on the separately catalogued multimedia material and in the signed Partial Copyright Licence.

The original Partial Copyright Licence attesting to these terms, and signed by this author, may be found in the original bound copy of this work, retained in the Simon Fraser University Archive.

Simon Fraser University Library
Burnaby, BC, Canada

ABSTRACT

This research is a palaeoethnobotanical study of human-plant interactions at Shields Pueblo (5MT3807), a large multi-component site located in the central Mesa Verde region. The research explores past plant use during the Pueblo II period (A.D. 900 – 1150). Archaeobotanical remains were used to identify plants collected and utilised by the Pueblo's inhabitants and to determine if the composition of the assemblage varied temporally and spatially. Shields Pueblo's archaeobotanical assemblage showed that the inhabitants grew crops and collected wild plants from a variety of plant communities. The occurrence of climatic shifts, varying growing season length, and population expansion in the Pueblo II period may be reflected in a broadening of plants collected by the inhabitants through time. Evaluation of the 'species area curve' sub-sampling technique determined it to be an adequate method for characterising what taxa are present in an archaeobotanical assemblage; however guidelines for the application of this method were identified.

Key Words: Archaeobotany, Palaeoethnobotany, American Southwest, Anasazi, Shields Pueblo

DEDICATION

For Clayton

ACKNOWLEDGEMENTS

I extend my sincere thanks to my committee members for their guidance and encouragement throughout my studies. To my supervisor Dr. Catharine D'Andrea who has been a superb advisor and a wonderful mentor. Her extensive knowledge of archaeobotany, enthusiasm, and thorough attention to multiple drafts of this thesis is greatly appreciated. Thanks to Dr. Jon Driver for sharing his knowledge of Southwestern archaeology literature and editorial guidance on earlier drafts of this thesis. I would also like to thank Dr. Sandra Peacock for agreeing to be my external committee member and for her editorial suggestions.

I also acknowledge Crow Canyon Archaeological Center who generously permitted me to study the plant material from Shields Pueblo. I thank Dr. Andrew Duff and Susan Ryan whose archaeological excavations made this study possible. My sincere thanks to Dr. Karen Adams whose passion for this work leaves me in constant awe and striving to do better.

There were numerous Simon Fraser archaeology students who contributed to this study. Thanks to Jennifer Ramsay, Teresa Trost, Tiffany Rawlings, Nick Weber, Laura Pasacreta, and Dennis Sandgathe who shared their humour and archaeological insight with me. Thanks especially to Karen Sharp for her enduring patience, friendship, and support through the thick and thin I am honoured to be your friend. Robyn Banerjee, Lynda Prybzyla, and Ann Sullivan contributed to this thesis in countless ways.

I am forever grateful to my loved ones, who received numerous calls at all hours about my triumphs and failures. Without your love and encouragement I would never have been able to complete this thesis. Thank you to my cousin Clayton whose passion for life taught me to not worry about the small stuff.

I am entirely responsible for any flaws in this paper.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE
INTRODUCTION AND RESEARCH FOCUS

Introduction

The reference to Escalante Ruin, near Dolores, Colorado by Fray Francisco Atanasio Dominguez in 1776 was the commencement for the discovery and exploration of archaeological sites in the American Southwest (Lipe 1999). The later discovery of cliff dwellings in the central Mesa Verde region (Figure 1) by W. H. Jackson and W. H. Holmes in 1874 initiated archaeological investigations of one of the most intensely studied regions in North America (Bartlett 1962). For a number of years, Mesa Verde proper was the focus of much of the early archaeological research conducted in southwestern Colorado. By the 1900s archaeologists began exploring the area surrounding the large rocky uplift (Prudden 1903; Fewkes 1919). These explorers discovered that in addition to the magnificent cliff dwellings of Mesa Verde, southwestern Colorado contained an array of sites of various sizes, construction, and geographic locations including large community centres (Varien 1999), small pit house hamlets (Breternitz 1986), 'unit pueblo(s)' (Kent 1991), and giant kivas (Guthe 1949).

This thesis concerns paleoethnobotany: the study of past plant use, supplemented by ethnohistorical data on plant use. Fortunately for present day researchers, accounts of plant use by Southwestern native groups were recorded as early as 1879 by ethnobotany pioneers such as Fewkes (1896), Stevenson (1915), Whiting (1939), and Elmore (1944). These accounts are invaluable to our understanding of how plants were incorporated into daily life whether for sustenance, as fuel, for medicine, for use in tool manufacturing, construction, or for ceremonial purposes.

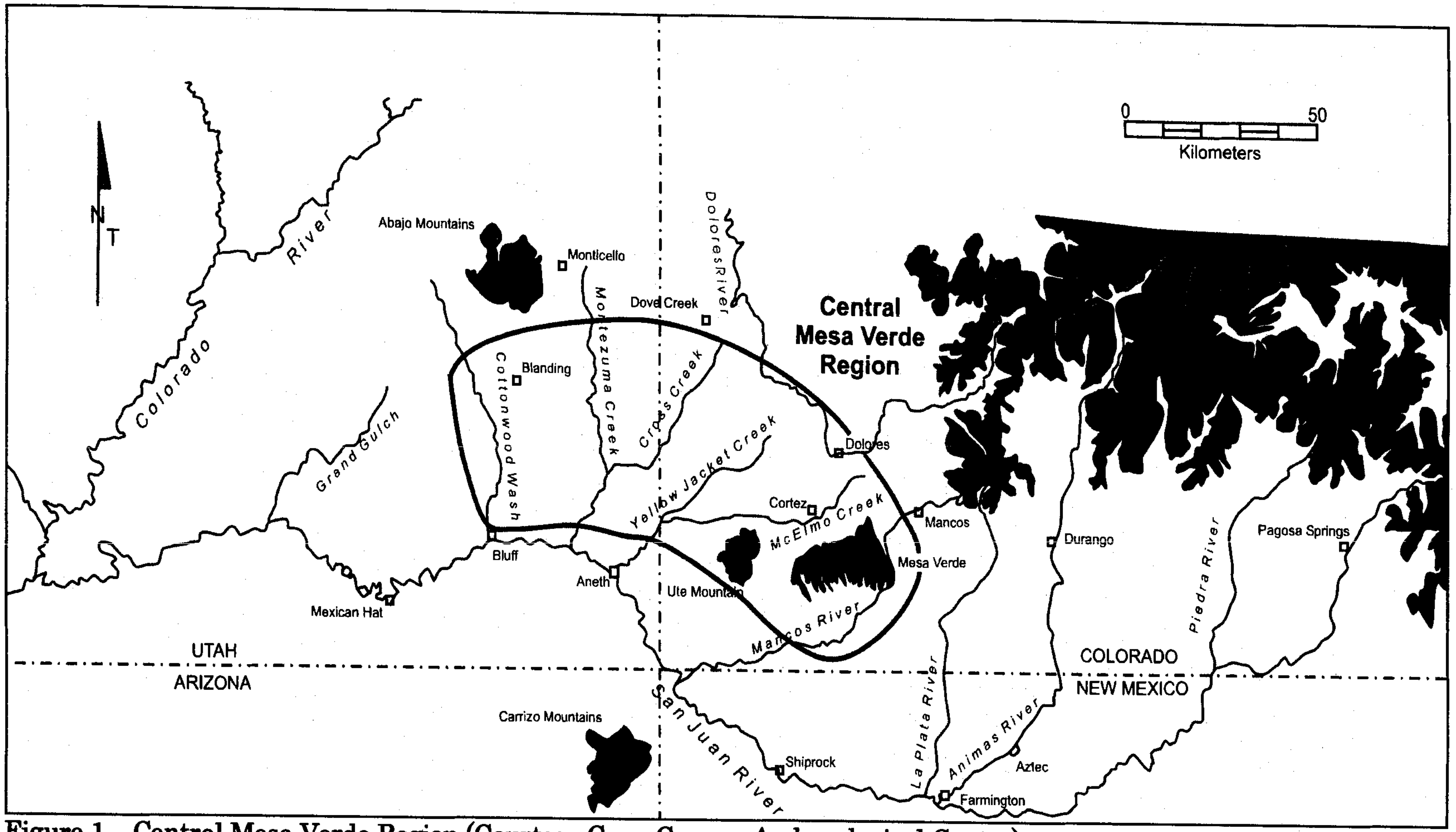

Figure 1 – Central Mesa Verde Region (Courtesy Crow Canyon Archaeological Centre).

The study of charred macrobotanical remains from archaeological contexts began in earnest in North America in the 1960s with the seminal paper by Stuart Struever (1968). However, due to the excellent conditions for preservation in the Southwest, identification and recovery of vegetative remains were noted in early twentieth century archaeological reports (Morris 1919). Of particular note is J. W. Harshberger (1896) examination of plant remains collected in Mancos Canyon by the Wetherill brothers. Harshberger's early work laid the foundation for future ethnobotanical research in the Southwest. The inclusion of the systematic collection of flotation samples into archaeological procedures did not begin until the 1960s (Bohrer 1970, 1986). Water flotation was utilised by archaeologists to gain insight into past plant use, environmental reconstruction, trade, as well as agricultural emergence and expansion.

In the Southwest, as in many other regions in North America, palaeoethnobotanical reports first appeared as appendices at the end of site reports (Watson 1977). Now palaeoethnobotanical studies have become a crucial component and occasionally the main focus of archaeological excavations. The migration of botanical analyses from the periphery of reports to the core illustrates the important role that this field has in our understanding of past cultures. The expansion of palaeoethnobotany to the forefront of archaeological research will continue as new techniques and tools become available to increase our knowledge of the relationship humans and plants had in the past and continue to have in the present.

Research Focus

This study examines prehistoric plant use at Shields Pueblo (5MT3807) a large multi-component Puebloan site situated in southwestern Colorado in the Monument-McElmo drainage (Figure 2). Shields Pueblo may have first been encountered during T. M. Prudden's (1903) survey of the San Juan watershed. Prudden mentions a group of sites in the Goodman Point area, a location directly south of Shields Pueblo (Figure 2). Although not specifically mentioned, Prudden was so close to the Shields Pueblo that it is likely that he encountered it. The site is located in an historic farm field in close proximity to two larger sites, Goodman

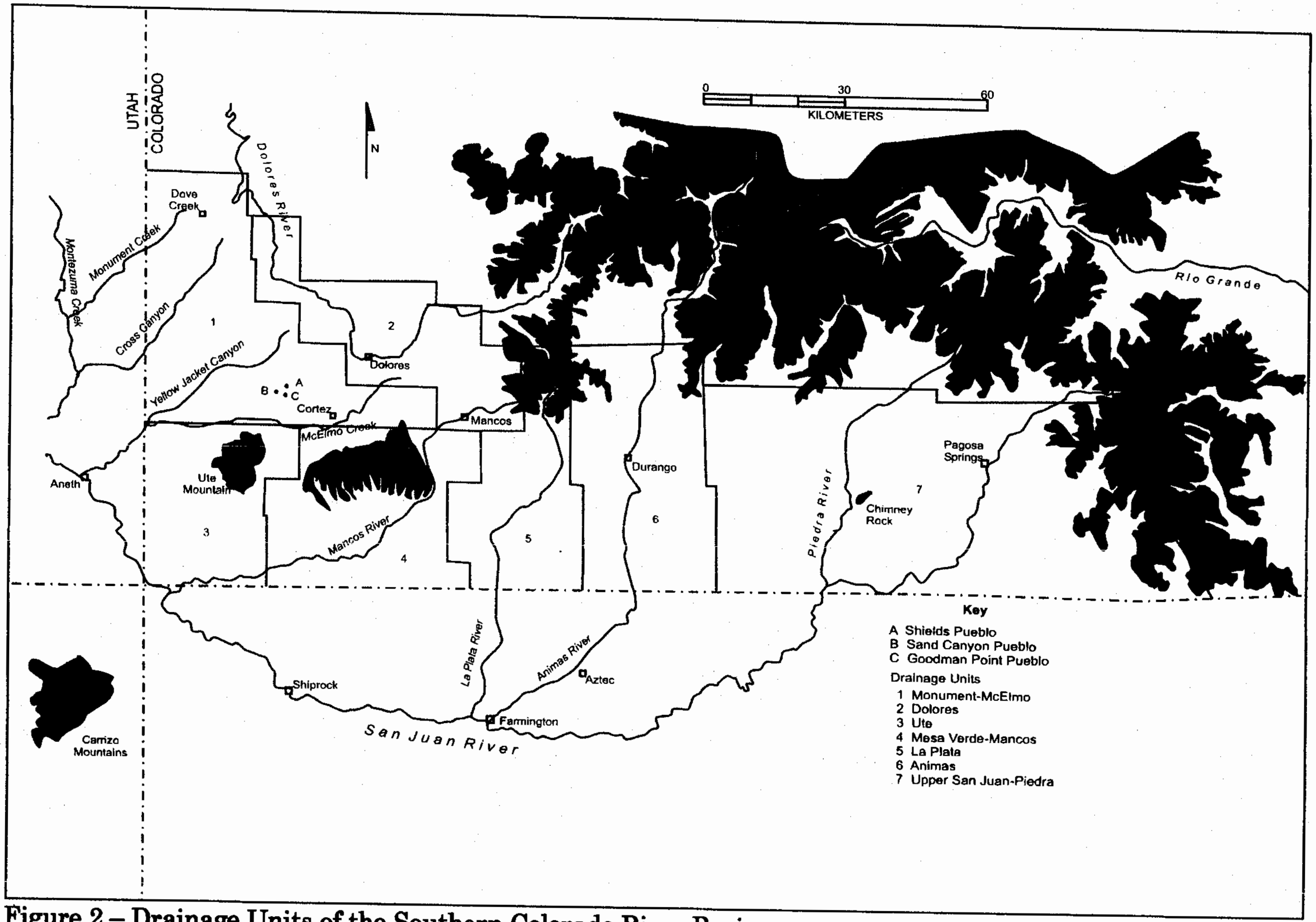

Figure 2 – Drainage Units of the Southern Colorado River Basin
(Courtesy of Crow Canyon Archaeological Center).

Point Pueblo (Adler 1990) to the south and Sand Canyon Pueblo (Varien 1999) to the west (Figure 2). Mesa Verde is located to the southeast and is visible from Shields Pueblo. In addition to these sites numerous sites of various size and construct are scattered across the landscape in the area surrounding Shields Pueblo (Adler 1986, 1990, 1992; Churchill 2002; Gould 1982; Hill 1985; Kent 1991; Lipe 1999; Kuckelman 2003; Varien 1999).

Excavation at Shields Pueblo began with work conducted by Colorado Mountain College (CMC) in the 1970s. Crow Canyon Archaeological Center (CCAC) began work at the Pueblo in 1996 with the mapping of the site, followed by surface collection and test excavations (Ward 1997). This early work identified 18 large sampling areas or architectural blocks (Figure 4). The architectural blocks represent large excavation units that delineate associated areas based upon dense artefact and sandstone rubble scatter. At the end of the 1997 season, a remote sensing study was conducted at the Pueblo (Varien 1997), due to an absence of surface architecture. Numerous anomalies were detected, including possible subterranean structures, which were not visible on the surface due to historic farming activities. The use of remote sensing as a tool for locating buried structures was extremely effective and the following three years of excavation focused on testing these anomalies, as well as excavating randomly and strategically selected units.

Throughout the excavation of Shields Pueblo, soil flotation samples were collected from hearth and secondary refuse deposits, as well as contexts of interest *e.g.,* pits and benches. Five hundred flotation samples were collected and processed to enable researchers to answer questions poised by CCAC (Duff and Ryan 1998, 2000, 2001; Ward 1997). CCAC's interests lie in placing Shields Pueblo in a larger regional context, investigating the growth and abandonment of puebloan communities in the central Mesa Verde region. When the final site report for Shields Pueblo is compiled it will provide southwestern archaeologists with a detailed picture of how the Anasazi of Shields Pueblo existed and interacted with other communities in the area.

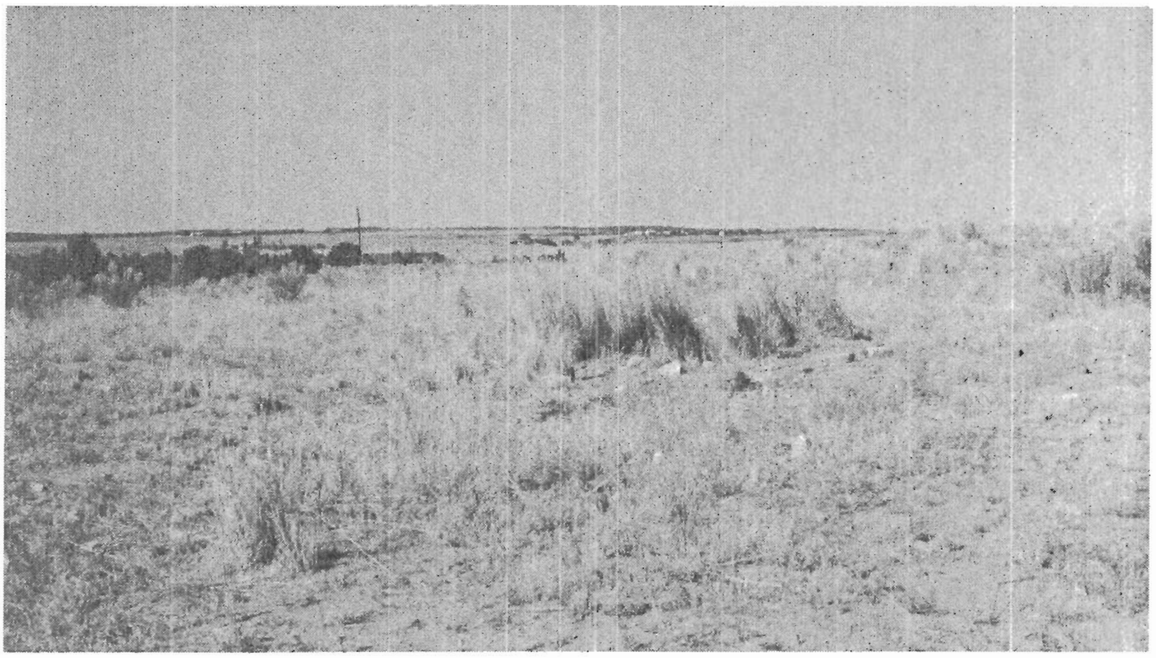

Figure 3a – Shields Pueblo looking West (© Dunk, 2006)

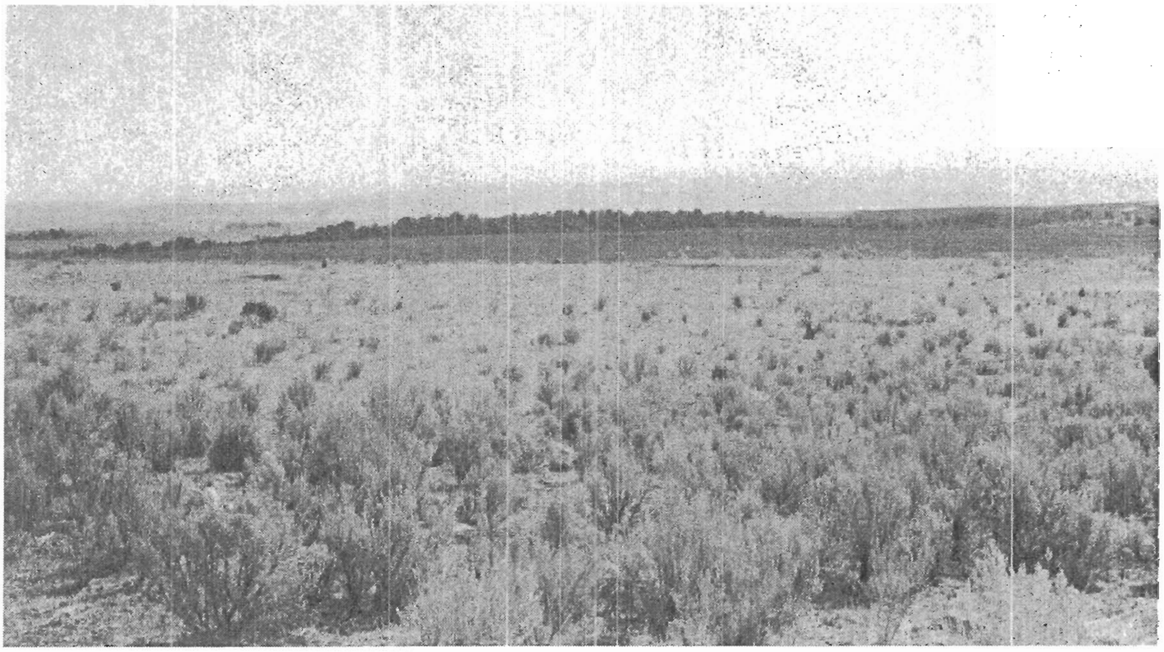

Figure 3b – Shields Pueblo looking East (© Dunk, 2006)

Figure 3c – Shields Pueblo looking North (© Dunk, 2006)

Palaeoethnobotanical Research Questions

Recent palaeoethnobotanical research conducted by Crow Canyon Archaeological Center (CCAC) has focused at a regional level addressing the impact humans had on the environment, specifically in the Central Mesa Verde region (Adams 1993, 1999; Adams and Bowyer 2002). This study will focus on a single time period, Pueblo II (A.D. 900-1150), at the large Puebloan site of Shields Pueblo (5MT3807) (Figure 2). The Pueblo II period was targeted because it is not an intensively studied period, due to a lack of sites in the region, and so this research will lend insight into plant use occurring during this time. The primary objective of this research is to conduct an in-depth study of prehistoric plant use at Shields Pueblo. The data collected will be examined to ascertain the nature of the plant assemblage, to assess whether there is any variability in the remains, and to suggest possible causal factors that may account for variability. The overall goal of this research is to gain a better understanding of the role plants played in Shields Pueblo's inhabitants' lives during the time period in question.

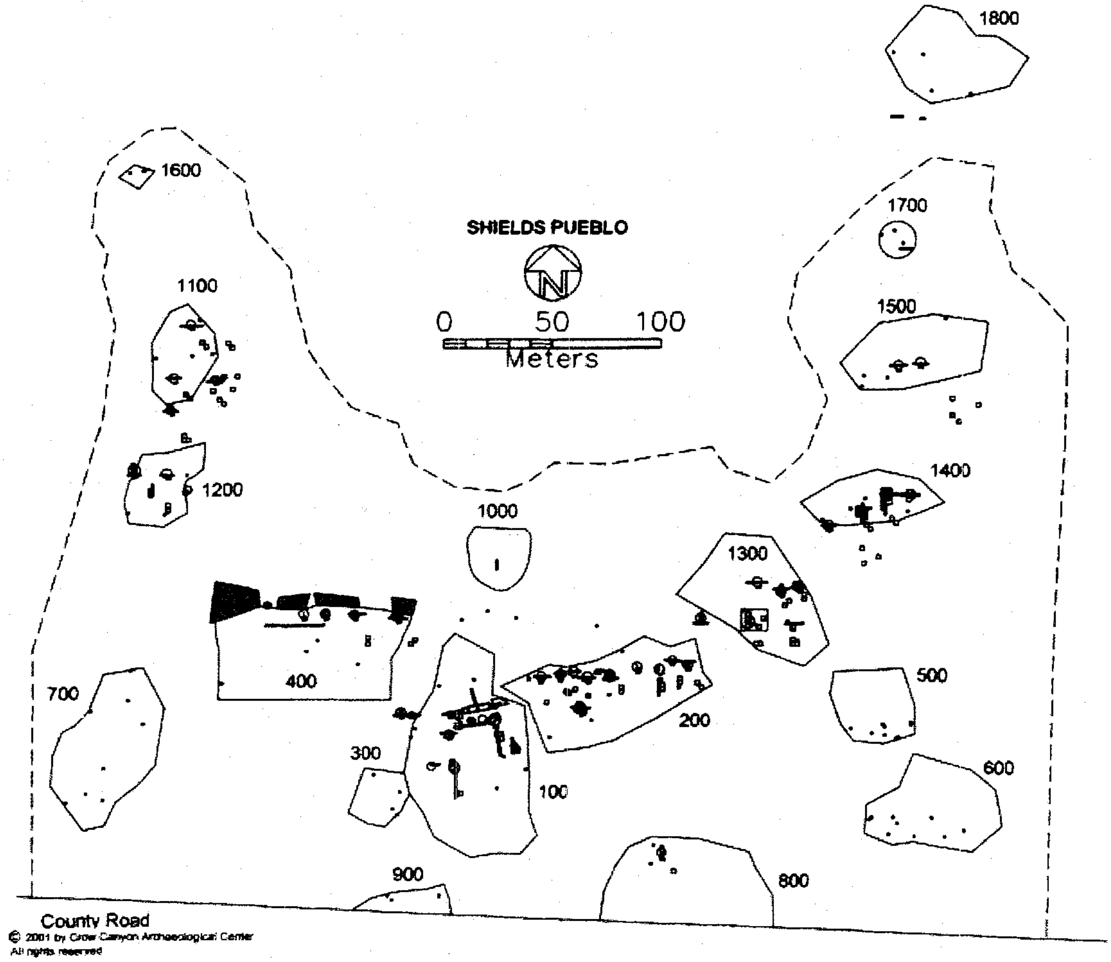

Figure 4 – Shields Pueblo Architectural Blocks (Courtesy Crow Canyon Archaeological Centre).
Note: Architectural blocks represent large excavation units that delineate associated areas based upon dense artefact and sandstone rubble scatter.

Although Shields Pueblo was sporadically occupied from A.D. 775 - 1300 this thesis will focus solely on the Pueblo II Period (A.D. 900 - 1150), specifically the Middle Pueblo II period (A.D. 975 – 1050) and the Late Pueblo II (A.D. 1150 -1150) periods. The terminal date used for the Pueblo II period at Shields Pueblo is A.D. 1150 rather than A.D. 1100 (Roberts 1935). Originally it was thought that the transition from Basketmaker II (1000 B.C. – A.D. 500) to Pueblo III (A.D. 1150 – A.D. 1300) was gradual and that Pueblo II (PII) sites were believed to consist solely of small villages (Kidder 1927, Roberts 1935). With the advent of tree ring dating it became apparent that the major construction events in Chaco Canyon, located to the south and believed to be the social centre of the southwest from A.D. 1000 to A.D. 1100 (Lekson 1999), were contemporaneous with the small PII villages. The 50 year movement of the Pueblo II terminus to A.D. 1150 falls after the end of classic Chaco-style great house construction, but before the rebounding of population levels in the Pueblo III period (Lipe and Varien 1999). This new end date for the PII period is used by archaeologists at Shields Pueblo and will be used in this thesis.

The first issue to be addressed in this thesis is an investigation of the nature of the Pueblo II plant assemblage to determine what, if any, temporal and/or spatial variation is present. The second topic concerns the laboratory sub-sampling method utilised during the analysis of flotation light fractions. The intent is to determine what data, *e.g,*. plant taxa and specimens, are being missed by using the 'species area curve' sub-sampling approach (Adams 1993; 2004). Through these questions I hope to obtain a comprehensive understanding of not only which plant resources were used by the Anasazi in the Pueblo II period, but also what effects flotation sub-sampling can have on the resulting identified plant assemblage. All available flotation samples dating to the Pueblo II period were analysed for this study and total 156 samples (69 hearths, 79 secondary refuse, and 8 other contexts). Of these 16 were analysed in their entirety. The samples were collected from three architectural blocks (100, 200, and 1300) (Figure 4). These architectural blocks or sampling areas represent large excavation areas. The flotation samples were collected from identified thermal features, secondary refuse deposits and other contexts of interest. The samples collected all fall within the PII period and can be further subdivided into the Middle Pueblo II (A.D. 975 – 1050) and Late Pueblo II (A.D. 1050 – 1150) periods.

It is probable that temporal variation will exist within Shields Pueblo's PII plant assemblage. This assumption is based primarily upon evidence for environmental degradation during the later portion of this time period (Van West and Dean 2000). During the A.D. 1100s, a prolonged period of decreased moisture and a gradual shortening of the growing season occurred in southwestern Colorado. Although there were numerous periods of dramatic short-term precipitation variability earlier in the period, the lengthy period of aridity from A.D. 1130 to 1180 drastically affected the ability of the Anasazi to grow domesticated plants. This difficult period may have forced the Anasazi to utilise a wider range of wild/non-domesticated plant resources (Adams and Bowyer 2002; Minnis 1981, 1985a, 1985b). Population expansion in the Pueblo II period, which continued in the Pueblo III, may also have placed added dietary pressure on the region's Anasazi (Adler 1990, Mahoney *et al.* 2002; Wilshusen 1996, 2002).

Van West's (1994) study of agricultural productivity used soil composition, the Palmer Drought Severity Index, and historic crop yields for southwestern Colorado to determine that if inhabitants had equal access to land, at no point in prehistory would there be a lack of arable land or shortage of maize for the Anasazi. However, the increase in violence (Kuckelman *et al.* 2000; Malville 1989; Morris *et al.* 1993; Turner and Turner 1999; White 1992) in the region and the movement of dwellings to more remote and access controlled locations during PII suggests that the Anasazi were adjusting to social changes (Rohn 1977; Varien 1999a). These changes imply that access to land was not equal. Therefore, we might expect those households or communities that were unable to secure agricultural land may have had to supplement their diet with non-domesticated resources during times of environmental hardship.

Field houses (a type of habitation site without a kiva) present in PII suggest that some fields were located a distance from the main habitation unit (Kohler 1992). These sites were likely used for short-term habitation and/or as storage during planting and harvesting periods when agricultural fields require the most management. Were these houses constructed purely for the maintenance of agricultural fields or was there a protective component to their presence (Kohler 1992)? If we assume that the presence of field houses demonstrates land ownership, it challenges the idea of equal access to land laid out by Van West (1994), supporting the assumption that some groups, who may have had little or no agricultural land, were forced to collect a wider range of plant resources to survive.

Spatial variability within the PII plant assemblage will be less apparent. Similar contexts being sampled at Shields Pueblo are likely to yield similar plant remains *e.g.*, subterranean structure hearths. However, due to the long temporal representation of secondary refuses, they are expected to have a greater diversity of plant taxa than hearths.

The goal of the sub-sampling experiment is to investigate the impact of using the 'species area curve' sub-sampling technique, which is utilised to process CCAC's flotation samples, on the resulting archaeobotanical assemblage. The sub-sampling protocol utilised in this thesis will likely provide a comprehensive inventory of taxa present in the assemblage, however the nature of this technique may limit the quantification indices which can be applied to the resulting data set.

Thesis Organisation

This thesis is organised into eight chapters. The following chapter will address the cultural and environmental context of Shields Pueblo and previous palaeoethnobotanical studies. Chapter three will include the methods employed to process the sediment samples and the techniques used to recover and identify charred plant specimens. Chapter four focuses on the nature of Shields Pueblo PII plant assemblage discussing plant taxa and specimens recovered, as well as possible uses based on ethnohistorical data. Chapter five presents the qualitative and quantitative analysis of the plant assemblage. Chapter six will focus on the 'species area curve' sub-sampling experiment. This chapter will present previous sampling studies, the methods utilised for this sub-sampling experiment, and the presentation and evaluation of the experiment results. The research questions posed in chapter one will be addressed in chapter seven. The final chapter will summarise the findings of the thesis and present future directions of research.

CHAPTER TWO
BACKGROUND

Introduction

Archaeobotanical remains can provide insights into past human-plant relations such as subsistence strategies, trade, fuel resources, seasonality, and are frequently used to reconstruct paleoenvironments. The American Southwest is a region that has been at the forefront of archaeobotanical research in North America. Investigators in the Southwest have been using plant remains for decades to address a wide variety of topics (Adams 1994; Adams and Bowyer 2002; Bayman *et al.* 1997; Brand 1994; Ezzo 1993; Gumerman 1988; Minnis 1989, 2004; Pierce *et al.* 1998; Sobolik and Gerick 1992).

This chapter will review the physical and cultural settings of the study area, the Monument-McElmo drainage. The physical setting will be described in terms of the region's geography, vegetation, geology, soils, and climate. The chronology and cultural history of the Pueblo II period also will be discussed, as well as previous archaeobotanical studies in the region.

The Setting

Geography and Vegetation

Shields Pueblo (5MT3807) is located within the geographical region known as the Southern Colorado River Basin (Figure 2). Specifically, it is situated in the Monument-McElmo drainage unit, which is comprised of the McElmo and Monument Creeks. The elevation in this drainage area ranges from 1525 to 2300 m asl (Adams and Petersen 1999). The Anasazi who inhabited this area in prehistory are considered to be part of the Central Mesa Verde cultural region (Figure 1).

The Southern Colorado River Basin is composed of seven biotic zones which are closely linked to elevation: Alpine Tundra, Spruce-Fir Forest, Pine-Douglas-Fir Forest, Pinyon-Juniper Woodland, Gambel Oak Scrubland, Grasslands, and

Sagebrush-Saltbush (Adams and Petersen 1999; Brown 1982). The Monument-McElmo drainage basin contains only four of these biotic zones: Pinyon-Juniper Woodland; Sagebrush-Saltbush; Gambel Oak Scrubland; and Grasslands. The drainage basin is mainly composed of woodland and brush zones with small pockets of grassland. Of the seven zones, the following three are extremely diverse in culturally significant plant resources which would have been necessary to the survival of the Anasazi.

The Pinyon-Juniper Woodland dominates much of the Monument-McElmo drainage unit. Several species of *Juniperus* and *Pinus edulis* are the primary taxa in this zone. This biotic zone is typically found at an elevation of 1500 - 2300 m asl and consists of a rocky landscape and very shallow soil coverage (Adams and Petersen 1999). Of the two coniferous species present, *Pinus edulis* (pinyon) provides a valuable harvestable food source. However, the nuts are highly unpredictable and vary in production regionally and yearly. Prehistoric inhabitants of this region may have overcome the unpredictability of this resource by raiding nests of the pinyon mouse (*Peromyscus* sp.) which stashes large quantities of the nuts (Brohrer and Adams 1977).

The Pinyon-Juniper Woodland zone also includes a wide variety of more dependable plant resources that could be harvested and stored by prehistoric inhabitants on a yearly basis. Species such as *Stipa hymenoides* (Indian ricegrass), *Sporobolus* spp. (dropseed grasses), *Artemisia* spp.(sagebrush), *Quercus gambelii* (gambel oak), *Chrysothamnus* (rabbitbrush), *Cercocarpus* (mountain mahogany), *Amenlanchier* (serviceberry), *Yucca* spp. (yucca), as well as a number of cacti (*Opuntia* spp., *Echinocereus*) would have fulfilled both dietary and material needs (Adams and Petersen 1999). This biotic community would have also been attractive to wild game, thus providing the inhabitants with hunting grounds.

The Sagebrush-Saltbush community is characterised by fewer plant species. Large sagebrush, saltbush, and rabbitbush are the primary taxa found in this zone, with sagebrush being the most dominant. This vegetation community is typically found between 1200 and 2000 m asl. Fires, grazing, and the introduction of foreign weedy annuals have resulted in succession occurring in this zone (Adams and

Petersen 1999). A few grasses are also present in this biotic zone, including *Stipa* sp. which is one of the most prevalent, and has been recovered from numerous archaeological sites (Adams 1999; Kent 1991; Murray and Jackman-Craig 2003).

Grasslands and Gambel Oak Scrubland represent the two smallest plant communities in the Monument-McElmo drainage unit. Initially, much of the Southwest was covered in grasslands; however, the historic period has seen a dramatic change in this biotic zone (Brown 1982). This plant community frequently forms a bridge between the Pinyon-Juniper Woodland at higher elevations, and Sagebrush-Saltbush at lower elevations. Valuable dietary resources found in this vegetation zone include perennial grasses and shrubs.

The Gambel Oak Scrubland is found at the highest elevation in the drainage unit at 2300 to 2750 m asl (Adams and Petersen 1999). While the total size of this plant community is extremely small it consists of a number of valuable plant species such as *Amelanichier* sp. (serviceberry), *Rosa* sp. (wild rose), and *Rhus* sp. (sumac).

Of the four biotic zones found in the Monument-McElmo drainage the Grasslands and Pinyon-Juniper Woodland are not only the largest, but also contain the greatest number of potentially useable resources for inhabitants. Grasslands provide a number of cool and warm season grasses, as well as a variety of cacti. Cool season grasses would have been especially important as they would have been one of the first plant resources available in spring. Pinyon-Juniper Woodlands would also have provided grasses and cacti as well as a number of nut and berry species.

Geology and Soils

The La Plata and San Juan Mountains, as well as their respective foothills, constitute the predominant geological formations in the Southern Colorado River Basin. Dakota Sandstone and Mancos Shale are the primary rock types with sandstone used by prehistoric groups to build structures (Ekren and Houser 1965; Whitkin 1964). The lower Morrison Formation contains low grade quartz, chert, and chalcedony sources, which would provide raw materials for stone tools. Aggradation and entrenchment of valley bottoms have also been documented in the region (Force and Howell 1997). These processes would have affected the potential for floodwater agriculture.

Loamy soil, which is suitable for agriculture, is the predominant soil type found in the region. The soil is the result of weathering sandstone and shale, and eolian material derived from the San Juan Basin (Price *et al.* 1988). Of course, ideal soil is not enough to grow crops. Adequate precipitation and temperatures also play key roles in their successful production.

Palaeoenvironment

Tree-ring records and pollen studies have been used to reconstruct past environments in the American Southwest (Dean *et al.* 1985; Petersen 1988; Van West 1994). These data have been employed by researchers to determine periods of favourable and inhospitable conditions, which may have affected food procurement techniques used by the region's prehistoric inhabitants.

The central Mesa Verde region of the Southern Colorado River Basin is characterised as a "cold, middle latitude, semiarid steppe where potential atmospheric evaporation exceeds the usual amounts of available precipitation" (Van West and Dean 2000:20). The majority of moisture that the region receives is in the form of snow during the winter and thunderstorms during the summer. The amount of precipitation an area receives depends upon its elevation. Cortez, Colorado, located southeast of Shields Pueblo, receives an annual mean precipitation of 336 ± 99 mm whereas Mesa Verde, whose elevation is roughly 250 m higher than Cortez receives an annual mean of 406 ± 88 mm (Dean and Van West 2002; Huckell and Toll 2004; Van West and Dean 2000).

Similar to precipitation, temperature is also dependent on elevation. In the central Mesa Verde region, average temperatures range from –11 degrees Celsius in January to 32 degrees Celsius in July (Van West and Dean 2000). The most important aspect of temperature for Anasazi farmers is the number of frost-free growing days (Fish 2004). Maize requires 115 to 130 frost-free days to reach maturity. Cortez, which is at a slightly lower elevation than Shields Pueblo, has a mean of 124 frost-free days (Van West 1994). This suggests that maize crops were frequently in peril. The timing of a frost within a growing season can also determine a crop's success. If the frost is early, before the shoots have emerged from the soil, the crop may survive or another one could be planted, providing there are enough seeds available. However, if the frost occurs late in the growing season the entire field could be lost and planting a second crop is not an option. As seen in the evidence of the rainfall and temperature, growing maize in the central Mesa Verde region would have been a difficult endeavour even in the best of times.

Isotopic studies on human remains (Decker and Tieszen 1989; Matson and Chilsom 1991) indicate that maize was heavily integrated into the Ansazi diet from Basketmaker II (1000 B.C. to A.D. 500) times to the abandonment of the region. Decker and Tieszen's (1989) isotopic study of 35 individuals from Mesa Verde National Park determined that carbon isotope levels did not differ significantly through time and that corn was an important food source from the onset of Basketmaker III. This isotopic study lends credence to Van West's (1994) arable land hypothesis, by demonstrating that the Anasazi were regularly consuming corn from BMIII to Pueblo III, therefore there also had to be enough arable land to grow corn during these periods.

Although, Matson and Chilsom's (1991) research was based further to the east on Cedar Mesa, their study of carbon isotopes, skeletal remains, coprolites, and settlement patterns determined that in the Basketmaker II period, Anasazi replied heavily upon maize agriculture. Their four-pronged approach resulted in an in-depth and comprehensive evaluation of the subsistence practices of Cedar Mesa inhabitants. Although the study was limited to the mesa's early occupants, the findings contribute to our understanding of the key role that corn played in early inhabitants in the region.

A number of other studies have reconstructed palaeoenvironments and evaluated resulting impacts on prehistoric inhabitants. Dean *et al.* (1985) developes a regional reconstruction of palaeoenvironment, demography, and human behaviour on the Colorado Plateau. While this conceptual study of environmental variability and its influence on Anasazi behaviour contributed to our understanding of how they adapted to regional level changes, it also demonstrated the need for local palaeoenvironmental reconstruction to explain specific instances of socio-cultural adaptation and change on the Colorado Plateau.

Rose *et al.*'s (1981) high-resolution palaeoclimatic reconstruction in the Southeastern Colorado Plateau provided archaeologists with methods to accurately reconstruct past climates. The study determined that the Palmer Drought Severity Indices (PDSI) produced the most accurate results for measures of soil moisture content. Combining the PDSI with the cumulative effects of precipitation and temperature for a given area permits one to estimate the ability of the land to produce crops.

Burns' 1983 study focused on reconstructing annual yields of beans and maize for southwestern Colorado through the use of historic dryland farming yield records. Burns' study linked soil moisture conditions and levels of agricultural productivity. He is able to make inferences about periods of shortfall and excess and to determine if these periods corresponded to major building episodes in the Southwest. Burns' results indicates the usefulness of palaeoenvironmental reconstruction, but he failed to consider the archaeobotanical record to determine if there was in fact an increase in crops during his projected periods of excess and a decrease during times of shortfall.

Petersen (1988) has addressed variation in the dry-land farming belt, the land best suited for agriculture. He investigates changes in the width and location of the dry-land farming belt from A.D. 550 to A.D. 1325. He concludes that variability in temperature and precipitation would have been significant enough to force populations to move due to the inability to produce adequate resources. Comparison of Petersen's findings to the archaeological record may indicate temporally associated sites changing with the dry-land farming belt.

Analysis of coprolites provides direct insight into not only what domesticated plants are being consumed, but also what wild plants are being collected and eaten by the Anasazi. Coprolite studies further support the concept that corn was a key food resource in Basketmaker III through Pueblo III periods (Minnis 1989; Stiger 1979). Stiger (1979) studied coprolites from Basketmaker III and Pueblo III sites on Mesa Verde. Of the macrofossils recovered, corn was the most ubiquitous in both Basketmaker III (65%) and Pueblo III (95%) coprolites. Pollen analysis of 59 coprolites obtained from two sites in Johnson Canyon indicated that corn pollen was present in 95% of the samples (Scott 1979). Isotopic, macrofossil and pollen analysis of coprolites indicate that corn was an important crop for the Anasazi since A.D. 500. The identification of corn, through coprolite analysis and isotopic testing of skeletal remains, in BMIII to PIII diets suggests that even with environmental fluctuations an adequate amount of precipitation and frost-free days routinely existed for the inhabitants of the region to grow corn.

Periods of environmental variability in the Southwest have been documented through tree ring and palynological studies. Van West and Dean's (2000) identification of environmental fluctuations through time is based on the Mesa Verde Douglas-fir chronology. Their research identifies a number of extremely dry periods. Of these, the authors characterise the A.D. 1130 to 1180 drought as the "most severe dry spell in terms of duration (50 years), intensity (12 years are estimated to have received less than 351 mm or 13.8 inches of annual precipitation), and persistence (little relief provided by normal to high-rainfall years)" (Van West and Dean 2000:23-26). Practising agriculture during this lengthy time of uncertainty, which falls partially in the time period being studied, would have been difficult and reliance on non-agricultural resources may have been necessary.

Chronology and Culture History of the Southern Colorado River Basin

The Central Mesa Verde region (Figure 1), located in the Southern Colorado River Basin, extends from the Mancos River in southwestern Colorado to Cottonwood Wash in southeastern Utah. The majority of the archaeology in this region has focused on sites located within Mesa Verde National Park; however, the last few decades have seen large research projects launched outside the park (Billman *et al.* 2000; Breternitz 1993; Hurley 2000). Two such projects are the Dolores Archaeological Program (DAP) (Breternitz 1993, Breternitz *et al.* 1986) and the Four Corners Archaeological Program (FCAP) (Hurley 2000).

The DAP was the outcome of the construction of the McPhee Reservoir on the Dolores River (Breternitz 1993). This major archaeological project was undertaken from 1978 to 1985 and was one of the largest mitigation projects conducted in the United States (Robinson *et al.* 1986). The primary goal of this salvage project was to mitigate the impact the reservoir would have on archaeological sites in the region. The majority of affected sites dated to the Basketmaker III (A.D. 500 to A.D. 750) and Pueblo I (A.D. 750 to A.D. 900) time periods. The result of this work is a six volume site report, which provides a wealth of information for archaeologists about the Basketmaker-Pueblo transition (Blinman *et al.* 1988; Breternitz *et al.* 1986; Kane *et al.* 1986; Kohler *et al.* 1986; Petersen and Orcutt 1987).

Following the completion of the DAP, the FCAP was established by the Bureau of Land Reclamation. The objective of this project was to investigate the archaeological impact of constructing the reservoir's irrigation system. The largest project undertaken by the FCAP was the Ute Mountain Ute Irrigated Lands Archaeological Project. This project focused on tribal land that was to be developed for agricultural purposes. The resulting information has provided the archaeological community with a more precise understanding of the communities on the edge of the central Mesa Verde region that date to the Pueblo II and Pueblo III periods (Billman *et al.* 1997).

Crow Canyon Archaeological Center (CCAC) is a not-for-profit organisation which conducts archaeological research and educational programs in conjunction with Native Americans and other organisations that share similar interests. It is one of the few organisations in the central Mesa Verde region that has continually incorporated the collection and analysis of botanical remains into their research projects (Adams 1993; 1999; Adams and Bowyer 1998; Murray and Jackson-Craig 2003). This practice has provided archaeobotanists and archaeologists alike with copious amounts of information about past human-plant relationships from the Basketmaker III to Pueblo III periods.

Prehistory

Numerous publications are available on the archaeology of the American Southwest region which provide a more comprehensive background than will be presented here (Adler 1996; Cordell 1997; Gumerman 1988, 1994; Kent 1991; Kohler 1993; Lipe *et al.* 1999; Plog 1997; Tainter and Tainter 1996; Van West 1994; Varien 1999a; Varien and Wilshusen 2002). The following discussion will focus specifically on the Pueblo II period of the Southern Colorado River Basin.

The Pueblo II period began around A.D. 900 and extended to A.D. 1150. This time is characterised by the appearance of small, highly dispersed occupational sites and Chaco-related great houses. Great houses were typically two-storey or higher structures that were constructed in a manner similar to those found in Chaco Canyon. A number of great houses in the area appear to have been the focus of long-distance trade based on the recovery of exotic artifacts (Hallasi 1979; Reed 1979). While most communities at this time remain widely spread across the landscape, some gradually became more clustered into "village-sized aggregate[s] of habitations" (Lipe and Varien 1999:256).

Pueblo II sites are located in a variety of geographical loci ranging from uplands, to talus mesa tops, benches, and the edges of canyon floors. However, the majority of sites is situated near arable land. Upland c was the preferred method of cultivation during this period; check dams and artificial terraces are also present at canyon sites (Smith and Zubrow 1999). Sites tend to be located near primary fields rather than reliable water sources. The placement of sites near field rather then water sources suggests that the availability of water was not a deciding factor in the location of sites and that there was adequate precipitation. Habitation sites typically are composed of 2 to 4 "Prudden unit"s (Prudden 1903) (which include a kiva, a semi-subterranean grinding room, surface rooms, and an associated midden). As the period progressed the frequency and number of these unit pueblos increased.

The construction of structures during PII also indicates a change in the types of materials being used. Masonry gradually replaces earthen and plastered surface rooms and kivas. An additional change in kiva architecture was the evolution from four post or pilaster roof supports to six pilaster supports constructed on kiva benches (Varien 1999). The increase in the use of masonary over jacal may be linked to environmental factors such as the inability to obtain suitable sized wood posts. However, modifications in construction style may also be attributed to population density (Table 1) and the inhabitants becoming more sedentary, therefore enabling them to place more energy and time into the construction of permanent dwellings.

Table 1 - Average Momentary Population Estimates for the Southern Colorado River Basin (from Wilshusen 1996).

Year (A.D.)	880 - 920	920 - 960	960- 1000	1000 - 1040	1040 - 1080	1080 - 1120	1120 - 1160	1160 - 1200	1200 - 1240	1240 - 1280	1280 -1320
Estimate											
Liberal	3,413	1,733	9,858	10,731	11,423	17,675	24,320	25,767	27,633	27,633	13837
Conservative.	1,680	3,366	4,929	5,337	5,711	8,810	12,132	11,884	13,788	13,788	6,918

Note: Conser. = Conservative

Shields Pueblo (5MT3807)

Shields Pueblo (5MT3807) is located in Montezuma County in southwestern Colorado (Figure 2). The main period of occupation dates between A.D. 1050 to 1300. However, there is evidence suggesting that the occupation began as early as A.D. 775 (Duff and Ryan 2001). Population estimates for the Pueblo indicate an increase in population through time with a hiatus from the Late Pueblo I to the Early Pueblo II periods (Rawlings 2006).

Shields Pueblo is a component of a regional research project being conducted by CCAC know as 'Communities Through Time: Migration, Cooperation, and Conflict.' CCAC projects focus on the development and abandonment of Puebloan communities in the Mesa Verde region from A.D. 1100 to 1300. Research questions addressed by CCAC at Shields Pueblo are focused on reconstructing occupational history and changing population levels both at the site and in the surrounding landscape (Duff and Ryan 1998, 2000, 2001). The resulting data will be used to determine "the nature and timing of population aggregation into community centers and to evaluate the impact these populations had on their surrounding natural environment" (Duff and Ryan 2001:1).

Prior to the commencement of CCAC's excavation at Shields Pueblo in 1997, systematic and unsystematic excavations were completed. The site was unsystematically excavated throughout the 1950s and 1960s. During this time a rare copper bell was recovered from a burial. This bell represents one of the northernmost ever found in the Southwest outside of Mexico, and Ward (1997) suggests its presence reflects a stratified society at the site, and supports the proposed concept of Shields Pueblo as a community centre. Colorado Mountain College excavated Shields Pueblo from 1975 to 1977. During their field school they excavated portions of five kivas, as well as other cultural deposits. Following this, the site was left untouched until CCAC surveyed the area in the 1980s.

The excavations conducted by CCAC at Shields Pueblo began in 1997. No surface architecture or roomblocks were evident at the Pueblo. During this field season an extensive survey and mapping was completed and 18 artefact and sandstone rubble areas (Figure 4) were located. These areas were defined by CCAC as architectural blocks, large excavation units that delineate associated areas based upon dense artefact and rubble scatter. Surface collection was undertaken at each high-density area and random 1x1 m units were excavated. At the end of the 1997 field season, a National Geographic Society grant (#6016-97) permitted a remote sensing survey to be conducted which pinpointed the location of possible buried architectural features (Varien 1997). The 1998 and 1999 field seasons were spent testing the remote sensing anomalies, which had a high success rate. The final season saw further excavation of the anomalies in addition to surface collections of a three-metre diameter of each 20 x 20 metre block (Duff and Ryan 2001). These detailed reports for each field season can be found on Crow Canyon Archaeological Center's website (www.crowcanyon.org).

Previous Palaeoethnobotanical Research

A wide range of palaeoethnobotanical research has been conducted in the American Southwest, a vast area extending from the Colorado Plateau in the north to the Sonoran Desert in the south. This region is one of the most intensively studied archaeological areas in North America, however the geographical distribution of this research is unbalanced (Huckell and Toll 2004). The Four Corners area and pockets of the Sonoran Desert have long been the focus of archaeological research in the Southwest and this continues today. In addition to geographical variation, there is significant variation in the current understanding of plant use during the earliest occupations of the region. There are three culturally significant groups which occupy the American Southwest the Hohokam, Mogollon, and Anasazi and to discuss the current palaeoethnobotanical research taking place in all three of these cultures exceeds the scope of this thesis. The following discussion will focus specifically on the Anasazi who were situated on the Colorado Plateau.

Published reports in the Colorado Plateau area have addressed a variety of topics such as the impact of environment on past populations, agricultural resources, available arable land and carrying capacity. In addition studies have focussed on identifying plants used for food and fuel (Adams 1993; 1999; Burns 1983; Dean 1996; Dean *et al.* 1985; Matson 1991; Matthews 1986; Murray and Jackson-Craig 2003; Petersen 1988; Rose *et al.* 1981; Toll 1981, 1983; Van West 1994; Wilshusen 1996; Winter 1993). This review will first address environmentally orientated studies conducted in the region, followed by those that focus on reconstructing prehistoric economies.

Van West's (1994) arable land study determined that even during the most inhospitable times, including the occurrence of droughts, floodplain degradation, and the concomitant downturn in potential agricultural productivity, there would still have been an abundance of arable soil relative to the estimated population for the Late Pueblo II and Pueblo III periods. However, as population increased in the Pueblo III period (Varien 1999), there was likely increased competition for resources which may have resulted in restricted access to prime arable land.

Minnis (1985a) studied a period of food stress in the Rio Mimbres Region of New Mexico and developed a model of human responses to environmental stress. Minnis considered Colson's (1979) five behavioural responses to food stresses as common ethnographically known responses to reducing risk:

1) diversification of activities rather than specialisation or reliance on a few plants or animals;
2) storage of foodstuffs;
3) storage and transmission of information on what are termed famine foods;
4) conversion of surplus into durable valuables which could be stored and traded for food in an emergency;
5) cultivation of social relationships to allow one to tap resources of other regions (Minnis 1985a:32-33).

Minnis (1985a) argues that social relations are the most effective way of mitigating serious problems. He theorises that in addition to Colson's model, response costs could be measured based on an increase in food sharing (Minnis 1996). This study suggests there is a pattern of responses to food shortage; the less costly and reversible responses are utilised first before more costly and irreversible ones.

Identifying food and fuel taxa used by the Anasazi has been a component of a number of archaeological investigations that have been conducted in the northern Southwest (Adams 1993; 1999; Brand 1994; Matson 1991; Matthews 1986; Minnis 1989;Murray and Jackson-Craig 2003; Stiger 1979; Toll 1981, 1983; Van West 1994; Winter 1993). The examination of macrofossils, pollen, and coprolites has provided a wealth of information that researchers have used to reconstruct prehistoric plant use. These studies have identified not only domesticated and non-domesticated resources utilised by the inhabitants of the region, but also elucidate changes in plant use both geographically and temporally.

One topic of intense investigation is the emergence and impact maize agriculture had on the Anasazi (Adams 1994; Fish 2004; Matson 1991). Archaeobotanical remains collected from cave sites in the Kayenta and Durango areas indicate the incorporation of maize agriculture into subsistence practices in the Basketmaker II period (Jones and Fonner 1954; Matson 1991). Stable isotope studies support the addition of corn in the prehistoric diets at this time (Chisholm and Matson 1994; Martin 1999). Coprolite analysis also supports this shift in diet during this period; however the findings also indicate the continued collection of plants such as cheno-am, purslane, beeweed, and prickly pear (Stiger 1979). The foraging of wild and weedy taxa in addition to farming is a practice that is repeated throughout prehistory.

Recent archaeobotanical research in the Chaco area of northwestern New Mexico has produced substantial evidence for the reliance on maize agriculture in early Pueblo occupations. Specifically, Toll's (1993) examination of Chaco area sites has yielded significant evidence of farming, with evidence of wild plant use being minimal. However, Winter's (1993) examination of archaeobotanical remains indicates that although the role of maize farming was expanding through time, the intensity and diversity of wild plants that were being collected during this period were at their highest.

Our understanding of prehistoric plant use improves as one moves closer to the present. No archaeobotanical assemblages have been reported for PalaeoIndian sites (Huckell and Toll 2004). The majority of archaeobotanical evidence dating to the Early and Middle Archaic for the Colorado Plateau has been derived from macrofossils, coprolites, and pollen collected from cave sites in southeastern Utah and northern Arizona (Coulam and Barnett 1980; Donaldson 1982; Hogan 1980; Toll 1981, 1983; Van Ness 1986; Van Ness and Hansen 1996). These investigations identified the repeated recovery of plants such as cheno-am, beeweed, tansy mustard, purslane, sunflower, and grasses such as ricegrass and dropseed, as well as prickly pear cactus and pinon nuts. These assemblages suggest that Archaic period inhabitants collected a range of plants, but specifically targeted weedy annuals.

Archaeobotanical investigations in the Central Mesa Verde region have been completed on both Mesa Verde proper and the surrounding area. Extensive studies of the cliff dwellings and open sites of Mesa Verde have been conducted, however the number of archaeobotanical reports resulting from this research is limited (Cattanach 1980, Cutler and Meyer 1965, Kaplan 1965). Few data have been presented on plants collected for consumption, and the core of these reports focus on utilitarian plant use (Cutler and Meyer 1965; Kaplan 1965; Osborne 1980).

Archaeobotanical investigations of sites situated within proximity to Shields Pueblo have provided interesting insight into local human-plant relationships (Adams 1993 1999; Adams and Bowyer 2002; Murray and Jackman-Craig 2003; Rainey and Jezik 2002; comparison sites). The resulting archaeobotanical reports from these sites have provided a solid base for our understanding of prehistoric plant use in the Central Mesa Verde region. The following will summarise the archaeobotanical findings of the more significant projectsThe Dolores Archaeological Project situated in the area north of Mesa Verde and west of Durango has yielded a wealth of archaeobotanical material from sites that range from A.D. 600 – 1250 (Matthews 1986). The importance of domesticated crops such as maize and beans is evident in the archaeobotanical assemblages derived from this extensive archaeological investigation. Evidence for the continued and increased exploitation of disturbance taxa, such as cheno-ams and tansy mustard, likely reflect the importance of these plants and the ease of their collection. An increase in the use of wild plants through time is also apparent and a shift in wood used for fuel use exists at some sites within the study area. Shifts in fuel wood use may reflect the expansion of cleared arable land (Kohler and Matthews 1988).

The archaeobotanical assemblage gathered from the Duckfoot site, a Pueblo I period site occupied between A.D. 850 and A.D. 880 (Lightfoot and Etzkorn 1993), provides insight into the lives of the occupants of this small residential hamlet. Archaeobotanical remains recovered from this site illustrate that populations had a mixed diet (Adams 1993). In addition to corn and common bean, a wide range of wild taxa including cheno-am, tansy mustard, hedgehog cactus, groundcherry, purslane, bulrush, and ricegrass was recovered from flotation samples. Wood charcoal specimens indicate that both trees and shrubs were burned in hearths and incorporated into the archaeobotanical record.

Yellow Jacket Pueblo is a large village site occupied from the mid-A.D. 1100s through to the late A.D. 1200s (Kuckelman 2003). The Pueblo is suspected to have been a centre for numerous surrounding sites. Identified food stuffs from the archaeobotanical record include domesticated, wild, and weedy plants (Murray and Jackman-Craig 2003). The inhabitants grew and consumed corn, beans, and squash. They also collected a variety of wild plants including cheno-am, groundcherry, datil yucca, purslane, bulrush, and ricegrass. Less frequently recovered taxa from the Pueblo include hedgehog cacti and acorn shells. Burned wood composed the largest quantity of archaeobotanical remains recovered from the site. A total of 15 tree and bush taxa was identify including juniper, sagebrush, pine, oak, serviceberry/peraphyllum, and mountain mahogany. Wood species more rarely recovered from the site include rabbitbrush, wolfberry, Mormon tea, saltbush, chokecherry/rose, cottonwood/willow, and cliff-rose/bitterbrush. The majority of these species currently exist on the landscape surrounding the Pueblo. Of note in the charcoal assemblage is the presence of trees that are absent from the modern landscape surrounding Yellow Jacket Pueblo such as Ponderosa pine and Douglas fir (Murray and Jackman-Craig 2003). Stands of these trees currently grow on Sleeping Ute Mountain and in the Dolores River canyon.

Archaeobotanical research conducted by CCAC in the Sand Canyon locality strived to reconstruct the diversity of food and fuel plants between A.D. 1180 and A.D. 1290 and evaluate the impact the areas occupants had on the environment (Adams and Bowyer 2002). Twelve sites from a variety of geographic locals, including mesa tops and talus slopes, were sampled in this study. The resulting archaeobotanical assemblage indicated that the localities inhabitants grew a variety of crops, *e.g.,* corn, beans, squash, gourds, and collected a suite of wild and weedy plants. The inhabitants also utilised a variety of tree and bush species for fuel and for construction. The number of fuel wood taxa increased through time. Adams and Bowyer (2002) detected no significant shift in resource use or in plant taxa target at the site level. They did observe variation in the last fires of hearths depending upon the location of the site. The archaeobotanical assemblage showed evidence of landscape disturbance indicated by an increase in the range of maize plant debris recovered from the site and the repeated recovery of seed taxa that prefer anthropogenic environments.

A number of conclusions can be drawn regarding plant use by the Anasazi in the Colorado Plateau based on previously conducted research. Once integrated, maize agriculture became an integral part of subsistence systems in the region. Wild plants continued to be collected by the Anasazi after the adoption of corn agriculture. These plants included prickly pear, pinon nuts, groundcherry, cheno-ams, sunflower, beeweed, and purslane (Brand 1994). The inhabitants also collected a range of tree and bush species to burn in their hearths and meet their construction requirements. These plants in partnership with maize provided the regions inhabitants with a diverse group of plants which could be used to fulfill their material and dietary needs.

Conclusion

The foregoing discussion situated Shields Pueblo geographically and culturally within the Northern San Juan Region. Previous archaeobotanical research provided insight into the impact the environment had on agriculture in southwestern Colorado as well as reconstruct past subsistence strategies. Expansion upon the knowledge of plant use during the Pueblo II period is a key objective of this thesis. While the Pueblo is located within a region of intense archaeological research, this project will focus solely on the Central Mesa Verde region's Pueblo II Period.

CHAPTER THREE
METHODOLOGY

Introduction

Since its inception in North America by Saffray in 1826, flotation has become a valuable tool for archaeologists in reconstructing past subsistence patterns. Flotation is a recovery technique that utilises differences in density to separate buoyant botanical remains from soil matrices (Pearsall 2000). Modifications of flotation methods have been developed to intensify the recovery of carbonised plant remains, including those that rely on chemical and/or mechanical processes (Bodner and Rowlett 1980; Pearsall 2000; Struever 1968; Wagner 1982; Watson 1976).

There are three guidelines for water flotation (Adams 1993). First, the method of flotation must be gentle in order to minimize damage to fragile plant remains. Secondly, the method should be relatively quick (*e.g.*, less than 15 minutes per sample, if possible) to ensure that plant remains do not become waterlogged and sink. Thirdly, safeguards should be in place to insure no cross contamination occurs between samples, such as cleaning equipment thoroughly after each sample is processed.

This chapter will address both field and laboratory methods used to collect and process flotation samples developed by Crow Canyon Archaeological Center (CCAC). Shields Pueblo samples reported herein were processed using CCAC's methods to ensure that these samples are easily comparable to those previously processed by CCAC.

Sample Collection and Flotation

Site Sampling

Excavations at Shields Pueblo began in the spring of 1997. From the inception of this project, the collection of flotation samples was a crucial step in providing a well-rounded picture of the subsistence activities practiced by the

Pueblo's ancient inhabitants. As previously mentioned, CCAC's research focused on gaining a better understanding of the development and abandonment of ancient Puebloan communities in the Mesa Verde archaeological area from A. D. 900 to 1300 (Duff and Ryan 1998, 2000, 2001). Their research examined this phenomenon on three levels: residential, community, and regional.

The flotation sampling protocol was designed to address specific research goals: palaeoenvironment reconstruction, food and fuel use, and an evaluation of land use patterns (Duff and Ryan 1998, 1999, 2000). To obtain adequate plant data to address these questions, a total of 500 flotation samples was collected. To assist in environmental reconstruction and dating, charcoal specimens and pollen from uncontaminated surfaces also were collected. Flotation and macrobotanical samples were obtained from hearths, middens, and other contexts of interest, such as benches and pits, to determine past fuel and food resources. The total volume collected from each context varied and depended upon each individual context. Whenever possible, a minimum of 1 litre was collected. Once collected, the samples were labeled with all relevant provenience information and transported to the lab for flotation and analysis.

For the purposes of this study, only samples collected from Pueblo II contexts are included which amount to 156 samples (Table 2). For a detailed list of samples for each context, see Appendix A. Prior to flotation, sediment samples greater than 1 l were divided into 1 l units for ease of processing. It was also at this time that they were assigned individual field specimen (FS) numbers, which can be used to trace each sample.

Table 2 – Flotation Samples and Volumes from Shields Pueblo Pueblo II Contexts.

Structure	Context	No. of Samples	Volume (l)
NST 101	Secondary Refuse	2	1.9
STR 103	Pit Not Specified 1	1	0.3
NST 108	Floor	1	0.4
STR 124	Secondary Refuse	3	2.6
STR 126	Pit Not Further Specified	1	1.0
NST 129	Fire In Pit 1	6	6.0
STR 137	Hearth 2	5	5.0
STR 138	Hearth 1	11	10.8
STR 138	Ashpit 3	2	2.0

Table 2 Continued

Structure	Context	No. of Samples	Volume (l)
STR 139	Hearth 6	11	10.1
STR 139	Ashpit 7	2	1.6
STR 139	Post 1	2	2.0
STR 139	Bin Not Specified 2	2	2.0
STR 139	Floor not define	1	1.2
STR 140	Hearth 1	6	6.0
NST 152	Secondary Refuse	10	7.6
NST 153	Secondary Refuse	11	9.0
NST 154	Secondary Refuse	4	4.0
NST 203	Hearth 1	1	0.8
STR 234	Hearth 6	8	7.9
STR 237	Hearth 6	8	7.8
STR 1307	Hearth 1	7	7.0
STR 1308	Hearth 2	2	1.8
STR 1308	Hearth 4	4	3.5
NST 1310	Secondary Refuse	16	13.3
NST 1320	Secondary Refuse	21	14.6
NST 1321	Secondary Refuse	8	7.3
Total		**156**	**137.1**

Note: STR – Structure, NST – Non-structure.

Flotation

All soil samples were processed using a manual flotation technique developed by CCAC (Appendix B). Before the soil samples are floated, a small amount of preparatory work is required. A wooden edged screen is placed across the width of a sink and lined with fabric (0.355 mm) which will capture botanical specimens as they are decanted onto the screen. A 10 l pail is filled with water and placed in the sink beside the screen. A one litre sample is poured into the bucket and gently agitated by hand. Clumps of soil are gently broken apart to release any encased plant remains. Flotation works on the premise that air bubbles trapped within botanical remains will cause them to float when placed in water while soil and heavier objects sink to the bottom (Pearsall 2000). After the water has been agitated the solution is left to stand for 15 seconds to allow suspended sediment to sink. It is then slowly decanted onto the fabric until only sludge is left in the bottom of the bucket. This process is repeated until no charred fragments appear floating on the water surface. The edges of the fabric are gathered and tied together to protect the light fraction. These satchels are hung to dry from a clothesline, away from breeze and direct sunlight.

The sludge that remains in the bottom of the bucket is referred to as heavy fraction. After the final bucket of water has been decanted the remaining heavy fraction is spread out on newspaper and permitted to dry. Once dry, the heavy fraction is bagged and curated. Although no further analysis of the heavy fraction was carried out for this study, a lithic specialist, Fumiyasu Arakawa, sorted through the heavy fraction to determine if any microdebitage was present (Arakawa pers. comm. 2002).

Sorting

Once dry, the total volume of light fraction is recorded and then the light fraction is poured through a set of nested sieves (4.75 mm, 2.8 mm, 1.4 mm, 0.71 mm, and 0.25 mm) (Adams 2004). Separating the light fraction into different particle sizes eases the labour and reduces the time it takes to sort flotation samples. After sieving, the resulting particle fractions are placed in separate bags and labeled. Sorting begins with the largest fraction (4.75 mm) working to the smallest. The logic behind this technique is that it allows the research to sort taxa by size and reduces eye strain by minimizing changes in eye focal distance (Bohrer and Adams 1977). An additional benefit of sorting samples in this manner is that complete plant parts are more likely to be found in the larger sieves and as one sorts through each fraction the likelihood of being able to readily identify fragmented plant parts increases, since complete examples may have previously been seen in the upper sieve sizes.

Material collected in the 4.75 mm sieve is spread on a paper plate, with a grid underlay, until the entire field of view under a binocular microscope is covered. The grid ensures that all material is scanned and that time is not wasted trying to determine what portions have already been scanned. Large identifiable pieces of charcoal or plant macrofossils are removed and set aside. A maximum of 20 pieces of wood charcoal are randomly selected from each sample, as established by CCAC

(Adams 2004). The entire 4.75 mm fraction is examined, and carbonised botanical remains removed for further study, before moving onto the next particle size.

The remaining light fraction is sorted using a sub-sampling procedure (Table 3), thus reducing the amount of analysis time (Adams 2004; Toll 1988). If the total volume of any light fraction particle size is ≤ 5.0 ml, the entire fraction size is examined. This volumetric standard was applied to all fraction sizes as a measure of determining if sub-samples were required. If the total volume of the ≤ 2.8 mm fraction is greater than 5.0 ml, sub-sampling was applied. For the 2.8 mm sieve material, a standard sub-sample volume of 1.8 ml was taken; for the 1.4 mm sieve the sub-sample volume was 0.9 ml; 0.71 mm the sub-sample volume was 0.5 ml, and for 0.25 mm it was 0.3 ml. For each separate particle size, standard sub-samples continued to be examined until no new taxa were recovered. Three additional sub-samples were then completed to confirm that no new taxa were present.

Table 3 – Particle Size Categories and Corresponding Sub-sample Volumes

Particle Size	Sub-sample Volume
4.75 mm	Completely sorted
2.8 mm	1.8 ml
1.4 mm	0.9 ml
0.71 mm	0.5 ml
0.25 mm	0.3 ml
<0.25mm	Not sorted

This method of sub-sampling is similar to one employed by ecologists and is referred to as the 'species area curve' (Mueller-Dombois and Ellenberg 1974). According to Adams (1993:196), the advantages of using this method of sub-sampling are two-fold. First, fractions that contain numerous taxa receive more attention during sorting. Secondly, specimens collected from the samples indicate to the analyst whether to stop sorting or to continue – the recovered specimens intuitively guide the analyst. Once no new taxa are recovered, the researcher may move onto the fraction from the next mesh size and repeat the sub-sampling method.

Identification Criteria

Recovered plant remains were identified using CCAC's comparative collection. Published descriptions and photographs were also used to aid in the identification of plant remains (Adams 1980; Bohrer and Adams 1977; Dunmire and Tierney 1997; Martin and Barkley 1961; Welsh *et al.* 1987). Each specimen was identified using distinct morphological attributes. The level of confidence in the identification of each specimen varied depending upon the condition of the specimen and taxonomic issues as more than one species may exist in the area at the present time and in prehistory. Few specimens were identified to the species level. Those genera that have more than one possible species are followed by the word 'type'. This term is used to indicate that although the genus is likely correct, the presence of more than one morphologically similar species makes it difficult to securely identify the specimen below the genus level (Adams 1993; 2004). The unique individual identifying characteristics for each of the identified taxa are provided in Chapter four. Appendix C provides both the common and scientific names for all identified taxa.

Wood Charcoal Identification

Wood charcoal is identified by breaking a fragment along the transverse or radial axis and studying it under a microscope. As with reproductive parts, charcoal is identified using morphological traits such as porosity, ring size and shape, and ray presence and size. CCAC analysis protocols require the analyst to examine a maximum of 20 charcoal specimens from each sample (Adams 2004). If more than 20 specimens were present, 20 were randomly selected. It was not possible to accurately identify specimens with less than one ring.

Seed Identification

Seeds were identified by using both their external and internal structure. Size, shape, surface pattern, point of attachment location and shape, embryo size, reflectivity, and hardness were key characteristics used to identify seeds. Comparison with modern specimens collected by CCAC researchers, photographs, or written descriptions were utilised to confirm species identification (Adams and Murray 2004; Martin and Barkley 1961).

Unknowns

Unknowns are described using standards laid out by Adams (2000:70). The precise dimensions of the unknowns are recorded as well as any distinguishing characteristics. This detailed approach was undertaken in the hope to establish a large database of unknowns available for other researchers to access.

Conclusion

This chapter outlined the methodology utilised by archaeologists and archaeobotanists to collect and process Shields Pueblo flotation samples. The 156 flotation samples included in this study were collected from PII contexts, primarily hearth and secondary refuse deposits. Samples were processed using a simple bucket flotation method and sorted using procedures established by CCAC. Identification of the remains focused on anatomical characteristics and published photographs and descriptions were used to assist in the classification of seeds and wood charcoal specimens.

CHAPTER FOUR
SHIELDS PUEBLO ARCHAEOBOTANICAL ASSEMBLAGE INVENTORY

Introduction

The following chapter is an inventory of the plant remains recovered from the 156 flotation samples collected from Shields Pueblo. The 156 samples consist of 69 hearths, 79 secondary refuse, and 8 other contexts. A brief description of individual contexts is presented in Appendix D. The qualitative and quantitative analyses of the assemblage presented here can be found in following chapter. A wide variety of charred macrofossils was recovered including seeds, achenes, cupules, cobs, caryopses, needles, berries, fruit capsules, charcoal, and other plant parts. These specimens total 5708, representing 43 taxa. Identified seed taxa include domesticated, wild (typically perennials that prefer an established environment), and weedy (frequently annuals that thrive is disturbed to highly disturbed soils) plants. The inventory is grouped by plant types: domesticates, non-domesticates, charcoal, and unknown and the identified taxa within these groups are organised by: family, genus, and species (Welsh *et al.* 1987). Seed morphology is described using the terminology establish by Martin and Barkley (1961). The assemblage of macrofossils is organised into three tables for ease of use and are arranged by temporal period, by structure, or non-structure, and finally by context. The identified plant taxa are organised by taxonomy. Table 4 comprises all reproductive parts recovered and Table 5 includes all unknown reproductive parts. Charcoal data are summarised in Table 6. Detailed tabulations of plants remains and parts by individual sample can be found in Appendix E.

Unique identifying characteristics, ecological information, historic ethnographic plant use (Table 7), and relative quantity and ubiquity are provided for each taxon, when possible. Identifying characteristics consist of distinctive

Table 4 - Raw Counts of Identified Seed Taxa by Excavation Units

SAMPLE INFORMTATION				SEED (n)														
Temporal Period	Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaceae-type	*Descurania*-type	*Echinocereus fendleri*-type
LATE	**Structure 103**																	
	Pit Not Specified	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Structure 124																	
	Secondary Refuse	3	2.6	1	-	-	2	3	2	-	-	-	-	-	-	-	-	-
	Structure 137																	
	Hearth 2	5	5.0	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
	Structure 138																	
	Hearth 1	11	10.8	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	Ashpit 3	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Structure 139																	
	Hearth 6	11	10.1	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	Ashpit 7	2	1.6	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
	Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bin 2	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Structure 140																	
	Hearth 1	6	5.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Structure 1307																	
	Hearth 1	7	7.0	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	Structure 1308																	
	Hearth 2	2	1.8	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	Hearth 4	4	3.5	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	Non-structure 129																	
	Fire in Pit 1	6	6.0	5	-	1	9	-	4	-	-	11	1	-	3	-	-	-
	Non-structure 108																	
	Floor	1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Non-structure 126																	
	Pit Not Specified	1	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Non-structure 101																	
	Secondary Refuse	2	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
	Non-structure 152																	
	Secondary Refuse	10	7.6	6	-	-	4	-	-	-	-	12	-	-	-	-	5	1
	Non-structure 153																	
	Secondary Refuse	11	9.0	3	-	-	-	1	2	-	-	-	-	-	-	-	2	-
	Non-structure 154																	
	Secondary Refuse	4	4.0	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
	Non-structure 1320																	
	Secondary Refuse	21	14.6	8	1	-	5	1	-	-	1	47	13	7	-	-	-	-
MIDDLE	**Structure 234**																	
	Hearth 6	8	7.9	4	-	-	-	-	1	-	-	1	-	-	-	-	-	-
	Structure 237																	
	Hearth 6	8	7.8	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-
	Non-structure 203																	
	Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Non-structure 1310																	
	Secondary Refuse	16	13.3	2	-	-	1	4	1	-	-	15	-	-	-	-	-	-
	Non-structure 1321																	
	Secondary Refuse	8	7.3	1	-	-	2	-	-	-	-	1	-	-	-	-	-	-
TOTAL		156	137.4	44	1	1	24	14	12	1	1	91	14	7	3	1	8	2

Table 4 - continued

SAMPLE INFORMATION				SEED (n)														
Temporal Period	Structure	No. of Samples	Volume (l)	Opuntia-type	Cleome-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	TOTAL SEED COUNTS (n)	TEMPORAL SEED COUNTS (n)
LATE	**Structure 103**																	
	Pit Not Specified 1	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
	Structure 124																	
	Secondary Refuse	3	2.6	23	-	-	39	-	-	-	1	-	-	-	-	2	73	
	Structure 137																	
	Hearth 2	5	5.0	1	-	-	2	-	-	-	4	-	-	-	1	1	14	
	Structure 138																	
	Hearth 1	11	10.8	1	-	-	12	-	-	3	1	-	-	-	-	1	19	
	Ashpit 3	2	2.0	-	-	-	1	-	-	-	-	-	-	-	-	-	1	
	Structure 139																	
	Hearth 6	11	10.1	-	4	-	40	2	-	-	19	-	-	1	-	2	72	
	Ashpit 7	2	1.6	-	-	-	3	-	-	-	1	-	-	-	-	-	5	
	Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
	Bin 2	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
	Undefined Floor	1	1.2	-	-	-	1	-	-	-	-	-	-	-	-	1	3	
	Structure 140																	
	Hearth 1	6	5.9	8	-	-	14	-	-	-	-	-	-	-	-	3	26	
	Structure 1307																	
	Hearth 1	7	7.0	-	-	-	7	-	-	-	-	-	-	-	-	1	10	
	Structure 1308																	
	Hearth 2	2	1.8	-	-	-	14	-	-	-	3	-	-	-	-	1	20	
	Hearth 4	4	3.5	-	-	1	20	-	-	-	5	-	-	-	-	1	33	
	Non-structure 129																	
	Fire in Pit 1	6	6.0	175	2	-	246	-	3	1	-	-	1	-	8	9	479	
	Non-structure 108																	
	Floor	1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 126																	
	Pit Not Specified	1	1.0	-	-	-	3	-	-	-	1	-	-	-	-	-	4	
	Non-structure 101																	
	Secondary Refuse	2	1.9	-	-	-	9	-	-	-	2	-	-	-	-	-	12	
	Non-structure 152																	
	Secondary Refuse	10	7.6	5	-	-	61	-	-	-	18	-	1	-	-	117	230	
	Non-structure 153																	
	Secondary Refuse	11	9.0	2	-	-	32	-	-	-	70	-	-	-	-	2	114	
	Non-structure 154																	
	Secondary Refuse	4	4.0	3	-	-	31	-	-	-	-	-	-	-	-	-	36	
	Non-structure 1320																	
	Secondary Refuse	21	14.6	5	-	-	416	-	-	3	120	1	-	-	-	16	644	1795
MIDDLE	**Structure 234**																	
	Hearth 6	8	7.9	-	-	-	202	-	-	-	1	-	-	-	-	2	211	
	Structure 237																	
	Hearth 6	8	7.8	1	1	-	17	-	-	9	2	-	-	-	-	-	34	
	Non-structure 203																	
	Hearth 1	1	0.8	-	-	-	4	-	-	-	2	-	-	-	-	-	6	
	Non-structure 1310																	
	Secondary Refuse	16	13.3	1	1	-	41	-	-	1	4	-	-	-	-	24	95	
	Non-structure 1321																	
	Secondary Refuse	8	7.3	8	1	-	6	-	-	-	-	-	-	-	-	2	21	367
TOTAL		156	137.4	233	9	1	1221	2	3	17	254	1	2	1	9	185	2162	

Table 5 - Raw Counts of Unidentified Botanical Remains

SAMPLE INFORMTATION				SEED (n)									VEGETATIVE (n)							
Temporal Period	Structure	No. of Samples	Volume (l)	UNK Poaceae 1	UNK Poaceae 2	UNK Seed 1	UNK Seed 2	UNK Seed 3	UNK/UNK 1	UNK/UNK 2	UNK/UNK 3	UNK Botanical	Unknown Charcoal	UNK twig end	UNK stem 1	UNK stem 2	UNK bud	UNK leaf	TOTAL COUNT (n)	TOTAL TEMPORAL COUNT (n)
LATE	**Structure 103**																			
	Pit Not Specified	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 124																			
	Secondary Refuse	3	2.6	10	-	-	-	-	-	2	-	-	-	-	-	-	-	-	12	
	Structure 137																			
	Hearth 2	5	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 138																			
	Hearth 1	11	10.8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Ashpit 3	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 139																			
	Hearth 6	11	10.1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
	Ashpit 7	2	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Bench 2	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 140																			
	Hearth 1	6	5.9	-	-	-	-	-	-	-	1	3	-	-	-	-	1	1	6	
	Structure 1307																			
	Hearth 1	7	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 1308																			
	Hearth 2	2	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Hearth 4	4	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 129																			
	Fire in Pit 1	6	6.0	-	-	-	-	-	-	-	-	8	-	3	-	-	-	-	11	
	Non-structure 108																			
	Floor	1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 126																			
	Pit Not Specified	1	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 101																			
	Secondary Refuse	2	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 152																			
	Secondary Refuse	10	7.6	-	-	-	-	-	-	-	-	2	-	-	4	-	-	-	6	
	Non-structure 153							1	1										2	
	Secondary Refuse	11	9.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 154																			
	Secondary Refuse	4	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 1320																			
	Secondary Refuse	21	14.6	6	-	-	1	-	-	-	-	-	2	-	-	-	-	-	9	48
MIDDLE	**Structure 234**																			
	Hearth 6	8	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Structure 237																			
	Hearth 6	8	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 203																			
	Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Non-structure 1310																			
	Secondary Refuse	16	13.3	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	6	
	Non-structure 1321																			
	Secondary Refuse	8	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
TOTAL		115	137.4	17	-	-	1	1	1	2	1	13	2	3	4	1	1	1	54	

Table 6 - Raw Counts of Charcoal and Vegetative Specimens by Excavation Units

SAMPLE INFORMATION				CHARCOAL (n)												
Temporal Period	Structure	No. of Samples	Volume (l)	*Juniperus*-type	*Ephedra*-type	*Pinus*-type	*Artemisia*-type	*Artemisia tridentata*-type	*Chrysothamnus*-type	*Atriplex*-type	*Quercus*-type	*Amelanchier/Peraphyllum*-type	*Cercocarpus*-type	*Prunus/Rosa*-type	*Purshia*-type	*Populus/Salix*-type
LATE	**Structure 103**															
	Pit Not Specified	1	0.3	7	-	-	-	-	-	-	-	-	-	-	-	-
	Structure 124															
	Secondary Refuse	3	2.6	16	-	5	20	-	-	-	-	-	-	-	-	-
	Structure 137															
	Hearth 2	5	5.0	33	-	-	2	-	-	-	-	-	-	-	-	-
	Structure 138															
	Hearth 1	11	10.8	48	-	21	24	-	-	-	-	1	1	-	-	-
	Ashpit 3	2	2.0	22	-	1	-	9	5	-	2	1	-	-	-	-
	Structure 139															
	Hearth 6	11	10.1	26	-	6	17	4	11	-	-	1	3	1	-	8
	Ashpit 7	2	1.6	10	-	1	-	9	5	-	5	-	-	-	-	10
	Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bin 2	2	2.0	1	-	-	-	-	1	-	2	-	-	-	-	1
	Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-
	Structure 140															
	Hearth 1	6	5.9	22	-	2	31	-	-	-	-	1	-	-	-	-
	Structure 1307															
	Hearth 1	7	7.0	75	-	12	10	28	-	-	-	-	2	-	-	-
	Structure 1308															
	Hearth 2	2	1.8	1	-	-	11	-	-	1	2	-	7	-	-	-
	Hearth 4	4	3.5	22	-	1	9	-	-	-	-	1	-	-	3	-
	Non-structure 129															
	Fire in Pit 1	6	6.0	83	-	6	11	-	6	-	4	2	-	-	-	7
	Non-structure 108															
	Floor	1	0.4	3	-	-	17	-	-	-	-	-	-	-	-	-
	Non-structure 126															
	Pit Not Specified	1	1.0	-	-	-	6	-	-	-	-	-	-	-	-	-
	Non-structure 101															
	Secondary Refuse	2	1.9	12	-	2	8	-	-	-	-	2	-	4	-	-
	Non-structure 152															
	Secondary Refuse	10	7.6	65	-	7	30	-	5	-	2	1	2	-	-	-
	Non-structure 153															
	Secondary Refuse	11	9.0	75	-	11	35	-	4	2	2	-	-	-	-	-
	Non-structure 154															
	Secondary Refuse	4	4.0	65	-	-	1	-	-	-	-	5	-	-	-	9
	Non-structure 1320															
	Secondary Refuse	21	14.6	105	-	40	72	3	1	5	-	1	-	-	-	-
MIDDLE	**Structure 234**															
	Hearth 6	8	7.9	3	1	-	55	20	9	-	-	-	2	-	-	-
	Structure 237															
	Hearth 6	8	7.8	8	-	14	82	-	1	-	-	-	-	-	-	-
	Non-structure 203															
	Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-
	Non-structure 1310															
	Secondary Refuse	16	13.3	30	-	2	22	-	4	-	2	-	2	-	-	-
	Non-structure 1321															
	Secondary Refuse	8	7.3	57	-	33	29	7	1	-	1	-	-	-	-	2
TOTAL		156	137.4	789	1	164	492	80	53	8	22	16	19	5	3	37

Table 6 - Continued

SAMPLE INFORMTATION				VEGETATIVE SPECIMENS (n)															
Temporal Period	Structure	No. of Samples	Volume (l)	*Zea mays* cupule	*Zea mays* cob	Cucurbitaceae-type	*Juniperus*-type leaf scale	*Juniperus*-type twig	*Pinus*-type bark scale	*Pinus*-type cone scale	*Pinus*-type cone umbo	*Pinus*-type needle	*Pinus*-type needle fascicle	*Pinus*-type twig	*Pinus*-type apical meristem	*Yucca baccata* pod	*Artemisia*-type leaf	TOTAL COUNTS (n)	TEMPORAL COUNTS (n)
LATE	**Structure 103**																		
	Pit Not Specified	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	
	Structure 124																		
	Secondary Refuse	3	2.6	29	-	-	-	2	-	-	-	-	-	-	-	-	1	73	
	Structure 137																		
	Hearth 2	5	5.0	6	-	-	-	2	-	-	-	-	-	-	-	-	-	43	
	Structure 138																		
	Hearth 1	11	10.8	26	-	-	-	-	1	-	-	-	-	-	-	-	1	123	
	Ashpit 3	2	2.0	7	-	-	-	-	5	-	-	-	-	-	-	-	-	52	
	Structure 139																		
	Hearth 6	11	10.1	131	2	-	-	-	-	-	-	-	-	-	-	-	-	210	
	Ashpit 7	2	1.6	18	-	-	-	-	2	-	-	-	-	-	-	-	-	60	
	Post 1	2	2.0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Bin 2	2	2.0		-	-	-	-	-	-	-	-	-	-	-	-	-	5	
	Undefined Floor	1	1.2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Structure 140																		
	Hearth 1	6	5.9	41	-	-	-	-	2	-	-	-	-	-	-	-	-	99	
	Structure 1307																		
	Hearth 1	7	7.0	49	-	-	-	-	1	-	-	1	-	-	2	-	-	180	
	Structure 1308																		
	Hearth 2	2	1.8	1	-	-	-	8	-	-	-	-	-	-	-	-	-	31	
	Hearth 4	4	3.5	39	2	-	-	4	-	-	-	-	-	-	-	-	-	81	
	Non-structure 129																		
	Fire in Pit 1	6	6.0	86	4	23	2	24	8	-	-	-	-	3	-	-	-	269	
	Non-structure 108																		
	Floor	1	0.4	27	9	-	-	-	-	-	-	-	-	-	-	-	-	56	
	Non-structure 126																		
	Pit Not Specified	1	1.0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	7	
	Non-structure 101																		
	Secondary Refuse	2	1.9	4	-	-	-	-	1	-	-	-	-	-	-	-	-	33	
	Non-structure 152																		
	Secondary Refuse	10	7.6	79	6	10	-	3	10	-	-	-	-	-	-	-	-	220	
	Non-structure 153																		
	Secondary Refuse	11	9.0	83	1	-	-	6	3	-	-	-	-	-	-	-	-	222	
	Non-structure 154																		
	Secondary Refuse	4	4.0	67	1	-	-	6	2	4	-	-	-	-	-	-	-	160	
	Non-structure 1320																		
	Secondary Refuse	21	14.6	318	12	-	-	56	12	-	6	-	-	-	-	6	-	637	2570
MIDDLE	**Structure 234**																		
	Hearth 6	8	7.9	103	1	-	-	-	1	-	-	-	1	-	-	-	-	196	
	Structure 237																		
	Hearth 6	8	7.8	35	-	-	2	5	19	-	-	-	-	4	-	-	5	175	
	Non-structure 203																		
	Hearth 1	1	0.8	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
	Non-structure 1310																		
	Secondary Refuse	16	13.3	309	-	-	-	8	2	-	-	-	-	-	-	-	1	382	
	Non-structure 1321																		
	Secondary Refuse	8	7.3	22	-	-	-	4	6	-	-	-	1	-	-	-	-	163	921
TOTAL		156	137.4	1488	38	33	4	128	75	4	6	1	2	7	2	6	8	2570	

Table 7 - Economically significant plants and their uses based on historic ethnographies.

Taxon	Food	Medicine	Fuel	Construction	Tools	Clothing	Weaving	Dyes	Ceremonial
Amaranthus	S,L,A	L							
Amelanchier									
Artemisia tridentata		L,U	W		W				W
Artemisia	S							L	St,W
Artemisia filifolia	A	L,P			U				
Aster									
Atriplex	L,S	L							
Atriplex canenesce	A,As	U,R,Bl						L,St	St
Bromus tectorum									U
Cercocarpus									
Cercocarpus montanus	L	W,R,P			W		W		W
Chenopodium	S,L	L							
Chrysothamnus nauseosus		U			St			Bi	
Cleome									L
Cleome serrulata	F,P,L	P						L	
Cucurbitaceae	F				F				
Cucurbita	Bl,F	S,Bl							F
Cycloloma	S	Bl							
Cyperaceae									
Descurania	S	U							
Echinocereus fendleri	F	F							
Ephedra	St	St							
Ephedra viridis		St							
Gossypium		S				SH			SH
Helianthus									
Helianthus annus	S	U,R			St			S	U,Bl
Juniperus	A	F,St	W	Bo, B	W,B	B	F	St,B	W,B,As
Juniperus osteosperma			W						
Malvaceae									
Opuntia	F								St
Panicum									

Table 7 - continued

Taxon	Food	Medicine	Fuel	Construction	Tools	Clothing	Weaving	Dyes	Ceremonial
Peraphyllum									
Physalis	F								
Pinus			W	B	W,G				W,B,G
Pinus edulis	N,G	Ne,G,Po	W	W	W,G		W	G	Ne,W,G,T
Pinus ponderosa									
Populus		L		Bo	W,Fb,St		W		W,T
Portulaca									G
Portulaca oleracea	S,F	S,P							
Portulaca retusa	S,A,F,L	U							
Prunus virginiana	F							F,R	W
Purshia									
Quercus	N	W,U			W,T		W	W	St,W
Rhus aromatica var. *trilobata*	F	U			W,T			L,St,W,Po,As	St,W
Rosa woodsii									
Rosa		Pt			Pt				
Rosaceae									
Salix				Bo	W,T,St		W		St,As,L,W
Scripus									
Solanaceae	F,St								
Sphaeralcea	S,R,L	U							St,R
Stipa hymenoides	C								
Yucca	A	L,R		St	L,Fb,G	Fb		L	L,G,R,Fb
Yucca baccata	F,S,L	L,R			Fb	Fb		R	L,Fb,St,R
Zea mays	S,L,H,St,A	H,Po,CC	CC	St	CC			CC,P	Po,S,H,E

*Key: A = animal; As = ashes; B = bark; Bl = blossoms; Bo = boughs; C = caryopsis; CC = corn cob; Fb = fibers; G = gum; H = husks; L = leaves; N = nuts; Ne = needles; P = plant; Po = pollen; Pt = petals; R = roots; S = seeds; SH = seed hair; St = stem/stalks; T = twigs; U = unknown; W = wood

References for Ethnobotanies:; Fewkes (1896); Robbins *et al.* 1916; Stevenson (1915); Swank 1935; Whiting (1939) anatomical landmarks *e.g.*, shape, surface pattern, embryo size, and point of attachment size and location. Charcoal identifying characteristics focus on the anatomy of the wood when studied in transverse section view *e.g.*, vessel presence, ring shape and width, ray size and continuity. Ecological information is obtained from Adams and Petersen (1999), Dunmire and Tierney (1997), and MacMahon (1999). Ethnographic studies consulted include those on the Tewa (Robbins *et al.* 1916), Zuni (Stevenson 1915), Hopi (Whiting 1966) and Acoma and Laguna Indians (Swank 1932).

Domesticates

Monocotyledonae

Poaceae (Grass)

Zea mays (maize)

Of all domesticates grown by the Anasazi, *Zea mays* is one of the most frequently recovered from archaeological sites and Shields Pueblo is no different. The earliest dates for corn, 8,000 to 10,000 years ago, are from caves located in the Tehuacan Valley, Mexico. These dates were derived from dating stratigraphic associated charcoal. Recent reevaluation of the material suggests that these remains could be place no earlier than 4,700 years ago (Long *et al.* 1989). The oldest instance of corn in the American Southwest is 4,000 years ago (Gregory 1999). A total of 1564 maize specimens was recovered from 88% of the flotation samples analysed. Of this number, 44 are kernels, 36 are cob fragments, and 1484 are cupules. Kernels are large caryopses with a porous, glassy surface when charred. A dominant feature of the caryopsis is the embryo depression. The embryo, contained within the depression, occasionally ruptures from the caryopsis when charred. Cob fragments recovered are composed of a number of fused cupules and do not represent an entire segment of the cob. Cupules are the most abundant specimen recovered from Shields Pueblo as a whole and this high rate of recovery is likely due to their tough dense composition. Cupules are 'cup-like' structures that hold two spikelets, which in turn hold two kernels. The size is highly variable and the surface is porous and pitted. The unique shape and texture of these specimens make them readily apparent when sorting light fractions.

The use of maize by historic groups is very well documented and only the main points will be summarised briefly here. The kernels, husks, and stalks are all well documented in their consumption by historic groups. The Tewa (Robbins *et al.* 1916), Acoma, Laguna (Swank 1932) and the Sia (Stevenson 1915) report the use of pollen for medicinal and ceremonial activities. Corncobs are also used as a fuel source, and this may explain why cupules are so frequently recovered from hearth samples. In addition to the previously mentioned groups, corn is extensively used by the Hopi in their ceremonies (Whiting 1966).

One area of research currently being investigated is the different varieties or 'races' of *Zea* in the southwest (Adams 1994; Eubanks 2001). Originally researchers categorised prehistoric maize types by studying morphological differences of cob and caryopses. The categorisation of maize into different 'races' was used to map and explain the dispersal of maize from Mexico to the American southwest and this technique of morphological classification remained at the forefront until recently (Minnis 2004). The development and refinement of molecular techniques has added a new component to the classification of maize and placed some earlier morphological classifications in question. The maize 'races' of southwestern Colorado are highly varied with early *Zea* specimens being similar to Mexican Pyramidal and Tropical Flint (Jones and Fonner 1954). However, the primary type associated with Mesa Verde proper and the surrounding region during the Basketmaker III to Pueblo III period is Pima/Papago (Cutler and Meyer 1965). The morphology of Pima/Papago maize remained constant through most of prehistory until an increase in cob size and changes in the anatomical structure of the cob occurred in late PII (Adams 1994).

The main limiting factor for corn agriculture is precipitation. It has been estimated that corn crops in the Mesa Verde region require a minimum of 30.5 cm of annual rainfall (Petersen 1988). The timing of the precipitation is also important. Lack of moisture during critical stages of development can significantly reduce kernel yield and weight (Grant *et al.* 1989). The second factor that can impact the success of a crop is the number of frost free days (when the temperature does not drop below –2.0 degrees Celcius. Corn needs 120 frost free days to reach maturity and weather stations located in Mancos and Yellow Jacket show that these areas receive 91 and 135 frost free days respectively, 90% of the time (Adams and Petersen 1999). As with the timing of precipitation, corn is most susceptible to frost when it is flowering, which occurs in the middle of the growing season when temperatures are most likely to stay above frost levels. The land surrounding Shields Pueblo receives enough moisture and frost free days to grow corn; however, based on prehistoric environmental reconstruction known periods of environmental deterioration did occur and would have placed the success of corn crops in peril (Dean and Van West 2000).

Understanding the techniques used for processing corn may assist in the interpretation of maize remains in archaeological assemblages. Numerous studies (Anderson 1950;Cutler 1966; Hall and Fry 1975; Ortman 1998) have been conducted which indicate that maize was processed in a number of different ways. Researchers indicate that kernels were typically removed from the cob around the time of maturity, but before the kernel had become hard and dry. The manner in which the kernels were prepared after being removed from the cob also varied with some archaeological evidence indicating that the kernels were boiled or in some cases parched before storage (Anderson and Blanchard 1942; Bohrer 1962). Kernels, and during times of food scarcity even cobs, were also ground as an additional means of preparation (Ortman 1998). The repeated recovery of corn kernels in flotation samples supports the idea that at some point during preparation kernels were either toasted prior to storing or consumption. Although not present at Shields Pueblo, the recovery of additional maize parts such as husks, stalks, tassels would indicate that agricultural fields were in close proximity to the habitation site (Fish 2004).

Dicotyledonae

Cucurbitaceae (Gourd)

Shields Pueblo flotation samples yielded 33 rind fragments. Identification of these fragments to genus was not possible, although better preserved specimens can be identified based on their anatomical characteristics. The inner cell patterns *Cucurbita,* visible when viewing the rind in cross section, are shorter and wider than the long, thin cells of *Lagenaria* (Adams and Murray 2004). Cucurbits represent one of three plants considered to be the 'Three Sisters': corn, beans, and squash. The earliest evidence of squash in the North America occurs in the east. Squash remains were recovered from the Phillips Spring site and have been dated to 2300 BC (Chomko and Crawford 1978). Evidence of squash in the Southwest is at least 1000 years younger, however, Piperno and Stothert (2003) point out that domesticated *Cucurbita* were grown in South America during the early Holocene, 9,000 to 10,000 years ago. Specimens of *C. pepo* from Northern New Mexico have been directly dated to 2,800 years ago (Simmons 1986). In addition to being a food resource, cucurbits were used to make containers and rattles (Stevenson 1915).

Cucurbita (gourd or squash)

Seeds of *Curcubita* have a smooth surface and margin and range in shape from ovate to oblong. The margin shape and texture is often used as the defining characteristic. A single, highly deteriorated seed was recovered from a secondary refuse deposit at the Pueblo. The seed was too damaged to determine the species based on shape, but is likely *C. pepo* or *C. moschata.* The fruits of these plants were a valuable food resource, and the blossoms were made into cakes by the Zuni (Stevenson 1915) and Hopi (Whiting 1966). In addition to being a food resource this taxon had medicinal and ceremonial uses. The seeds and blossoms were used to relieve discomfort associated with cactus needles. The Zuni also wore the fruit in phallic dances, and they were made into rattles for “anthropic” and ”zooic” worship (Stevenson 1915:52).

Malvaceae (Mallow)

Gossypium (cotton)

A single cotton knot was recovered from a hearth at Shields Pueblo. It is not only the seed that is most important to historic and prehistoric groups, but the seed hair or bolus. Cotton was used by the Tewa (Robbins *et al.* 1916) and Zuni (Stevenson 1915) to make clothing and string, and the bolus was used in ceremonies. The Tewa (Robbins *et al.* 1916) also used the seed as a remedy for baldness.

Non-Domesticates

Monocotyledonea

Agavaceae (Agave)

Yucca baccata (yucca)

Yucca baccata is an extremely important wild plant available in the prehistoric Southwest. Banana yucca seeds are flattened and possess a ripple or wavy-like pattern on the surface. The seed margins are wide and have a flat edge. Shields Pueblo yielded 24 charred seeds and six seed capsule fragments. Considering that the capsule is the portion of the plant that is frequently consumed one wonders how these fragments arrived in the archaeological record. Perhaps the capsule was unpalatable or more desirable foodstuffs were available. This plant's main habitat is open grassy areas or on the borders of pinyon-juniper woodlands. The leaves of this succulent were used as medicine, to make tools, and the fibres contained within the leaves could be made into cordage for clothing. One of the most common uses of yucca fibres was in the making of sandals. A total of 409 sandals was recovered from Antelope House, Canyon de Chelly (Magers 1986). Yucca roots contain saponin, a lathering agent, which was used as soap for hair and wool (Dunmire and Tierney 1997). The fruit is harvested in late summer and were known to be consumed by prehistoric groups (Fry and Hall 1986). The bananas have a sweet taste similar to sugar snap peas.

Figure 5 – *Yucca baccata* plant
(Copyright 1997 Dunmire by permission)

Cyperaceae (Sedge)

Achenes belonging to this family are ovate in shape and trapezoid in cross section. They often possess style remnant in the form of a raised point at the apex which can be useful for identification. A rough, striated surface pattern is clearly visible. A total of 14 achenes was recovered from analysed flotation samples. Plants belonging to this family are associated with moist habitats. Two genera that are commonly recovered at Southwest sites are *Rumex* and *Scripus* (Adams 1999; Bohrer 1975; Doebly 1985). These two taxa are similar in appearance except for the pointed apex found on *Rumex* achenes.

Scripus (bulrush)

A total of 12 bulrush achenes was recovered from eight samples at the Pueblo. As mentioned above, this plant thrives in moist environments and provides seeds in the fall (Adams 1998). Historic groups used these achenes as food and stalks in building construction (Dunmire and Teirney 1997). The Acoma and Laguna consumed the roots and stems of this plant, but not the seeds (Swank 1932).

Poaceae (Grass)

Bromus tectorum (brome grass)

A single caryopsis of brome grass was recovered from a secondary refuse flotation sample. Although no reviewed ethnographies mention the use of this plant as a food resource, the Kayenta Navajo made a lotion that was used to bathe god impersonators before they wore their masks (Wyman and Harris 1941).

Panicum (panic grass)

One *Panicum* caryopsis was recovered from Shields Pueblo samples. Coprolite studies in the area indicate the consumption of *Panicum* caryopses (Minnis 1989).

Stipa hymenoides (Indian ricegrass)

The floret is ovoid in shape, slightly more bulbous at the proximal end, with pointed proximal and distal ends. Ricegrass caryopses are ovoid and possess a discernable embryo depression. Longitudinal arrangements of cells on the surface of the caryopsis are clearly visible when magnified. A total of 91 specimens including florets and caryopses was recovered from flotation samples. Indian rice grass is one of the first plants available for collection in the spring. It grows in disturbed habitats and produces seeds in the spring which may cling to the plant after maturing. These grains are high in protein and 1 oz can yield as much as 120 calories (Dunmire and Teirney 1997). *Stipa* plants grow in clumps and can be found in open sandy locations. The consumption of *Stipa* grains as a food resource is demonstrated by their recovery from human coprolites (Minnis 1989; Stiger 1977). Whiting (1966) indicates that the caryopses were extensively collected by the Hopi.

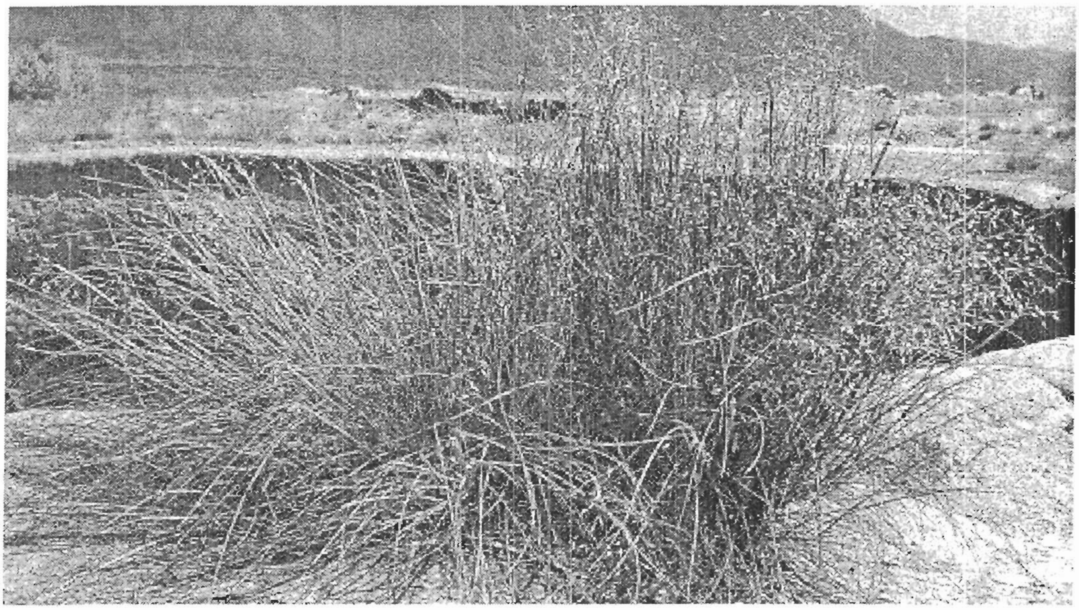

Figure 6 – *Stipa hymenoides* (Copyright 1997 Dunmire by permission)

Dicotyledonae

Anacardiaceae (Cashew)

Rhus aromactica var. *trilobata* (lemonade berry)

Lemonade berry seeds are ovcid with a smooth surface texture. The most defining characteristic is a lens-shaped opening located opposite the attachment scar. The uncharred fruit is sticky and hairy and roughly the size of a pea. A total of 14 specimens of lemonade berry was recovered from Shields Pueblo samples including seven fruits and seven seeds. Shrubs of this genus are present in grasslands, pinyon-juniper woodlands, and oak scrubland (Adams and Petersen 1999). *Rhus aromatica* bushes flower in late spring and fruits are available by late summer. Coprolite analyses from sites located on Mesa Verde indicate that prehistoric groups consumed *Rhus* fruits (Minnis 1989). Ethnohistoric records convey that the fruit was eaten fresh or dried and stored for future use (Castetter

1935; Whiting 1966). Wood from the bush was frequently used in construction, for tools and basketry materials, and for medicine (Castetter 1935; Steveson 1915; Swank 1932). The wood of this bush was also used by the Hopi to make prayer sticks and is one of the Hopi's four ritual kiva fuels (Colton 1965; Hough 1897). Ethnohistories list one of the most common uses of the plant as a natural dye (Colton 1965; Whiting 1966). The leaves, stem, wood, pollen, and ashes are all used to produce a variety of colours. The leaves and stems produce a black dye that can be applied to baskets and hides.

Asteraceae (Sunflower)

A total of seven Asteraceae achenes was recovered from seven separate secondary refuse samples. Little information on the use of this plant is contained in ethnographies; however, one source states that the leaves and stems of *Helianthus* were used as a medicine by the Hopi and Zuni (Dunmire and Tierney 1997).

Helianthus (sunflower)

. Shields Pueblo's sunflower achenes are similar to those of modern sunflower in shape, with longitudinal striations on the surface, however they are smaller in size at 4-5 mm in length. Only three sunflower achenes were recovered from Shields Pueblo samples. Sunflower plants prefer disturbed soils with reasonable levels of moisture and are often situated along roadsides and fallow fields. The achenes were dried and then eaten like nuts. The Hopi used the achenes to make ceremonial body paint (Whiting 1966). The leaves were prepared in a manner similar to beeweed and used as paint for pottery (Stewart and Adams 1999). The Zuni used sunflower plants for both ceremonial and medicinal purposes (Stevenson 1915).

Brassicaceae (Mustard)

A single seed identifiable to Brassicaceae was recovered from a hearth at the Pueblo. The seed most likely is *Descurania*, but due to its deteriorated condition it could not be confidently placed in this genus.

Descurania (tansy mustard)

The seeds of this plant are extremely small, less than 1 mm in length, with a visible groove where the recumbent embryo is found. The oblong seed's surface is covered in an irregular pattern of pitted cells. A total of eight seeds was recovered from four contexts at Shields Pueblo. This plant thrives in disturbed habitats and flowers in spring. Coprolite evidence indicates that tansy mustard was a food source in prehistory (Scott 1979). The leaves of tansy mustard are one of the first to become available in the spring and are reported to have been consumed by the Hopi (Colton 1965). They are also used to produce paint for pottery (Stewart and Adams 1999).

Cactaceae (Cactus)

Echinocereus fendleri (hedgehog cactus)

Hedgehog cactus seeds are small oval shaped seeds marked by round protuberances and their naturally black colour makes it difficult to determine whether they are charred or uncharred. Two hedgehog cactus seeds, one charred and one uncharred, were recovered from secondary refuse areas at the Pueblo. *Echinocereus* spp. are commonly found in pinyon-juniper woodlands and fruit ripens in late summer. Evidence of the consumption of this fruit is found in both coprolite specimens (Minnis 1989) and in ethnographies (Castetter 1935; Swank 1932; Whiting 1966). The fruit is also suggested to be a possible famine food (Dunmire and Tierney 1997), this may be due to the unpleasant taste or the work required to make palatable. In addition to being a food resource the fruit of the hedgehog cactus is also thought to have medicinal properties. The Isleta used roasted leaves to treat swellings (Jones 1935). Unlike prickly pear cactus no ethnographies have indicated that the pads of this cactus were consumed.

Opuntia (prickly pear cactus)

The seeds from the berries of prickly pear cactus, commonly known as tunas, are disk-shaped with a distinctive marginal rim. A total of 26 samples from a variety of contexts produced 233 seeds. Similar to the hedgehog cactus, prickly pears are found in pinyon-juniper woodlands and the more open sageburrsh-saltbush plant communities. *Opuntia* produces fruit in the late summer that can cling to the plant well after maturity, a fact that compromises the reliability of this fruit as a seasonality indicator. Tunas are a source of protein, vitamin C, potassium, and calcium (Dunmire and Tierney 1997). Fruit was collected using specialised sticks and then rolled in sand or over coals to remove the spines (Castetter 1935; Robbins *et al.* 1916; Swank 1932; Whiting 1966). Once the spines were removed the fruit could be eaten, or halved, dried, and stored as practiced by the Acoma (Castetter 1935) and Zuni (Stevenson 1915). The Zuni also mixed the fruit with corn to form a mush. The juice from the fruit was used as a temper for pottery (Chamberlain 1906). Prickly pear seeds were not typically consumed, unless food resources were scarce. The recovered seeds were likely discarded either during consumption or cleaning the fruit. The pads can also be consumed, but are typically reserved for times of food shortages (Swank 1932). Cactus' spines were used for sewing and tattooing by the Hopi (Swank 1932).

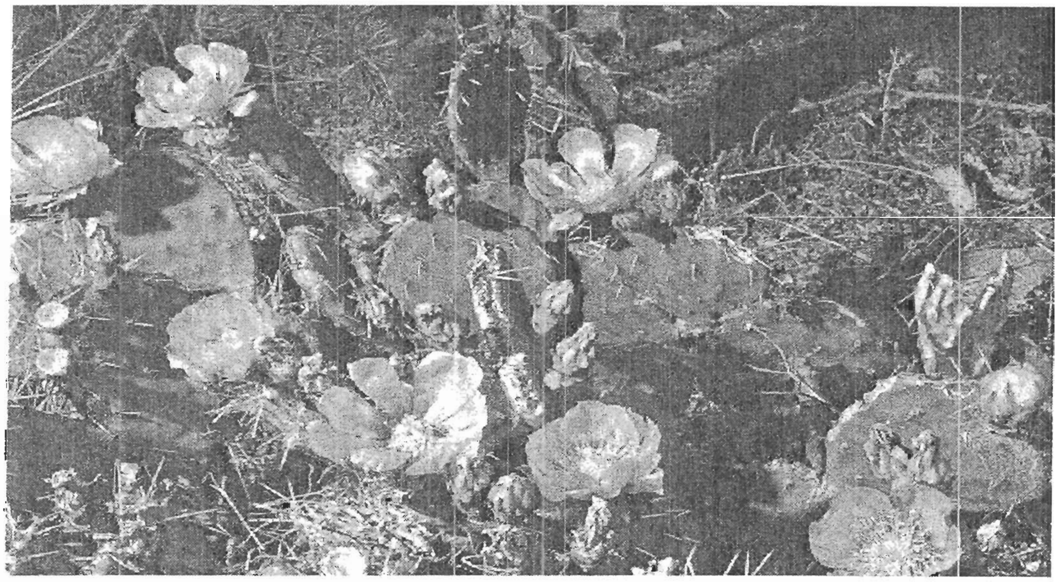

Figure 7 – *Opuntia* cactus (Copyright 1997 Dunmire by permission)

Capparaceae

Cleome (beeweed)

Seeds from this plant are compressed globose in shape and have a pronounced rim along the margin of the folded embryo. The surface is covered in tubercles. A total of nine seeds was recovered from flotation samples. Beeweed prefers a moist environment with disturbed soil and consequently it is frequently found in ditches along roads. It flowers in early summer and produces fruit by late summer. It is one of the main plants used in making paints for pottery. The leaves are placed in a reduction boil and the resulting paste is used as paint (Robbins *et al.* 1916; Stevenson 1915). Analysis of Anasazi pottery indicates that this plant was used as paint in prehistoric times (Stewart and Adams 1999). The leaves were also boiled and eaten in a manner similar to spinach. Coprolite studies and ethnographic reports suggest that the seeds were also consumed (Castetter 1935; Minnis 1989; Stiger 1977; Swank 1932). The seeds were often toasted and ground prior to consumption (Swank 1932). The plant is a source of calcium and vitamin A (Dunmire and Tierney 1997). The Tewa used the entire plant to treat stomach illness by grinding the plant and mixing it with water (Robbins *et al.* 1916). The mixture is then wrapped in cloth and applied to the abdomen. There is some discussion that this plant may have been encouraged by prehistoric groups (Whiting 1966).

Chenopodiaceae (Goosefoot)

Cheno-am

Cheno-am represents the seeds of two anatomically similar genera, *Chenopodium* (goosefoot) and *Amaranthus* (pigweed), both are compressed-lenticular shaped and sometimes difficult to separate based on seed anatomy. Both genera were reportedly used by historic groups. A total of 117 of the 156 flotation samples analysed contained cheno-am seeds, totalling 1217 specimens. Goosefoot and pigweed thrive in anthropogenic environments, such as paths, roadsides, and field margins. Both flower and fruit at roughly the same time; however, goosefoot fruits slightly earlier than pigweed. The production of fruit in pigweed is conditional upon spring and summer rainfall (Dunmire and Tierney 1997). The leaves of both plants are prepared and eaten in a manner similar to spinach (Whiting 1966), and are a source of vitamins, iron and calcium, as well as protein and lysine (Dunmire and Tierney 1997). Leaves were steeped and the resulting vapour used to treat headaches by the Zuni (Stevenson 1915). They were also placed directly on burned skin and made into a lotion to sooth bruises (Wyman and Harris 1951). Seeds are toasted, ground, and mixed with corn by the Hopi (Whiting 1966), Zuni (Stevenson 1915), and Tewa (Robbins *et al.* 1916). The fact that this plant thrives in highly disturbed environments suggests that it would have been readily available to Anasazi farmers and c been collected from fallow fields and along, and possibly within, growing corn fields. While there is no clear evidence that this plant was cultivated at Shields Pueblo, evidence of its domestication has been identified at sites situated in eastern North America (Gremillion 1993; Smith 1984).

Cycloloma (winged pigweed)

Winged pigweed seeds are circular-lenticular shaped, similar to cheno-ams, but encircled by a more pronounced flat marginal rim or calyx. Only 2 winged pigweed seeds were recovered from the samples. The seeds are most likely *Cycloloma atriplicifolium*, as this is the only species present historically. This plant fruits in the fall and prefers sandy fields, desert shrub, and juniper woodlands. Stevenson (1915) reports that the Zuni ground and mixed the seeds with cornmeal and formed them into cakes or balls. They also associate this plant with the Gods of War, and as such the blossoms were chewed and spread on their hands and face as an enemy approached. The Hopi also used this plant for ritual and medicinal purposes (Whiting 1966).

Malvaceae (Mallow)

Seeds belonging to this family vary from compressed-reniform to flat- with a divot near the point of attachment. A total of three seeds was recovered from hearth features at the Pueblo. They flower and fruit during the summer. Genera recovered from Southwestern sites include *Gossypium* and *Sphaeralcea*, both of which were recovered from Shields Pueblo flotation samples.

Sphaeralcea (globemallow)

Globemallow seeds are compressed-reniform with a deep notched point of attachment. They range in length from 1 to 2 mm. The surface texture of the seed is wrinkled with small depressions. A total of 17 globemallow seeds was recovered from Shields Pueblo. *Sphaeralacea* plants prefer disturbed habitats. The leaves, seeds, and roots of this plant were utilised by numerous historic groups (Swank 1932; Robbins *et al.* 1916; Whiting 1966). Minnis' (1991) research verifies the use of this plant as a famine food.

Medicinally, the plant was used to stop bleeding and was made into an infusion to treat those afflicted by witchcraft (Steveson 1915). Stevenson (1915) states that the roots were boiled as a tea and drunk each evening for the Sword Swallowers fraternity ceremony. Roots were also chewed and rubbed on the bodies of Sword Swallowers to prevent injuries.

Portulacaceae (Purslane)

Portulaca (purslane)

Purslane seeds have several diagnostic features including, small size, ovate shape and raised tubercles on the surface. A total of 254 seeds was recovered from Shields Pueblo flotation samples. This low-growing, sun loving plant represents the second most abundant seed taxon at the Pueblo. The leaves are available for consumption in mid-summer and the fruit ripens in early fall. Evidence of the direct consumption of seeds and greens is found in coprolites recovered in the region (Minnis 1989; Scott 1979; Stiger 1977). Purslane seeds contain a variety of vitamins including A, C, and B, as well as mineral, iron, calcium, and protein (Dunmire and Teirney 1997). Swank (1932) records one use of the plant by the Acoma and Laguna in making a medicinal tea.

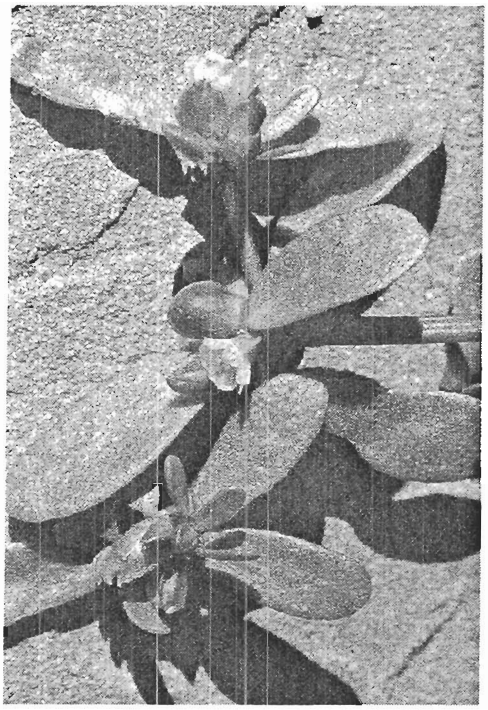

Figure 8 – *Portulaca* plant
(Copyright 1997 Dunmire by permission)

Rosaceae (Rose)

A single Rosaceae seed was recovered from the site and due to the condition it was not possible to identify it below family level.

Prunus virginiana (chokecherry)/*Rosa woodsii* (wild rose)

Two chokecherry and one wild rose seeds were recovered from Shields Pueblo flotation samples. Evidence of the consumption of chokecherry is found in the recovery of the seeds from prehistoric coprolites (Minnis 1989). Ethnohistories report the consumption of chokecherry fruit by the Acoma and Laguna (Castetter 1935; Swank 1932). The Ute Mountain Ute processed rosehips for storage by crushing them and laying them in the sun to dry (Fowler 1986). The rosehips are high in vitamin C and the seeds contain vitamin E (Dunmire and Tierney 1997). The petals were used by a variety of historic groups to treat mouth and stomach maladies.

Solanaceae (Nightshade)

Seeds from this family vary in size from oval to reniform, and the surface is reticulate. A total of nine seeds could not be confidently identified below the family level, but are most likely *Physalis*.

Physalis (groundcherry)

The seeds of this genus are identified by the oval shape, reticulated surface pattern, and notch on the marginal rim. Groundcherry berries and seeds were recovered from 37 samples totaling 185 specimens. *Physalis* prefers disturbed habitats and produces berries from summer to early fall. The Tewa (Robbins *et al.* 1916), Zuni (Stevenson 1915), Acoma, Laguna (Swank 1932), and Hopi (Whiting 1966) all consumed the berries. Ethnographic accounts indicate that the berries were eaten raw, dried, and/or boiled and used as a condiment (Stevenson 1915).

Charcoal

Gymnospermae

Cupressaceae (Cypress)

Juniperus (Juniper)

Juniper charcoal is characterised by a band of latewood that is narrow in comparison to earlywood and the absence of resin canals; however, rootlet holes that mimic resin canals may be present. Juniper specimens (charcoal, leaf scales, and twigs) were the most ubiquitous charcoal recovered from Shields Pueblo samples. A total of 937 pieces of juniper wood was recovered from 129 flotation samples. Pinyon-Juniper woodlands cover the majority of the drainage area surrounding the site and offer access to three species of juniper: *J. osteosperma*, *J. monosperma*, and *J. scopulorum* (Adams and Petersen 1999).

Based on ethnographic accounts this species was used in a myriad of ways. The wood was used in construction, and tool making, as well as a fuel source (Swank 1932; Whiting 1966). The Hopi and Acoma used the twigs, leaves, and bark of juniper trees for medicinal and ritual purposes (Stevenson 1915; Swank 1932; Whiting 1966). Evidence of the consumption of berries has been found in the analysis of human coprolites from Mesa Verde (Minnis 1989) and in ethnographies of the Acoma, Isleta, Laguna, Tewa, (Castetter 1935; Robbins *et al.* 1916). Juniper berries cling to branches after ripening and are not a suitable seasonality indicator because they can be collected and used after the fruiting season.

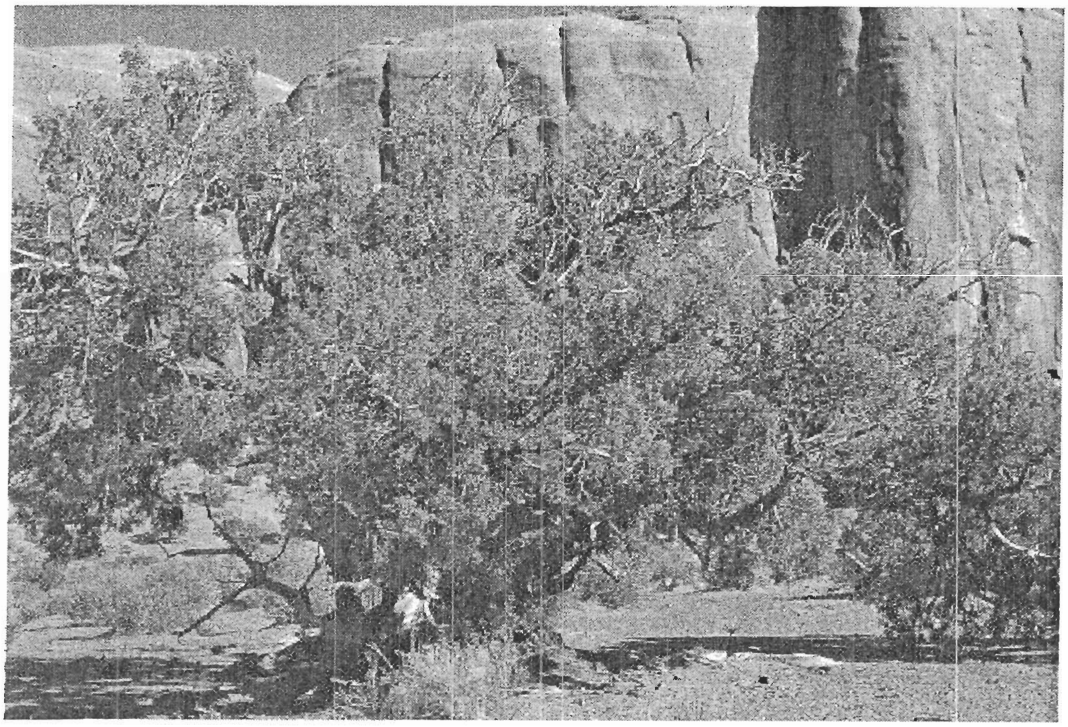

Figure 9 – *Juniperus* tree (Copyright 1997 Dunmire by permission)

Ephedraceae (Ephedra)

Ephedra (ephedra, joint-fir, Mormon tea, Navajo tea)

Charcoal from this taxon contains numerous small, evenly distributed vessels and the rays are medium in size ranging from 1-3 vessel widths. The ring boundaries are difficult to discern and are marked by scalloped patterns. A single piece of ephedra charcoal was recovered from a hearth at the Pueblo. The infrequency of this taxon corresponds with historic accounts which indicate that ephedra was not a commonly used hearth fuel (Adams 1999). *Ephedra viridis*, Morman tea or Navajo tea, is the likely source of this charcoal. The main use of this plant was as medicine. The stems were used to make a medicinal tea used to treat stomach pains, colds, as well as urinary tract problems by the Hopi (Whiting 1966), Ute (Dunmire and Tierney 1997), and Acoma and Laguna (Swank 1932). The leaf of this bush was chewed by the Tewa as a treatment for diarrhea (Robbins *et al.* 1916). The Hopi and Zuni also used this plant to treat syphilis (Stevenson 1915; Whiting 1966). The plant also contains 'pseudoephedrine' an alkoloid, which constricts blood vessels, thus raising blood pressure (Dunmire and Tierney 1997).

Pinaceae (Pine)

Pinus (Pine)

Identifying characteristics of pine charcoal contains resin canals, and there is a distinct boundary between early and late wood. *Pinus* occurs in 54 of the 156 samples analysed in this study. Presently, Pinyon-Juniper woodlands cover a majority of the Monument - McElmo drainage. The most likely species of pine recovered from this assemblage is *Pinus edulis* (Pinyon Pine), with *P. ponderosa* also available further east. The primary edible resource is the seed of the Pinyon pine. This species provided a sporadic food resource, which was consumed by historic native groups such as the Acoma, Hopi, Laguna, Tewa, Ute, and Zuni (Chamberlain 1909; Robbins *et al.* 1916; Stevenson 1915; Swank 1932; Whiting 1966). The paucity of the resource and the amount of energy involved in collecting the seeds is compensated for in the high caloric return, amino acids, and protein derived from the nuts (Dunmire and Tierney 1997). Ethnographies indicate that pack rat nests were raided to collect large quantities of pinenuts, with little energy output. In addition to being a food resource, pine trees produce a variety of materials that can be used in construction, as fuel, medicine, and waterproofing (Robbins *et al.* 1916; Swank 1932; Stevenson 1915; Whiting 1966). A variety of plant parts were recovered from Shields Pueblo's flotation samples including charcoal, bark scales, cone scales, cone umbos, a needle, needle fasicicles, twigs, and apical meristems. The presence of non-wood pine parts suggests a local pine source, as large pine boughs were not likely to be carried extended distances.

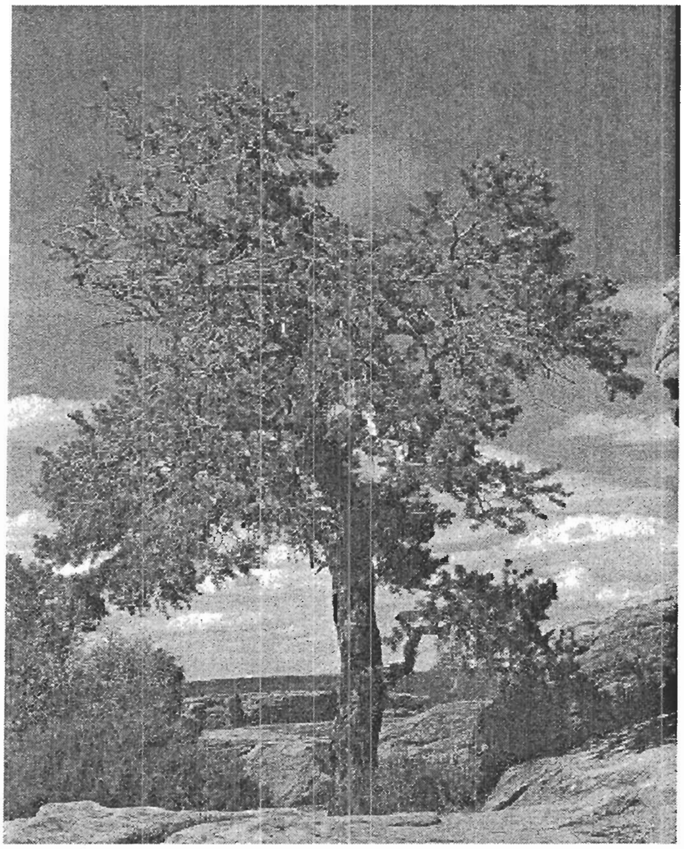

Figure 10 – *Pinus* tree (Copyright 1997 Dunmire by permission)

Dicotyledonae

Asteraceae (Sunflower)

Artemisia spp. (sagebrush)

This ring porous charcoal is easily identified in transverse section by a dendritic flame pattern formed by vessels. A cork band along the rings often results in the charcoal breaking along this boundary into 'ring shakes'. An additional identifying trait are the lenticular pores visible in tangential view. A total of 574 pieces of sagebrush charcoal, 84 of which were identifiable to *A. tridentata* (giant sagebrush), was identified. Charcoal specimens were recovered from 72% of the flotation samples analysed. Sagebrush charcoal is the third most abundant charcoal taxon recovered from flotation samples. Also present in Shields Pueblo samples

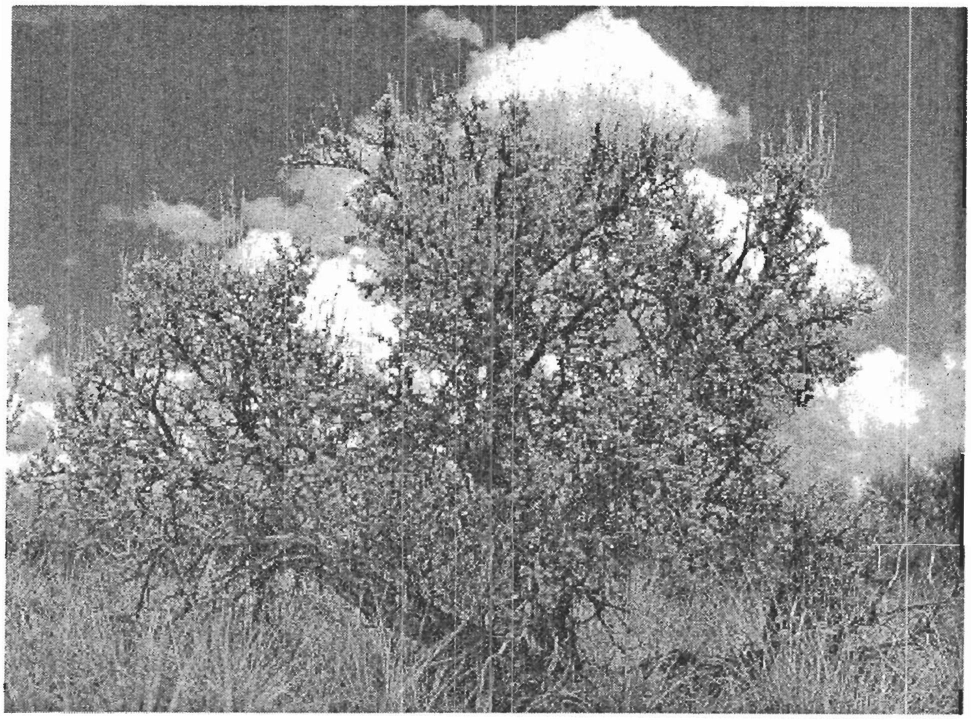
Figure 11 – *Artemisia* bush (Copyright 1997 Dunmire by permission)

were charred sagebrush leaves, 14 in total, and eight were identified as *A. tridentata*. These tri-lobed leaves may have been attached to pieces of wood being burned and thus became incorporated into the archaeobotanical record. The sagebrush-saltbush plant community covers a small portion of the Monument-McElmo drainage basin. Within this plant community there are two species of sagebrush available for use: *A. tridentata* and *A. filifolia*. Sagebrush prefers habitats that are well drained, with deep soils and today can be found on or around archaeological sites. This bush flowers and fruits in the late summer to early fall. Historic studies indicate that sagebrush was used for food, medicine, fuel, tool material, and for ceremonial purposes. The seeds were ground into a mush and mixed with water and formed into balls and cakes by the Zuni (Stevenson 1915). Sagebrush is a source of iron and vitamin C (Dunmire and Teirney 1997). It is used to treat constipation, water snake bites, stomachaches, headaches, colds, indigestion, and to ease childbirth (Robbins *et al.* 1916; Stevenson 1915). Sagebrush wood is commonly employed in the construction of ceremonial objects and production of medicine (Robbins *et al.* 1916; Swank 1932; Whiting 1966).

Chrysothamnus nauseosus (rabbitbrush)

Rabbitbrush charcoal is distinctive in cross-section due to the wavy pattern created by latewood vessels and light reflective surface appearance. Twenty-five samples contained a total of 51 pieces of charcoal. Rabbitbrush is located in dry open areas and is associated with sagebrush and grasslands. Wood from this plant is considered to be one of the Hopi's chief kiva fuels (Whiting 1966). The Zuni use the stems of rabbitbrush in basket weaving (Stevenson 1915) and the flowering heads produce a yellow dye for wool (Colton 1965; Robbin *et al.* 1916; Stevenson 1915). The flowering head can be harvested from August to October (Adams 1998). The Hopi used this species as medicine, fuel, dye, and in the construction of ceremonial implements (Whiting 1966).

Chenopodiaceae (Goosefoot)

Atriplex canenesce (four-wing saltbush)

Saltbush charcoal is characterised by alternating arcing bands of vessels and non-vessels. The pith is highly light reflective. The utricle core is quadrangular in shape with four points of attachment where fruit bracts adhere. Eight pieces of saltbush charcoal and one utricle core were recovered from four samples. Saltbush is found in grasslands, pinyon-juniper woodlands, and sagebrush environs. This bush flowers from May to August and fruits appear in the late summer or early fall. As the name implies the fruit has a slightly salty taste and may have been sought after for this property. The consumption of saltbush is further confirmed in the region through the recovery of seeds from coprolites (Minnis 1989). The wood is one of the Hopi's four chief kiva fuels (Whiting 1966). The leaves and seeds were consumed individually, or mixed with ashes to make dough (Castetter 1935; Robbins *et al.* 1916, Stevenson 1915). This plant was used in ceremonies, as a medicine, and as a dye. The Zuni ground the roots and blossoms and mixed them with salvia to treat ant bites (Stevenson 1915) and the Acoma and Laguna made a tea from the stems of the bush as a blood medicine (Swank 1932).

Fagaceae

Quercus (Oak)

Oak charcoal is relatively easy to identify due to its extremely wide rays, which occasionally are visible to the naked eye. This ring porous charcoal has vessels, larger in the early wood than late, and can contain occluded cells. A total of 51 pieces of oak charcoal was recovered from 25 contexts at the Pueblo. The main species of oak found in the area surrounding Shields Pueblo is *Q. gambelii* (gambel oak). Gambel oak grows in sunny, rocky locations. The wood from this tree is utilised in numerous ways: medicine, fuel, tools, weaving, dyes, and ceremonial functions. The main food resource is acorns and although none were recovered from the site, ethnographic data indicate they were collected by several groups (Castetter 1935; Robbins *et al.* 1916; Swank 1932). The nuts were boiled, roasted, or dried and ground. The leaves can be chewed and used to soothe insect bites (personal experience). The wood is also used in buildings, bows, to make clubs, throwing sticks and batten sticks for weaving, and the twigs were used in basket weaving (Castetter 1935; Robbins *et al.* 1916; Swank 1932).

Rosaceae (Rose)

Rosaceae constitutes the largest number of genera recovered from all families identified at the site. Six genera were identified in flotation samples, primarily as charcoal. Charcoals belonging to this family are typically semi-ring porous with numerous vessels that grade from larger in the earlywood to smaller in the latewood.

Amelanchier utahensis (serviceberry)/*Peraphyllum ramosissimum* (peraphyllum)

Serviceberry/peraphyllum charcoals are semi-ring porous with small, abundant, and evenly spaced vessels. The charcoal also has numerous, discontinuous rays which are 1-2 cells wide. A total of 16 charcoal fragments from 11 samples was identified as serviceberry/*Peraphyllum* at Shields Pueblo. Due to the extreme closeness in the anatomical signatures in the charcoal, these two taxa are frequently combined into one category. These small trees prefer pinyon-juniper woodlands and oak scrubland environments (Adams and Petersen 1999). Historic groups used these plants as a fuel and food resource (Stevenson 1915; Swank 1932; Whiting 1966). In addition to a fuel source the heavy, hard wood is ideal for tool making (Callaway *et al.* 1986; Whiting 1966).

Cercocarpus montanus (mountain mahogany)

Charcoal of this taxon is diffuse porous, with widely spaced, singular vessels of various sizes. Numerous continuous and discontinuous rays 1-2 cells wide are present throughout the wood. A total of 19 pieces of mountain mahogany charcoal was recovered from 5% of the total number of flotation samples analysed. The wood of this plant was not regularly used as a fuel by historic groups, but was commonly used for tools because of its density (Swank 1932; Whiting 1966). The Tewa collected this bush and mixed it with salt and water for a laxative (Robbins *et al.* 1916). The Hopi collected the bark to produce a red coloured dye for wool and leather (Whiting 1966).

Prunus virginiana (chokecherry)/*Rosa woodsii* (wild rose)

Chokecherry/wild rose are similar in their anatomy and discerning between them is difficult. The wood is semi-ring porous, with solitary and paired vessels that grade from larger in earlywood to smaller in latewood. The charcoal also contains numerous rays that are only one to three cells wide. Five pieces of charcoal were recovered. Both taxa bloom in late spring and fruit in late summer and thrive in grassland and oak scrubland habitats and near streams (Adams and Petersen 1999). The composition of chokecherry wood, tough, but flexible, make it ideal for bow manufacturing (Callaway *et al.* 1986; Swank 1932).

Purshia (bitterbrush)

Purshia charcoal has thin rays and distinctive ring boundaries, which are scalloped, and with widely spaced vessels present in latewood. Only three pieces of this semi-ring porous charcoal specimens were identified to *Purshia* and all were recovered from a single sample. Two species of *Purshia* available for use in the Four Corners area: *P. tridentata* and *P. mexicana*. *Purshia* bushes prefer the environment of the oak scrubland (Adams and Petersen 1999). The wood from this plant is not typically used as a fuel by modern groups (Dunmire and Teirney 1997). Ethnographic data indicate that the wood of this species was used for more utilitarian purposes such as arrow shafts, basketry, cigarettes, and medicine (Elmore 1944). The Hopi consume the bitter tasting leaves for medicinal purposes (Whiting 1966).

Salicaceae (Willow)

Populus (cottonwood)/*Salix* (willow)

This semi-ring porous charcoal contains numerous thin rays, as well as both solitary and paired vessels. These two genera can only be clearly distinguished if rays are examined in tangential section. A total of 37 pieces of charcoal was recovered from 12 samples at the Pueblo. Cottonwood and willow prefer moist environments and are often found along creek beds and canyon bottoms. Both genera are recorded to be used in construction, tool making, weaving and in ceremonies (Stevenson 1915; Swank 1932; Whiting 1966). Cottonwood is used primarily as a summer fuel due to its intense flame light, but cooler flame temperature (Dunmire and Teirney 1997). The Zuni used the bark of willow trees in a tea to treat coughs (Stevenson 1915).

Unknowns

Unknown Poaceae 1

The dimensions of this caryopsis are 2.0 x 0.75 mm (l x w). A very shallow and small embryo depression is present (length=0.5 mm). Overall the grass grain is slender and the surface contains a faint reticulate pattern. A total of eight specimens was identified to this category.

Unknown Poaceae 2

Unknown Poaceae 2 is an elliptical caryopsis with two grooves running the entire length from embryo to tip. A portion of the embryo is missing, so embryo size could not be accurately measured. The caryopsis size is 2.0 x 1.0 mm and no surface pattern is visible. A single specimen was recovered.

Unknown Seed 1

Unknown Seed 1 is represented by a single specimen. The seed is trigonous and concave between the side margins. The side is rather large measuring 4.5 x 2.0 mm. There is a circular point of attachment on one end of the seed.

Unknown Seed 2

This small round seed possesses a faintly reticulated surface pattern. The seed dimensions are 2.0 x 0.8 mm and it is circular in cross section. The surface of the seed is slightly wrinkled, possibly due to charring. A small raised protuberance is located at one end. Two specimens of this seed were recovered from Shield Pueblo samples.

Unknown Seed 3

This seed is trigonus, similar to seeds of the sedge family, with one side flatter than the other two. In cross section the seed appears as a trapezoid. The seed is 1.75 mm long and 1.0 mm wide at the widest point. A surface pattern runs the length of the seed. A single specimen was identified for this category.

Unknown Botanical 1

This specimen is octagonal in cross section with a reticulated surface. Roughly equally spaced oblong depressions are present along the length of each side. The specimen is 4.0 mm long and 1.5 mm wide at the smallest point and 2.0 mm wide at the largest.

Unknown Botanical 2

Unknown 2 is an extremely fragmented and degraded specimen. The specimen is 4.0 mm long and possesses a depression along the length and is 0.5 mm wide. Two ridges run the length of the depression. The specimen may be a deformed maize embryo; however, the size is far too large.

Unknown Botanical 3

A single specimen was identified as Unknown 3. The roughly oval shaped specimen is ovoid in cross section. The surface is bumpy, undulating and extremely rough. An oval point of attachment may be present at one end. The specimen is 4.0 mm long, and 1.0 mm wide at the narrowest point and 2.0 mm wide at the widest point.

Conclusion

This chapter has presented the seed, wood charcoal, and vegetative material identified from Shields Pueblo's flotation samples. A total of 5708 specimens representing 43 different plant taxa was identified. The identified remains are known to have had economic uses to historic groups as sources of food, fuel, medicine, ceremonial purposes, and as raw material for tool manufacturing and household construction. The assemblage indicates that a variety of plant communities were utilised by the inhabitants. The following chapters will interpret the results of analyses and discuss evidence of patterning.

CHAPTER FIVE
QUALITATIVE AND QUANTITATIVE ANALYSIS

Introduction

This chapter focuses on the qualitative and quantitative analysis of the archaeobotanical data presented in chapter four. All available flotation samples, 156, collected from Pueblo II (PII) contexts were anaylsed in this study which yielded 43 taxa and 5708 specimens. The identified macrofossils consisted of seeds, achenes, fruits, caryopses, rinds, cupules, cob fragments, charcoal, twigs, leaves, bark and cone scales, as well as cone umbos. Determining how to quantify the results and best illustrate patterns in an archaeobotanical assemblage is difficult. Bias in the archaeobotanical record, such as specimen fragmentation, must be taken into account when selecting tabulation methods. The use of raw counts to characterise an archaeobotanical assemblage makes the assumption that the absolute counts directly reflect human-plant interactions. However raw specimen counts are seldom used to investigate spatial and temporal patterning and more likely reflect other factors such as preservation, fragmentation, and/or sampling.

Identified plant remains will be described by determining species abundance, ubiquity, and seed richness and density. These quantification techniques were used to elucidate archaeobotanical patterning among individual contexts, architectural blocks, and temporal periods. The following is a brief discussion of the manner in which these indices were calculated and the strengths and weakness of these measures.

Abundance calculates the total number of seeds present in an assemblage and then calculates what proportion of that total each taxon represents. This measure is used to assess the distribution of seed taxa among different assemblages at the Pueblo. Abundance measures reduce the biases that affect an archaeobotanical assemblage through the comparison of relative quantities proportions of plants in contexts of similar preservation. This percentage measure normalises the data, permitting contexts of different sizes to be compared (Pearsall 1988).

Frequency measures, such as ubiquity, are one of the most commonly used quantification techniques in archaeobotany (Pearsall 1989; Popper 1988). Ubiquity measures the number of times a taxon is present within a group of independent contexts, regardless of the absolute count (Popper 1988). The ubiquity score of seed and charcoal specimens are calculated as a percentage of the total number of samples in which each taxon is found. The benefit of using this measure is that the bias associated with using raw counts is removed. An additional strength of this measure is that that ubiquity value of one taxon does not impact the value of another, permitting independent comparison of different taxa.

Richness refers to the variety of a given assemblage *e.g.*, the total number of identified taxa present. There are indices that can be used to measure diversity (Popper 1988), however they often require high specimen counts for each taxon, which does not occur in Shields Pueblo PII archaeobotanical assemblage.

Density measures were calculated by determining the number of charred seeds recovered from the total volume of sediment analysed (Miller 1988). The general assumption of this measure is that the larger the sediment sample the more botanical remains it is likely to contain. By using volume as a standarising variable against which other variables can be compared permits researchers to investigate site formation processes and laboratory techniques. Density a useful tool in assessing the intensity of activities involving fires that may have occurred at a site (Pearsall 1989).

To determine if the sample size of an assemblage was adequate to characterise species richness, cumulative frequency graphs were plotted (Lepofsky *et al.* 1996). These figures were created for individual features, architectural blocks, and temporal periods (Figure 12 and Appendix F). The assumption behind cumulative frequency plots is that the number of identified taxa, when randomly plotted against the number of identified specimens, will result in a curve that reaches a plateau when the sample size is adequate (Krebs 1989). This method is a rough calculation for assessing sample size adequacy and could be improved upon by continuously re-ordering the samples and repeating the procedure for all possible combinations and then calculating the mean. Cumulative frequency curves were used specifically for assessing sample size adequacy of taxa richness. In the event that the curve did not level off it could be assumed that additional taxa may be recovered, if additional samples were collected and analysed.

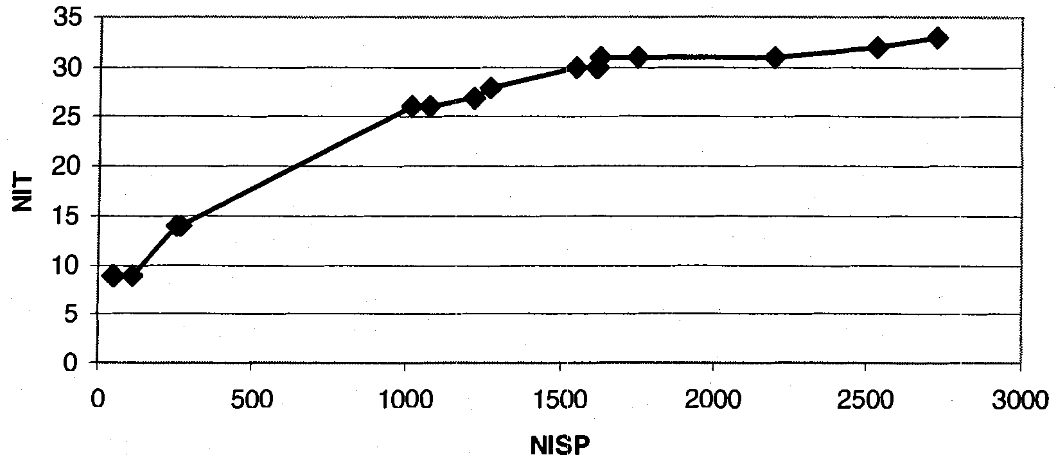

Figure 12 – Cumulative Frequency Curve of 100 Block Archaeobotanical Assemblage.
NISP – Number of identified specimens, NIT – Number of identified taxa.
♦ - individual context *e.g.*, Structure 139

Qualification and Quantification

Seed Assemblage

Interpreting an archaeobotanical assemblage involves consideration of not only the cultural and non-cultural processes of the past and present but also the effects of sampling. Seeds recovered from flotation samples can be derived from a variety of events such as direct plant use, indirect plant use, and prehistoric and modern seed rain (Minnis 1981). Cultural processes can introduce seeds into an assemblage through direct introduction onto the site (charring and toasting of seeds) or indirect introduction (seeds and vegetation attached to roofing material or fuel wood). Prehistoric seed rain refers to the occurrence of seeds that, although charred, may have accidentally been incorporated into the assemblage, as well as seeds that enter the assemblage naturally and becomes charred, *e.g.*, through forest fires after a site has been abandoned (Minnis 1981). The modern seed rain refers to those seeds that enter the archaeobotanical record that are typically uncharred and have likely been blown in, or inadvertently transported onto the site during excavation. Due to the nature of the four-year excavation of Shields Pueblo and the open exposure of archaeological contexts for prolonged periods of time only charred remains were considered to be prehistoric in origin and culturally significant. By exclusively considering charred remains the modern seed rain was excluded as a possible source for seed introduction into the assemblage.

Spatial Analysis

The spatial analysis is organised by architectural block *e.g.* 100, 200, and 1300. The three architectural blocks represent large sampling areas that delineate associated areas based on dense artifact and sandstone rubble scatter. The total, hearth, and secondary refuse assemblages for each block will be discussed separately. Density, abundance, and ubiquity measures which when tabulated were <0.1%, are represented by P (present). Abundance and density measures were not calculated for wood charcoal due to the recovery method standardised by Crow Canyon Archaeological Center (CCAC). Whenever possible, 20 pieces of wood charcoal were identified from each flotation sample. In some instances less than 20 specimens were identified because the charcoal was too fragmented to confidently identify. Thus calculated wood charcoal abundance and density measures would not accurately represent wood charcoal patterns but rather the researchers ability to identify 20 specimens. Accordingly, ubiquity measures and richness were used to quantify the charcoal assemblage.

100 Block

A total of 81 flotation samples was collected from the 100 block, representing 18 contexts in 13 structures (Table 8 – 9, Figure 14). Five hearths, seven secondary refuse and six other contexts were sampled. The whole assemblage will be discussed first, followed by hearth contexts, and secondary refuse deposits. In the final section a comparison between the 100 block hearth and secondary refuse assemblages will be discussed. Cumulative frequency curves are presented for the complete, hearth, and secondary refuse assemblages for both seed and charcoal taxa (Appendix F). Overall the cumulative frequency curves for the charcoal assemblages indicate that a sufficient number of samples has been analysed (Figure 13). However, the seed assemblage curve is still rising, indicating that additional samples should be analysed to account for all possible taxa (Appendix F).

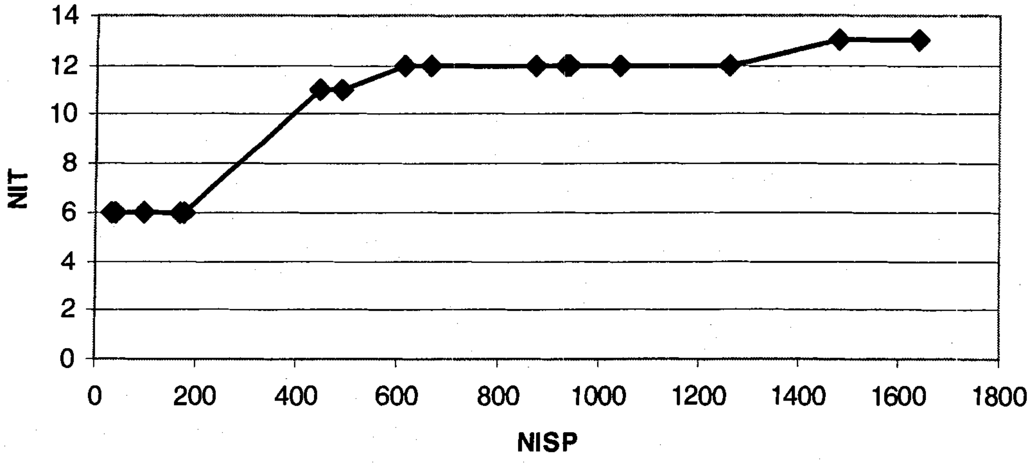

Figure 13 – Cumulative Frequency Curve of Total 100 Block Charcoal Assemblage
NISP – Number of identified taxa, NIT – Number of identified taxa.
♦ - individual context *e.g.*, Structure 139

Total Assemblage

The 100 block archaeobotanical assemblage produced 22 seed and 12 charcoal and non-wood taxa. The seeds species include two of the three known PII domesticates, corn and cotton, as well as 7 wild and 10 weedy plants taxa. Generally, the abundance distribution of the plant categories for the 100 block total assemblage is similar to that of the block's hearths and secondary refuses (Figure 15). The seed assemblage included unique specimens such as hedgehog cactus, winged-pigweed, sunflower, tansy mustard, wild rose, chokecherry,

Table 8 - 100 Block Indentified Seed Assemblage

CONTEXT INFORMATION			SEED (n)																												
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaceae-type	*Descurania*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Cleome*-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	**TOTAL SEED COUNTS (n)**
Structure 103																															
Pit Not Specified	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Structure 124																															
Secondary Refuse	3	2.6	1	-	-	2	3	2	-	-	-	-	-	-	-	-	-	23	-	-	39	-	-	-	1	-	-	-	-	2	73
Structure 137																															
Hearth 2	5	5.0	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	4	-	-	-	1	1	14
Structure 138																															
Hearth 1	11	10.8	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	12	-	-	3	1	-	-	-	-	1	19
Ashpit 3	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Structure 139																															
Hearth 6	11	10.1	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	4	-	40	2	-	-	19	-	-	1	-	2	72
Ashpit 7	2	1.6	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-	-	-	-	5
Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Bin 2	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1	3
Structure 140																															
Hearth 1	6	5.9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	14	-	-	-	-	-	-	-	-	3	26
Non-structure 129																															
Fire in Pit 1	6	6.0	5	-	1	9	-	4	-	-	11	1	-	3	-	-	-	175	2	-	246	-	3	1	-	-	1	-	8	9	479
Non-structure 108																															
Floor	1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Non-structure 126																															
Pit Not Specified	1	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-	-	-	-	4
Non-structure 101																															
Secondary Refuse	2	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	9	-	-	-	2	-	-	-	-	-	12
Non-structure 152																															
Secondary Refuse	10	7.6	6	-	-	4	-	-	-	-	12	-	-	-	-	5	1	5	-	-	61	-	-	-	18	-	1	-	-	117	230
Non-structure 153																															
Secondary Refuse	11	9.0	3	-	-	-	1	2	-	-	-	-	-	-	-	2	-	2	-	-	32	-	-	-	70	-	-	-	-	2	114
Non-structure 154																															
Secondary Refuse	4	4.0	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	-	-	31	-	-	-	-	-	-	-	-	-	36
Total	81	73.3	23	0	1	16	6	9	1	0	24	1	0	3	0	8	2	218	6	0	494	2	3	4	117	0	2	1	9	138	1088

Table 9 -100 Block Charcoal Assemblage

CONTEXT INFORMATION			CHARCOAL (n)													VEGETATIVE SPECIMENS (n)														
Structure	No. of Samples	Volume (l)	*Juniperus*-type	*Ephedra*-type	*Pinus*-type	*Artemisia*-type	*Artemisia tridentata*-type	*Chrysothamnus*-type	*Atriplex*-type	*Quercus*-type	*Amelanchier/Peraphyllum*-type	*Cercocarpus*-type	*Prunus/Rosa*-type	*Purshia*-type	*Populus/Salix*-type	*Zea mays* cupule	*Zea mays* cob	Cucurbitaceae-type	*Juniperus*-type leaf scale	*Juniperus*-type twig	*Pinus*-type apical meristem	*Pinus*-type bark scale	*Pinus*-type cone scale	*Pinus*-type cone umbo	*Pinus*-type needle	*Pinus*-type needle fascicle	*Pinus*-type twig	*Yucca baccata* pod	*Artemisia*-type leaf	**TOTAL COUNTS (n)**
Structure 103																														
Pit Not Specified	1	0.3	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Structure 124																														
Secondary Refuse	3	2.6	16	-	5	20	-	-	-	-	-	-	-	-	-	29	-	-	-	2	-	-	-	-	-	-	-	-	1	73
Structure 137																														
Hearth 2	5	5.0	33	-	-	2	-	-	-	-	-	-	-	-	-	6	-	-	-	2	-	-	-	-	-	-	-	-	-	43
Structure 138																														
Hearth 1	11	10.8	48	-	21	24	-	-	-	-	1	1	-	-	-	26	-	-	-	-	-	1	-	-	-	-	-	-	1	123
Ashpit 3	2	2.0	22	-	1	-	9	5	-	2	1	-	-	-	-	7	-	-	-	-	-	5	-	-	-	-	-	-	-	52
Structure 139																														
Hearth 6	11	10.1	26	-	6	17	4	11	-	-	1	3	1	-	8	131	2	-	-	-	-	-	-	-	-	-	-	-	-	210
Ashpit 7	2	1.6	10	-	1	-	9	5	-	5	-	-	-	-	10	18	-	-	-	-	-	2	-	-	-	-	-	-	-	60
Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Bin 2	2	2.0	1	-	-	-	-	1	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Structure 140																														
Hearth 1	6	5.9	22	-	2	31	-	-	-	-	1	-	-	-	-	41	-	-	-	-	-	2	-	-	-	-	-	-	-	99
Non-structure 129																														
Fire in Pit 1	6	6.0	83	-	6	11	-	6	-	4	2	-	-	-	7	86	4	23	2	24	-	8	-	-	-	-	3	-	-	269
Non-structure 108																														
Floor	1	0.4	3	-	-	17	-	-	-	-	-	-	-	-	-	27	9	-	-	-	-	-	-	-	-	-	-	-	-	56
Non-structure 126																														
Pit Not Specified	1	1.0	-	-	-	6	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Non-structure 101																														
Secondary Refuse	2	1.9	12	-	2	8	-	-	-	-	2	-	4	-	-	4	-	-	-	-	-	1	-	-	-	-	-	-	-	33
Non-structure 152																														
Secondary Refuse	10	7.6	65	-	7	30	-	5	-	2	1	2	-	-	-	79	6	10	-	3	-	10	-	-	-	-	-	-	-	220
Non-structure 153																														
Secondary Refuse	11	9.0	75	-	11	35	-	4	2	2	-	-	-	-	-	83	1	-	-	6	-	3	-	-	-	-	-	-	-	222
Non-structure 154																														
Secondary Refuse	4	4.0	65	-	-	1	-	-	-	-	5	-	-	-	9	67	1	-	-	6	-	2	4	-	-	-	-	-	-	160
Total	81	73.3	488	0	62	202	22	37	2	17	14	6	5	0	35	607	23	33	2	43	0	34	4	0	0	0	3	0	2	1641

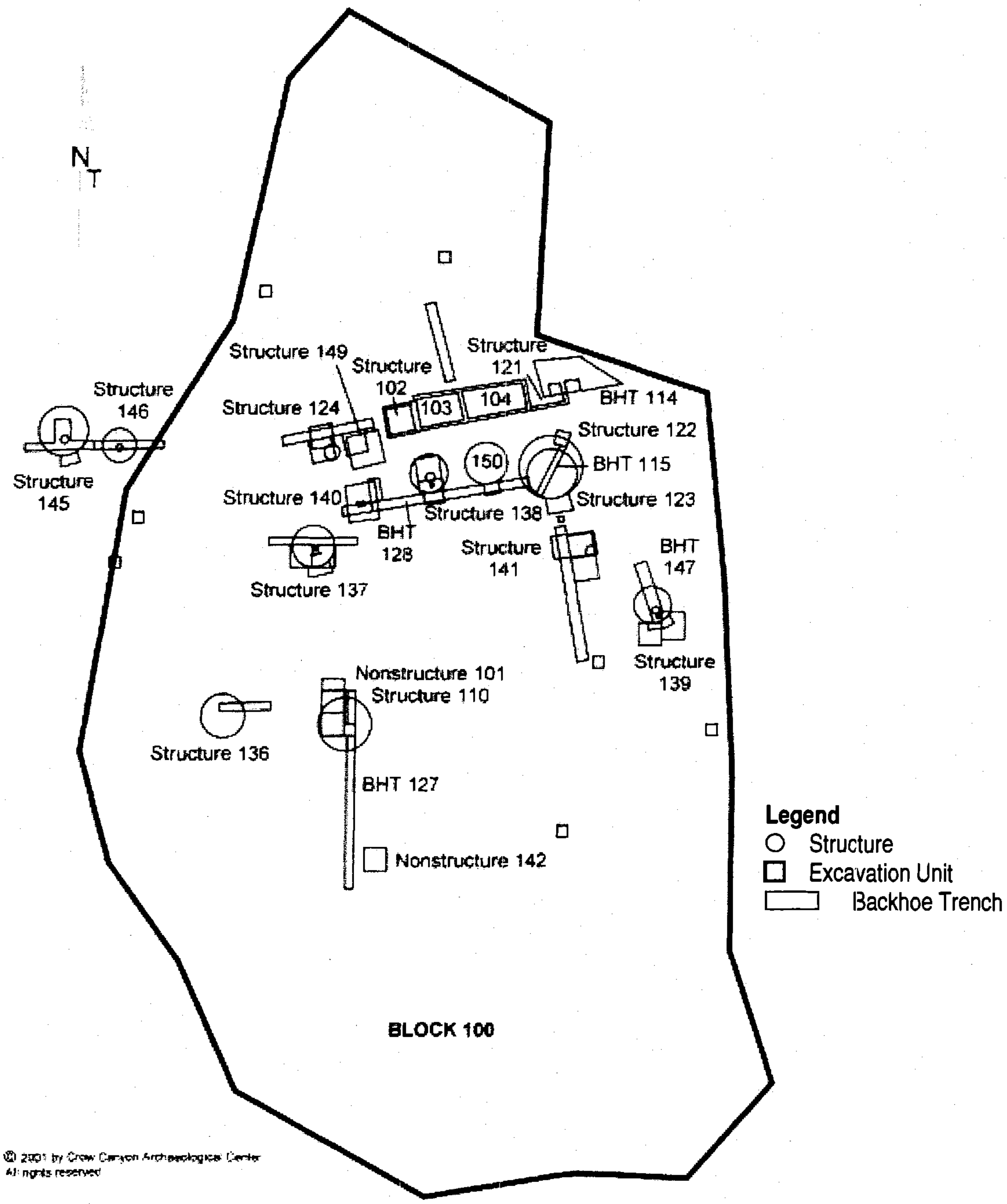

Figure 14 – Shields Pueblo 100 Block (Courtesy Crow Canyon Archaeological Centre).
Note: Architectural blocks represent large excavation units that delineate associated areas based upon dense artefact and sandstone rubble scatter.

Bromus tectorum, as well as a seed of the nightshade family. Seed richness and density values for excavated units situated within the 100 block varied significantly (Table 10). Taxa with low seed abundance values (Table 11) were not limited to a single structure within the architectural block, thus indicating that numerous households in the 100 block were collecting a variety of wild and weedy taxa. The most ubiquitous seed taxa (Table 12) from 100 block flotation samples were cheno-am, 71.6%, followed by purslane, 28.4%, and prickly pear, 21.0%. These taxa are also among the most abundant taxa identified from 100 block flotation samples (Table 11).

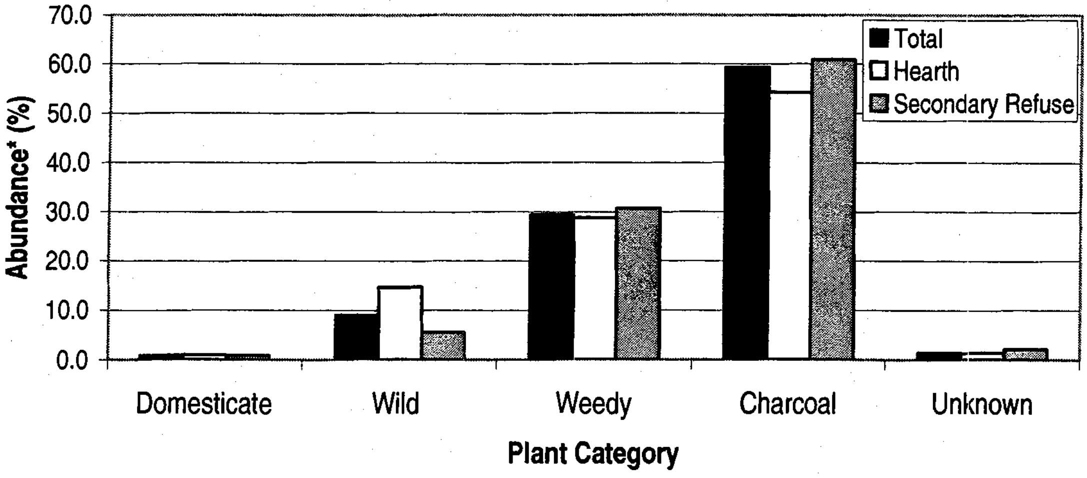

Figure 15 – Plant Category Abundance* of the 100 Block Total, Hearth, and Secondary Refuse Assemblages.
*Abundance was calculated by tabulating the number of specimens recovered from each plant category, and then determining what percent of that total each category represents.

Table 10 - 100 Block Seed Density (n/l) and Richness (n)

SAMPLE INFORMATION			SEED (n)																														
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaceae-type	*Descurania*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Cleome*-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	**SEED DENSITY (n/l)**	**SEED RICHNESS****	**TOTAL SEED AND CHARCOAL RICHNESS****
Structure 103																																	
Pit Not Specified	1	0.3	0.8	-	0.2	1.5	-	0.7	-	-	-	0.2	-	0.5	-	-	-	29.2	0.3	-	41.0	-	0.5	0.2	-	-	0.2	-	-	-			1
Structure 124																																	
Secondary Refuse	3	2.6	0.4	-	-	0.8	1.2	0.8	-	-	-	-	-	-	-	-	-	8.8	-	-	15.0	-	-	-	0.4	-	-	-	-	0.8	28.1	8	11
Structure 137																																	
Hearth 2	5	5.0	0.6	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	0.2	-	-	0.4	-	-	-	0.8	-	-	-	0.2	0.2	2.8	7	9
Structure 138																																	
Hearth 1	11	10.8	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	P	-	-	1.1	-	-	0.3	P	-	-	-	-	0.1	1.8	6	12
Ashpit 3	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	0.5	1	9
Structure 139																																	
Hearth 6	11	10.1	0.3	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	0.4	-	3.4	0.2	-	-	1.9	-	-	P	-	0.2	7.2	8	16
Ashpit 7	2	1.6	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	-	-	-	0.6	-	-	-	-	-	3.2	3	10
Post 1	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			1
Bin 2	2	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			4
Undefined Floor	1	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	0.8	-	-	-	-	-	-	-	-	0.8	2.5	3	4
Structure 140																																	
Hearth 1	6	5.9	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-	-	2.4	-	-	-	-	-	-	-	-	0.5	4.4	4	8
Non-structure 129																																	
Fire in Pit 1	6	6.0	0.8	-	0.2	1.5	-	0.7	-	-	1.8	0.2	-	0.5	-	-	-	29.2	0.3	-	41.0	-	0.5	0.2	-	-	0.2	-	1.3	1.5	79.3	15	23
Non-structure 108																																	
Floor	1	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			3
Non-structure 126																																	
Pit Not Specified	1	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	1.0	-	-	-	-	-	4.0	2	4
Non-structure 101																																	
Secondary Refuse	2	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	4.7	-	-	-	1.1	-	-	-	-	-	6.3	3	9
Non-structure 152																																	
Secondary Refuse	10	7.6	0.8	-	-	0.5	-	-	-	-	1.6	-	-	-	-	0.7	0.1	0.7	-	-	8.0	-	-	-	2.4	-	0.1	-	-	15.4	30.1	10	18
Non-structure 153																																	
Secondary Refuse	11	9.0	0.3	-	-	-	0.1	0.2	-	-	-	-	-	-	-	0.2	-	0.2	-	-	3.6	-	-	-	7.8	-	-	-	-	0.2	12.7	8	14
Non-structure 154																																	
Secondary Refuse	4	4.0	0.3	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	0.8	-	-	7.8	-	-	-	-	-	-	-	-	-	9.0	4	9

Table 11 - Seed Abundance (%) and Ranking (#)

Taxon	ASSEMBLAGE		
	Total	Hearth	Secondary Refuse
Zea mays	2.1	1.9 (5)	2.4
Cucurbita-type			
Gossypium-type	0.1	0.2	
Yucca baccata-type	1.5	1.5	1.5
Cyperaceae-type	0.6	0.5	0.6
Scripus-type	0.8	0.8	0.9
Bromus tectorum-type	0.1		0.2
Panicum-type			
Stipa hymenoides-type	2.2 (5)	1.9 (5)	2.6 (5)
Rhus aromatica var. *trilobata*	0.1	0.2	
Asteraceae-type			
Helianthus-type	0.3	0.5	
Brassicaceae-type			
Descurania-type	0.7	1.3	
Echinocereus fendleri-type	0.2		0.2
Opuntia-type	20.0 (2)	29.9 (2)	7.1 (4)
Cleome-type	0.6	1.0	
Atriplex canenesce-type			
Cheno-am	45.4 (1)	50.7 (1)	38.1 (1)
Cycloloma-type	0.2	0.3	
Malvaceae-type	0.3	0.5	
Sphaeralcea-type	0.4	0.6	
Portulaca-type	10.8 (4)	3.9 (3)	19.9 (3)
Rosaceae-type			
Prunus virginiana-type	0.2	0.2	0.2
Rosa woodsii-type	0.1	0.2	
Solanaceae-type	0.8	1.5	
Physalis-type	12.7 (3)	2.6 (4)	26.2 (2)
No. of Seeds	1088	619	462

Table 12 - 100 Block Seed Ubiquity (%)

Taxon	ASSEMBLAGE		
	Total	Hearth	Secondary Refuse
Zea mays	16.0	15.4	20.0
Cucurbita-type			
Gossypium-type	1.2	2.6	
Yucca baccata-type	12.3	10.3	17.1
Cyperaceae-type	3.7	2.6	5.7
Scripus-type	6.2	5.1	8.6
Bromus tectorum-type	1.2	2.6	
Panicum-type			
Stipa hymenoides-type	7.4	10.3	5.7
Rhus aromatica var. *trilobata*	1.2	2.6	
Asteraceae-type			
Helianthus-type	2.5	5.1	
Brassicaceae-type			
Descurania-type	4.9		11.4
Echinocereus fendleri-type	2.5		2.9
Opuntia-type	21.0	25.6	20.0
Cleome-type	7.4	15.4	
Atriplex canenesce-type			
Cheno-am	71.6	79.5	74.3
Cycloloma-type	1.2	2.6	
Malvaceae-type	3.7	7.7	
Sphaeralcea-type	4.9	10.3	
Portulaca-type	28.4	25.6	34.3
Rosaceae-type			
Prunus virginiana-type	2.5	2.6	2.9
Rosa woodsii-type	1.2	2.6	
Solanaceae-type	2.5	5.1	
Physalis-type	17.3	17.9	17.1
Total No. of Samples	81	39	35

The total wood charcoal assemblage recovered from block 100 included 11 of 13 wood charcoal taxa identified at the site, the exceptions were ephedra and bitterbrush (Table 14). Juniper (91.4 %), sagebrush (63.0%), and pine (33.3%) charcoal were the most ubiquitous charcoal taxa recovered from 100 block samples (Figure 16). The assemblage also contained the only example of Cucurbitaceae rind fragments found at the site, as well as corn cupules and cob fragments. Corn cupules were recovered from 79.0% of the samples analysed, while cob fragments were only found in 9.9%. Additionally, pine bark scales and juniper twig ends were recovered from 19.8% of the samples and a single juniper leaf scale, a pine cone scale, and a pine twig were recovered from only 1.2% of the samples.

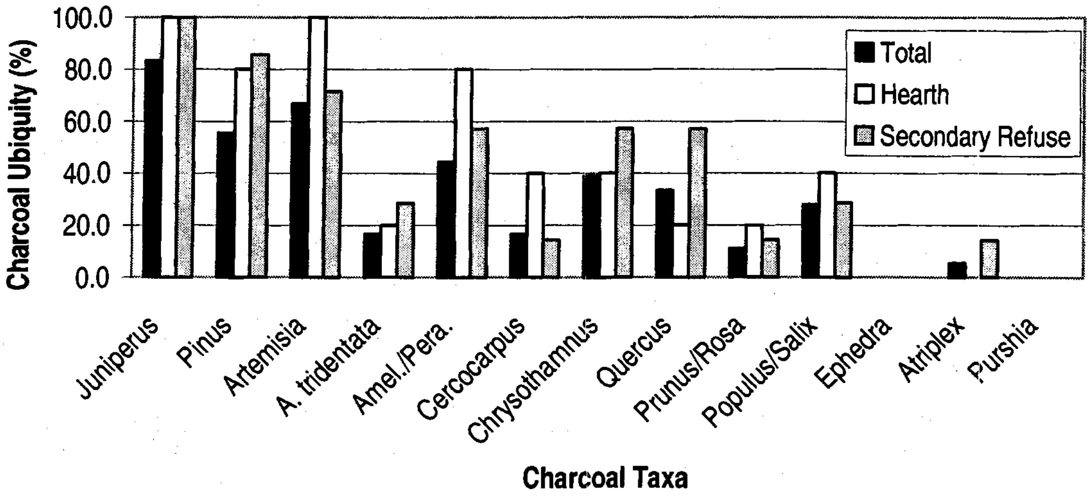

Figure 16 – 100 Block Assemblage Charcoal Ubiquity* (%).
*Charcoal Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

100 Block Hearths

Thirty-nine flotation samples from five hearths were collected from 100 block. Four hearths were located within structures and one was situated on an extramural surface. Charcoal, similar to the total and secondary refuse assemblages, was the most abundant plant category in 100 block hearths (Figure 15). A total of 19 seed taxa was identified and the total seed density measure for 100 block hearth was 16.1

seeds/litre (Figure 17). The most abundant seed taxon recovered from hearth samples was cheno-am (Table 11). Additional weedy plants which were abundant in hearth assemblages included purslane, chokecherry, and Indian ricegrass.

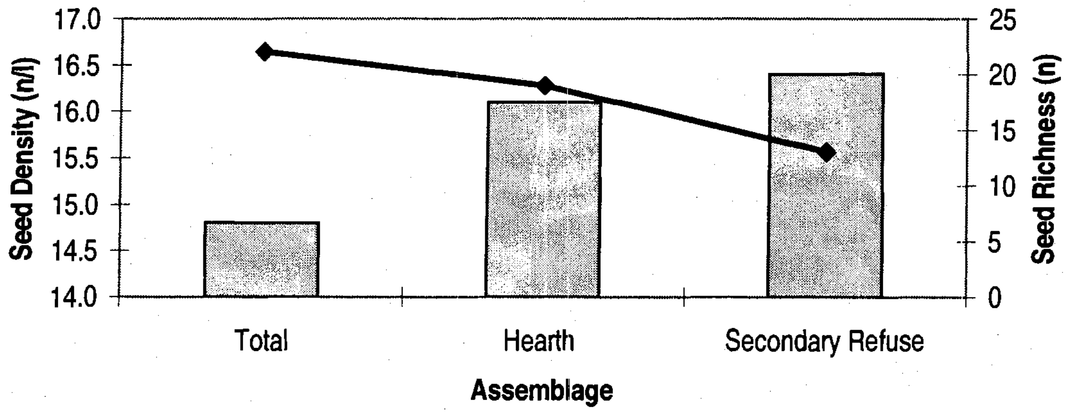

Figure 17 – 100 Block Assemblage Seed Density* (n/l) and Richness (n).**
*Seed density (histogram) was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness (line) was tabulated by determining the total number of identified taxa.

Seed density values for 100 block hearths were similar, with the exception of NST 129 (Table 10). Assuming that seed density values reflect intensity of use (Popper 1998), hearths located within structures rather than outside in the 100 block appear to have been used with similar regularity. The density values of hearths within structures ranged from 1.8 to 7.2 seeds/l, whereas the seed density of NST 129, an extramural hearth, was 79.3 seeds/l (Table 10). The number of different plants being collected and brought within the structures also varied. All five hearths contained both wild and weedy taxa, some of which had low ubiquity scores 2.6% such as chokecherry, wild rose, lemonade berry, and winged-pigweed (Table 12). Similarly in hearths, taxa with low ubiquity values were low in abundance (Table 11). Cheno-am, prickly pear, and purslane were the most ubiquitous taxa recovered from the hearths 79.5%, 25.6%, and 25.6% respectively.

A total of 13 wood species was identified from charcoal fragments recovered from hearths. Juniper (92.3%), sagebrush (61.5%), and pine (38.5%), were the most frequently recovered charcoal taxa (Table 13). Additional taxa such as rabbitbrush, mountain mahogany, oak, and cottonwood/willow were found in lower quantities. Corn cupules were recovered from 74.4% of the samples, cob fragments were found in four, or 10.3 % of the samples. Hearth cumulative frequency curves for the three assemblages (total, seed, and charcoal) are close to leveling off, thus enough samples were analysed to adequately characterise the 100 block hearth assemblage's richness (Appendix F).

Table 13 – 100 Block Charcoal Ubiquity (%)

	ASSEMBLAGE		
Taxon	**Total**	**Hearth**	**Secondary Refuse**
Juniperus-type	91.4	92.3	97.1
Ephedra-type			
Pinus-type	33.3	38.5	34.3
Artemisia-type	63.0	61.5	68.6
Artemisia tridentata-type	7.4	2.6	14.3
Chrysothamnus-type	22.2	10.3	25.7
Atriplex-type	1.2		2.9
Quercus-type	12.3	7.7	17.1
Amelanchier/Peraphyllum-type	13.6	12.8	11.4
Cercocarpus-type	4.9	5.1	2.9
Prunus/Rosa-type	2.5	2.6	2.9
Purshia-type			
Populus/Salix-type	13.6	15.4	11.4
Zea mays cupule	79.0	74.4	88.6
Zea mays cob	9.9	10.3	8.6
Cucurbitaceae-type	2.5	2.6	2.9
Juniperus-type leaf scale	1.2	2.6	
Juniperus-type twig	19.8	15.4	28.6
Pinus-type bark scale	19.8	12.8	28.6
Pinus-type cone scale	1.2		2.9
Pinus-type cone umbo			
Pinus-type needle			
Pinus-type needle fascicle			
Pinus-type twig	1.2	2.6	
Pinus-type apical meristem			
Yucca baccata -type pod			
Artemisia-type leaf	2.5	2.6	2.9
Total No. of Samples	81	39	35

*Charcoal Ubiquity was calculated by determining the number of samples a taxon was present in as a proportion of the total number of samples.

100 Block Secondary Refuse

Seven secondary refuse contexts were sampled from 100 block at Shields Pueblo (Table 8 and 9). Only one domestic taxon was recovered, corn. Identified wild taxa include yucca, prickly pear, hedgehog cactus, lemonade berry, chokecherry, and specimens representing the sedge family. Seven weedy taxa were present in 100 block secondary refuse deposits. Of note is the presence of a *Bromus tectorum* caryopsis, found only in this architectural block at the Pueblo dating to the PII period. Plant category abundance measures indicate that wild plants compose a smaller portion of the secondary refuse assemblage than in the hearth and total assemblages, and charcoal forms the largest part of the secondary refuse assemblage (Figure 15). As with the block's hearth assemblage, cheno-am, chokecherry, and purslane were the most abundant weed taxa recovered (Table 11). Seed density and richness values for the seven secondary refuse varied (Table 10). Structure 124 and non-structure 152 possessed the highest richness and density values of 100 block secondary refuse (Figure 18). Of note is the high density of groundcherry seeds present in non-structure 152, suggesting that the inhabitants frequently collected this plant. These two assemblages suggest that ashes from nearby hearths were routinely dumped in these secondary refuses.

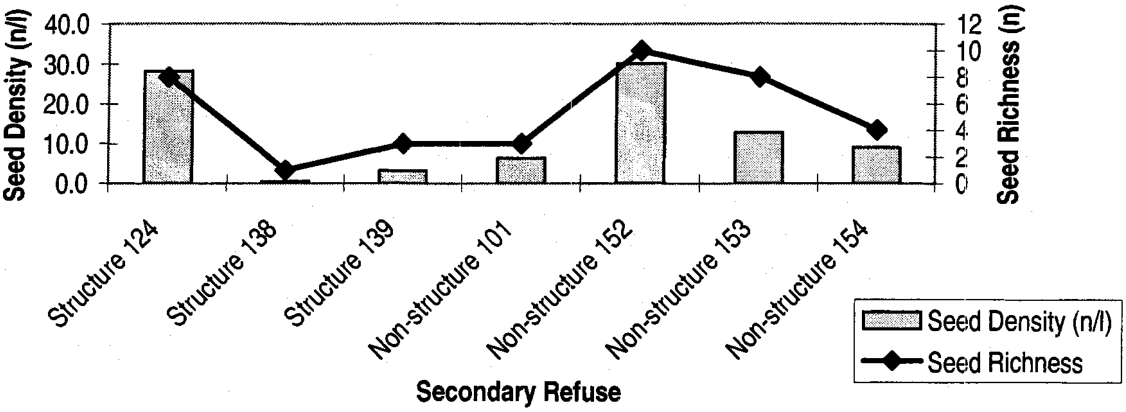

Figure 18 – 100 Block Secondary Refuse Seed Density* and Seed Richness**
*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

The most ubiquitous seed taxa from secondary refuse samples were cheno-am 74.3 %, purslane 34.3%, corn 20.0%, prickly pear 20.0%, and groundcherry 17.1% (Table 11). The remaining identified seed taxa possessed low abundance and ubiquity frequencies and were represented by only a few specimens.

A total of 13 charcoal taxa was recovered from secondary refuse deposits. The most ubiquitous taxa were juniper, 97.1%, sagebrush, 68.6%, and pine, 34.3% (Table 14). Vegetative specimens of domestic taxa recovered from 100 block secondary refuses included corn and the only fragments of Cucurbitaceae rind present in Shields Pueblo secondary refuses. *Zea mays* cupules were present in 88.6% of the samples, while cobs were present in only 8.6%. Pine and juniper vegetative parts were also ubiquitous in secondary refuse samples indicating that branches were being routinely brought back to the site and burned. The cumulative frequency curve for the seed assemblage continues to rise indicating that additional taxa may be recovered if more samples were collected and analysed. In contrast, an adequate number of samples from secondary refuse contexts were analysed to characterise the complete and charcoal assemblages (Appendix F).

100 Block Hearths vs. Secondary Refuses

When the total assemblages for hearth and secondary refuse were compared in the 100 block distinct differences were noted, especially within the seed assemblages. Overall the hearth assemblage contained six taxa not present in the secondary refuse assemblage. Abundance values of seed also varied between the two assemblages (Table 11). However, when the most abundant taxa were compared by rank, cheno-am and purslane ranked in the first and third respectively in both the hearth and secondary refuse assemblages. This indicates that these species were routinely collected and deposited into the archaeobotanical record. Seed densities were greater in secondary refuse contexts than hearths with the exception of NST 129 (Table 10). Lower seed densities in hearths may reflect the practice of cleaning out hearths during occupation or prior to abandonment. Seed richness values also varied greatly in both secondary refuses and hearths (Figure 17). A greater time depth represented by secondary refuses should result in a greater accumulation of different taxa. The ubiquity values for taxa present in both contexts were higher in the secondary refuse assemblage, with the exception of cheno-am, prickly pear, and Indian ricegrass. Additionally low ubiquity taxa, sunflower and *Bromus tectorum*, were found in only hearth contexts (Table 12).

Hearth and secondary refuse contexts contained the same charcoal taxa with the exception of four-wing saltbush being present solely in the latter assemblage. Secondary refuse and hearth samples both contained Cucurbitaceae rind fragments. The most ubiquitous charcoal taxa, for both contexts, were juniper, sagebrush, and pine (Table 13). Rabbitbrush and oak charcoal, and corn cupules were more ubiquitous in secondary refuse samples than in hearths. Hearth samples also contained more non-wood plant parts indicating that branches with leaves or reproductive parts were repeatedly being burned in 100 block fires or they may be the result of roofing material falling into a hearth.

200 Block

Hearth Assemblage

No secondary refuse deposits were sampled in 200 block, therefore only the hearth assemblage can be discussed. Three hearths from three different structures were excavated and resulted in 17 flotation samples (Table 14, Figure 19). Weedy plants represent the most abundant seed taxa recovered (Figure 20). Of the 11 seed taxa identified all but three, corn, prickly pear, and sedge were weedy plants. The weedy taxa recovered from 200 block hearths include cheno-am, globemallow, beeweed, purslane, groundcherry, Indian ricegrass, and specimens from the sedge and mustard families. Cheno-am was the only seed taxon that was consistently recovered (88.2%) from 200 block samples (Table 15). The second most ubiquitous species was purslane (41.2%).

Table 14 - 200 Block Identified Seed Assemblage (n)

SAMPLE INFORMATION			SEED (n)																												TOTAL SEED COUNTS (n)
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Scripus*-type	*Rhus aromatica* var. *trilobata*	Rosaceae-type	*Rosa woodsii*-type	*Prunus virginiana*-type	*Atriplex canenesce*-type	*Cleome*-type	*Cycloloma*-type	Cheno-am	*Helianthus*-type	Asteraceae-type	*Descurania*-type	Brassicaceae-type	Cyperaceae-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Solanaceae-type	*Physalis*-type	*Stipa hymenoides*-type	*Bromus tectorum*-type	*Panicum*-type	
Structure 234																															
Hearth 6	8	7.9	4	-	-	-	-	-	1	-	-	-	-	-	-	-	202	-	-	-	-	-	-	-	1	-	2	1	-	-	211
Structure 237																															
Hearth 6	8	7.8	1	-	-	-	-	1	-	-	-	-	-	-	1	-	17	-	-	-	1	1	-	9	2	-	-	1	-	-	34
Non-structure 203																															
Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	2	-	-	-	-	-	6
Total	17	16.5	5					1	1						1		223				1	1		9	5		2	2			251

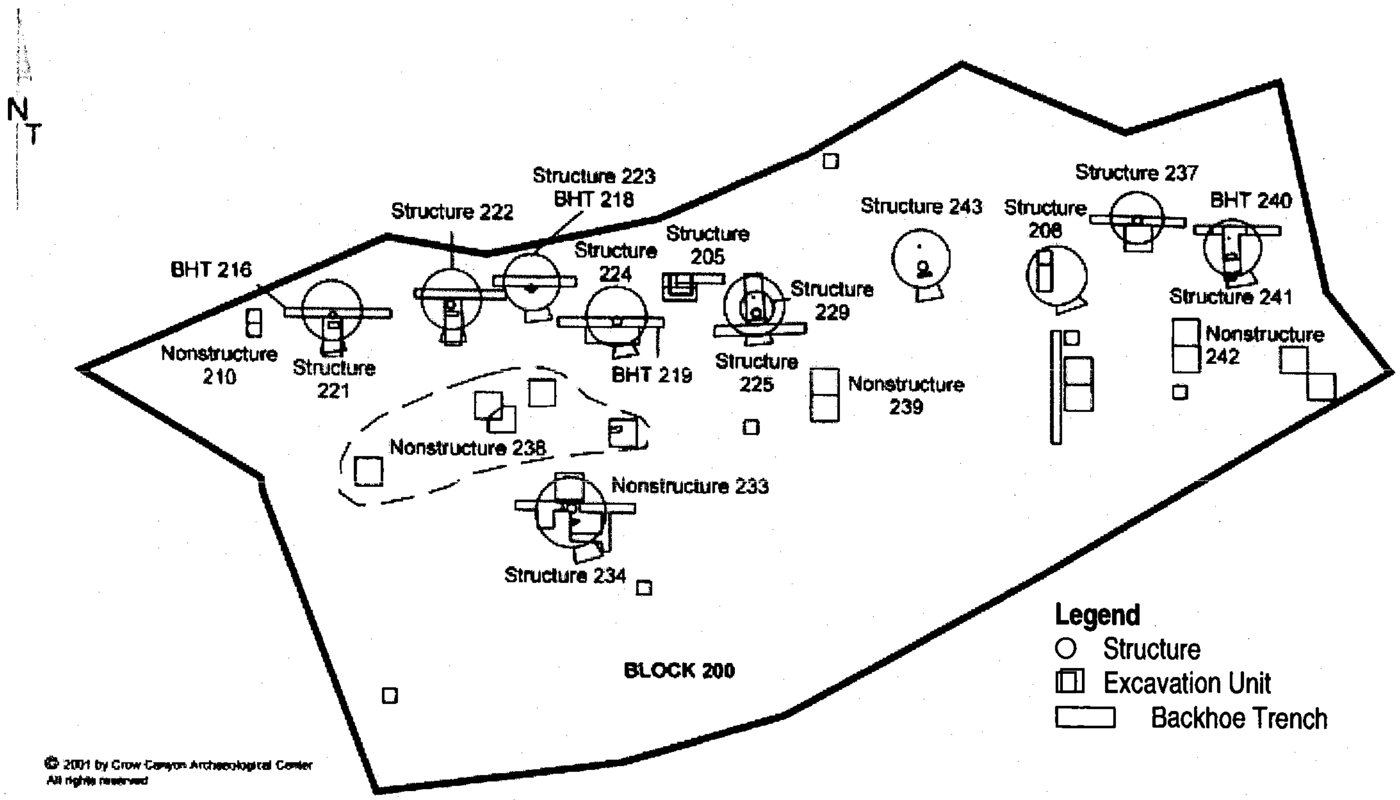

Figure 19 – **Shields Pueblo 200 Block (Courtesy Crow Canyon Archaeological Centre).**
Note: Architectural blocks represent large excavation units that delineate associated areas based upon dense artefact and sandstone rubble scatter.

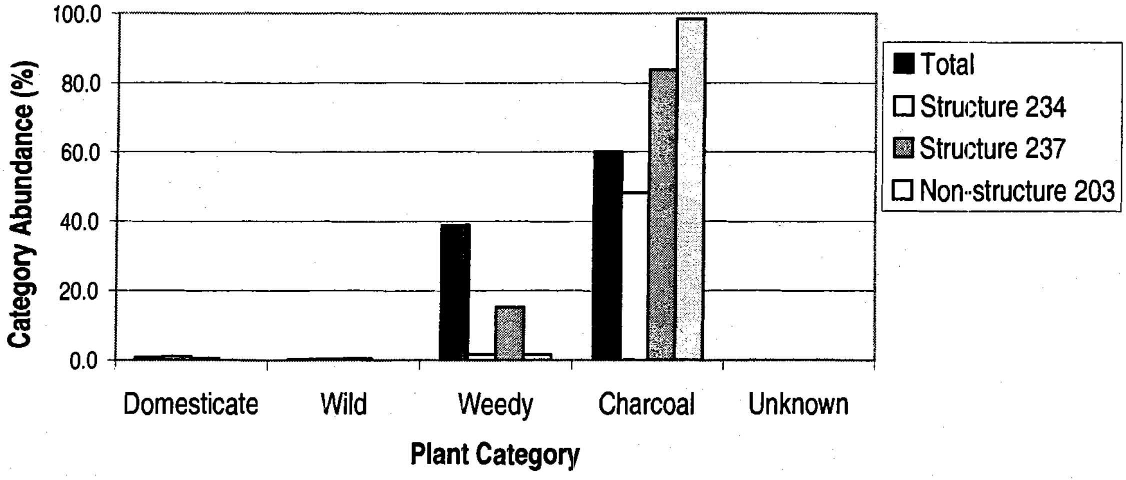

Figure 20 – 200 Block Plant Category Abundance*
*Abundance was calculated by tabulating the number of specimens recovered from each plant category, and then determining what percent of that total each category represents.

Seed density and richness values varied among all three hearths (Table 16). The hearth in structure 234 had the highest density of the 200 block, (26.7 seeds/l) while structure 237 had the lowest (4.4 seeds/l). Structure 237 also had the highest seed richness count (9). The low seed density of this hearth may reflect limited use of this feature, however the high richness count suggests that a wider range of plants were brought into this structure in comparison to other 200 block structures.

Table 15 – 200 Block Seed Ubiquity (%)

Taxon	ASSEMBLAGE			
	Total	**Structure 234**	**Structure 237**	**Non-structure 203**
Zea mays	17.6	25.0	12.5	
Cucurbita-type				
Gossypium-type				
Yucca baccata-type				
Cyperaceae-type	5.9		12.5	
Scripus-type	5.9	12.5		
Bromus tectorum-type				
Panicum-type				
Stipa hymenoides-type	11.8	12.5	12.5	
Rhus aromatica var. *trilobata*				
Asteraceae-type				
Helianthus-type				
Brassicaceae-type	5.9		12.5	
Descurania-type				
Echinocereus fendleri-type				
Opuntia-type	5.9		12.5	
Cleome-type	5.9		12.5	
Atriplex canenesce-type				
Cheno-am	88.2	100.0	75.0	100.0
Cycloloma-type				
Malvaceae-type				
Sphaeralcea-type	5.9		12.5	
Portulaca-type	41.2	12.5	62.5	100.0
Rosaceae-type				
Prunus virginiana-type				
Rosa woodsii-type				
Solanaceae-type				
Physalis-type	11.8	12.5	12.5	
No. of Samples	17	8	8	1

*Seed Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

Table 16 - 200 Block Seed Density *(n/l) and Richness** (n)

SAMPLE INFORMATION			SEED DENSITY** (n)																													SEED RICHNESS**	TOTAL SEED AND CHARCOAL RICHNESS**
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaea-type	*Descurania*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Cleome*-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	TOTAL SEED DENSITY (n)		
Structure 234 Hearth 6	8	7.9	0.1	-	-	-	-	0.1	-	-	0.1	-	-	-	-	-	-	-	-	-	25.6	-	-	-	0.1	-	-	-	-	0.3	26.7	6	13
Structure 237 Hearth 6	8	7.8	0.1	-	-	-	0.1	-	-	-	-	-	-	-	0.1	-	-	0.1	0.1	-	2.3	-	-	1.2	0.3	-	-	-	-	-	4.4	9	13
Structure 203 Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	3.1	-	-	-	-	-	7.5	2	3

*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

Table 17 - 200 Block Charcoal Counts (n)

			CHARCOAL (n)													VEGETATIVE SPECIMENS (n)													
Structure	No. of Samples	Volume (l)	*Juniperus*-type	*Ephedra*-type	*Pinus*-type	*Artemisia*-type	*Artemisia tridentata*-type	*Chrysothamnus*-type	*Atriplex*-type	*Quercus*-type	*Amelanchier/Peraphyllum*-type	*Cercocarpus*-type	*Prunus/Rosa*-type	*Purshia*-type	*Populus/Salix*-type	*Zea mays* cupule	*Zea mays* cob	Cucurbitaceae-type	*Juniperus*-type leaf scale	*Juniperus*-type twig	*Pinus*-type bark scale	*Pinus*-type cone scale	*Pinus*-type cone umbo	*Pinus*-type needle	*Pinus*-type needle fascicle	*Pinus*-type twig	*Yucca baccata* pod	*Artemisia*-type leaf	TOTAL COUNTS (n)
Structure 234 Hearth 6	8	7.9	3	1	-	55	20	9	-	-	-	2	-	-	-	103	1	-	-	-	1	-	-	-	1	-	-	-	196
Structure 237 Hearth 6	8	7.8	8	-	14	82	-	1	-	-	-	-	-	-	-	35	-	-	2	5	19	-	-	-	-	4	-	5	175
Non-structure 203 Hearth 1	1	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5
	17	16.5	11	1	14	137	20	10	0	0	0	2	0	0	0	143	1	0	2	5	20	0	0	0	1	4	0	5	376

Eight charcoal taxa were identified in the 200 block samples including pine, juniper, sagebrush, as well as mountain mahogany, oak, and ephedra (Table 17). Sagebrush was the most frequently recovered charcoal taxon followed by pine and juniper (Table 18). The single ephedra charcoal specimen was the only example of this taxon identified at Shields Pueblo. Other charcoal species recovered in low

Table 18 - 200 Block Charcoal Ubiquity* (%)

Taxon	Assemblage		
	Total	**Hearth**	**Secondary Refuse**
Juniperus-type	23.5	23.5	
Ephedra-type	5.9	5.9	
Pinus-type	23.5	23.5	
Artemisia-type	82.4	82.4	
Artemisia tridentata-type	5.9	5.9	
Chrysothamnus-type	17.6	17.6	
Atriplex-type			
Quercus-type	5.9	5.9	
Amelanchier/Peraphyllum-type			
Cercocarpus-type	5.9	5.9	
Prunus/Rosa-type			
Purshia-type			
Populus/Salix-type			
Zea mays cupule	88.2	88.2	
Zea mays cob	5.9	5.9	
Cucurbitaceae-type			
Juniperus-type leaf scale	11.8	11.8	
Juniperus-type twig	29.4	29.4	
Pinus-type apical meristem			
Pinus-type bark scale	17.6	17.6	
Pinus-type cone scale			
Pinus-type cone umbo			
Pinus-type needle			
Pinus-type needle fascicle	5.9	5.9	
Pinus-type twig	11.8	11.8	
Yucca baccata-type pod			
Artemisia-type leaf	17.6	17.6	
Unknown			
No. of Samples	17	17	0

*Charcoal ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

frequencies from 200 block hearths include oak and mountain mahogany. Charcoal ubiquity varied between the three 200 block hearths (Figure 21). Cupules were recovered from 88.2% of the samples collected from the block, but no cob fragments were found. Non-wood specimens such as twigs, needle fascicles, and bark scales, of wood charcoal were recovered and these plant parts were more ubiquitous than some wood charcoal taxa.

Cumulative frequency curves were plotted for the total, seed, and charcoal assemblages (Appendix F). The total and seed assemblage curves do not level out indicating that too few samples were analysed to adequately characterise 200 block's hearth assemblage richness. However, the charcoal curve does level indicate that enough samples were sorted.

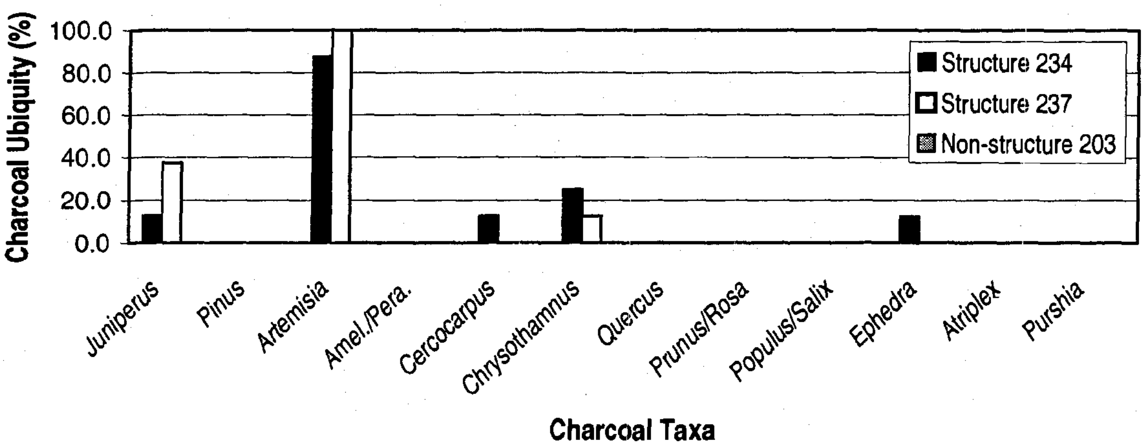

Figure 21 – Charcoal Ubiquity* by Individual 200 Block Contexts
*Charcoal Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

1300 Block

Total Assemblage

A total of 58 flotation samples from six separate contexts was sampled from the 1300 block (Figure 22). Thirteen sediment samples from three hearths were collected in addition to 45 samples from three secondary refuse deposits. These samples yielded 17 seed taxa and 12 charcoal taxa (Table 19 and 20). Cumulative

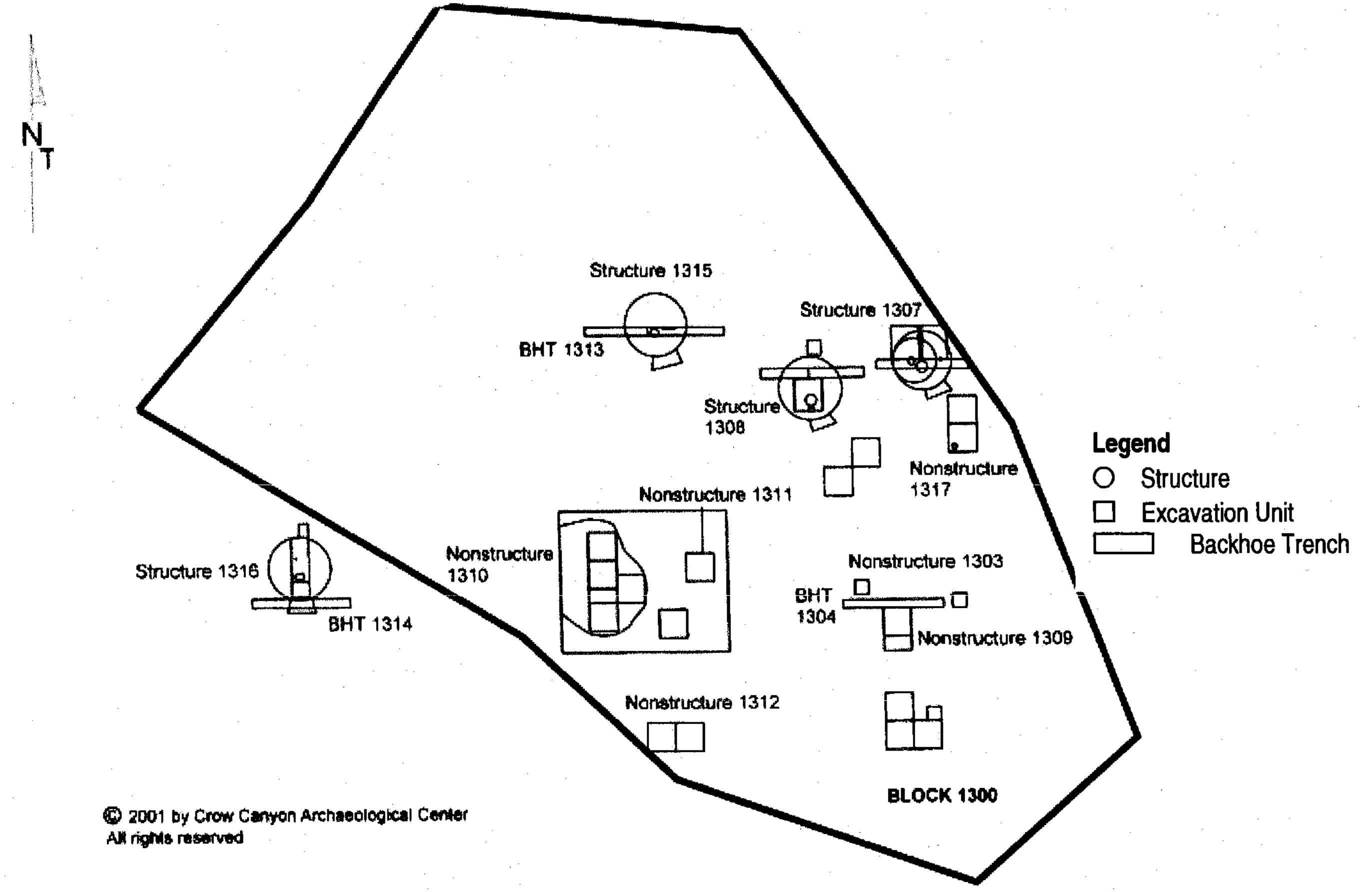

Figure 22 – Shields Pueblo 1300 Block (Courtesy Crow Canyon Archaeological Centre).
Note: Architectural blocks represent large excavation units that delineate associated areas based upon dense artefact and sandstone rubble scatter.

Table 19 - 1300 Block Identified Seed Assemblage

PROJECT INFORMATION			SEED (n)																												
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaceae-type	*Descurania*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Cleome*-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	**TOTAL SEED COUNTS (n)**
Structure 1307																															
Hearth 1	7	7	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	1	10
Structure 1308																															
Hearth 2	2	1.8	-	-	-	-	1	1	-	-						-	-	-	-	-	14	-	-	-	3	-	-	-	-	1	20
Hearth 4	4	3.5	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	20	-	-	-	5	-	-	-	-	1	33
Non-structure 1310																															
Secondary Refuse	16	13.3	2	-	-	1	4	1	-	-	15	-	-	-	-	-	-	1	1	-	41	-	-	1	4	-	-	-	-	24	95
Non-structure 1320																															
Secondary Refuse	21	14.6	8	1	-	5	1	-	-	1	47	13	7	-	-	-	-	5	-	-	416	-	-	3	120	1	-	-	-	16	644
Non-structure 1321																															
Secondary Refuse	8	7.3	1	-	-	2	-	-	-	-	1	-	-	-	-	-	-	8	1	-	6	-	-	-	-	-	-	-	-	2	21
Total	58	47.4	16	1	0	8	7	2	0	1	65	13	7	0	0	0	0	14	2	1	504	0	0	4	132	1	0	0	0	45	823

Table 20 - 1300 Block Charcoal Assemblage

SAMPLE INFORMATION			CHARCOAL (n)													VEGETATIVE SPECIMENS (n)														
Structure	No. of Samples	Volume (l)	*Juniperus*-type	*Ephedra*-type	*Pinus*-type	*Artemisia*-type	*Artemisia tridentata*-type	*Chrysothamnus*-type	*Atriplex*-type	*Quercus*-type	*Amelanchier/Peraphyllum*-type	*Cercocarpus*-type	*Prunus/Rosa*-type	*Purshia*-type	*Populus/Salix*-type	*Zea mays* cupule	*Zea mays* cob	Cucurbitaceae-type	*Juniperus*-type leaf scale	*Juniperus*-type twig	*Pinus*-type apical meristem	*Pinus*-type bark scale	*Pinus*-type cone scale	*Pinus*-type cone umbo	*Pinus*-type needle	*Pinus*-type needle fascicle	*Pinus*-type twig	*Yucca baccata* pod	*Artemisia*-type leaf	**TOTAL COUNTS (n)**
Structure 1307																														
Hearth 1	7	7	75	-	12	10	28	-	-	-	-	2	-	-	-	49	-	-	-	-	2	1	-	-	1	-	-	-	-	180
Structure 1308																														
Hearth 2	2	1.8	1	-	-	11	-	-	1	2	-	7	-	-	-	1	-	-	-	8	-	-	-	-	-	-	-	-	-	31
Hearth 4	4	3.5	22	-	1	9	-	-	-	-	1	-	-	3	-	39	2	-	-	4	-	-	-	-	-	-	-	-	-	81
Non-structure 1310																														
Secondary Refuse	16	13.3	30	-	2	22	-	4	-	2	-	2	-	-	-	309	-	-	-	8	-	2	-	-	-	-	-	-	1	382
Non-structure 1320																														
Secondary Refuse	21	14.6	105	-	40	72	3	1	5	-	1	-	-	-	-	318	12	-	-	56	-	12	-	6	-	-	-	6	-	637
Non-structure 1321																														
Secondary Refuse	8	7.3	57	-	33	29	7	1	-	1	-	-	-	-	2	22	-	-	-	4	-	6	-	-	-	1	-	-	-	163
Total	58	47.4	290	0	88	153	38	6	6	5	2	11	0	3	2	738	14	0	0	80	2	21	0	6	1	1	0	6	1	1474

frequency curves were plotted for the complete assemblages (Appendix F). The curve for the complete assemblage for the 1300 block is leveling off indicating that enough samples were analysed to account for all possible taxa.

The seed assemblage was comprised of two domesticates, eight wild, and seven weedy taxa. The most abundant plant category identified was charcoal followed by weedy, wild, domesticate, and unknown (Figure 23). The domesticated species included corn and the only seed specimen of squash. Yucca, lemonade berry, prickly pear, and four-wing saltbush represent the more significant wild seed species identified. Weedy taxa were the most abundant plant category recovered, especially cheno-am 61.2%, purslane 16.0%, Indian ricegrass 7.9%, and groundcherry 5.5% (Table 21). Again, cheno-am seeds were also the most frequently recovered taxon, present in 77.2% of the samples (Table 22). Only one or two specimens typically represented taxa with low ubiquity values. Two frequently recovered weedy taxa include groundcherry and Indian ricegrass. Contexts analysed within this architectural block were characterised by having low seed density values, less than 12.0 seeds/l (Table 23), with the exception of non-structure 1320, whose seed density and richness values were the second highest of the site.

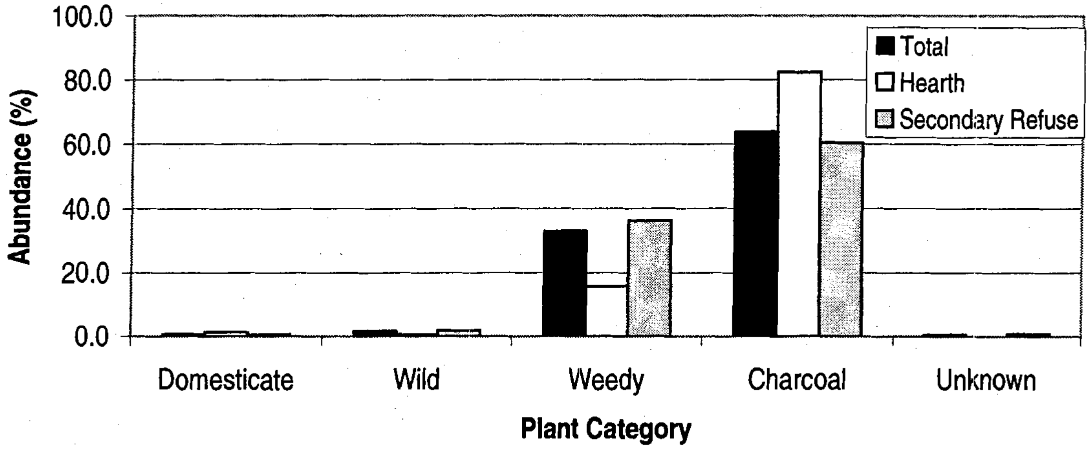

Figure 23 – 1300 Block Plant Category Abundance* by Assemblage
*Abundance was calculated by tabulating the number of specimens recovered from each plant category, and then determining what percent of that total each category represents.

Table 21 - 1300 Block Seed Abundance* (%) and Ranking (#)

Taxon	ARCHITECTURAL BLOCK		
	Total	**Hearth**	**Secondary Refuse**
Zea mays	1.9 (5)	7.9 (3)	1.4
Cucurbita-type	0.1		0.1
Gossypium-type			
Yucca baccata-type	1.0		1.1
Cyperaceae-type	0.9	3.2 (5)	0.7
Scripus-type	0.2	1.6	0.1
Bromus tectorum-type			
Panicum-type	0.1		0.1
Stipa hymenoides-type	7.9 (3)	3.2 (5)	8.3 (3)
Rhus aromatica var. *trilobata*	1.6		1.7
Asteraceae-type	0.9		0.9
Helianthus-type			
Brassicaceae-type			
Descurania-type			
Echinocereus fendleri-type			
Opuntia-type	1.7		1.8 (5)
Cleome-type	0.2		0.3
Atriplex canenesce-type	0.1	1.6	
Cheno-am	61.2 (1)	65.1 (1)	60.9 (1)
Cycloloma-type			
Malvaceae-type			
Sphaeralcea-type	0.5		0.5
Portulaca-type	16.0 (2)	12.7 (2)	16.3 (2)
Rosaceae-type	0.1		0.1
Rosa woodsii-type			
Prunus virginiana-type			
Solanaceae-type			
Physalis-type	5.5 (4)	4.8 (4)	5.5 (4)
Total Seed Count (n)	823	63	760

*Abundance was calculated by tabulating the number of specimens recovered from each plant category

Table 22 - 1300 Block Seed Ubiquity (%)**

	Assemblage		
Taxon	**Total**	**Hearth**	**Secondary Refuse**
Zea mays	21.1	23.1	20.5
Cucurbita type	1.8		2.3
Gossypium -type			
Yucca baccata-type	12.3		15.9
Cyperaceae-type	10.5	15.4	9.1
Scripus-type	3.5	7.7	2.3
Bromus tectorum-type			
Panicum-type	1.8		2.3
Stipa hymenoides-type	38.6	15.4	45.5
Rhus aromatica var. *trilobata*	8.8		11.4
Asteraceae-type	3.5		4.5
Helianthus-type			
Brassicaceae-type			
Descurania-type			
Echinocereus fendleri-type			
Opuntia-type	14.0		18.2
Cleome-type	3.5		4.5
Atriplex canenesce-type	1.8	7.7	
Cheno-am	77.2	76.9	77.3
Cycloloma-type			
Malvaceae-type			
Sphaeralcea-type	7.0		9.1
Portulaca-type	28.1	30.8	27.3
Rosaceae-type	1.8		2.3
Rosa woodsii-type			
Prunus virginiana-type			
Solanaceae-type			
Physalis-type	38.6	23.1	43.2
Total No. of Samples	58	13	45

**Seed Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

Table 23 - 1300 Block Seed Density* (n/l) and Richness (n)

SAMPLE INFORMATION			SEED (n)																													
Structure	No. of Samples	Volume (l)	*Zea mays*	*Cucurbita*-type	*Gossypium*-type	*Yucca baccata*-type	Cyperaceae-type	*Scripus*-type	*Bromus tectorum*-type	*Panicum*-type	*Stipa hymenoides*-type	*Rhus aromatica* var. *trilobata*	Asteraceae-type	*Helianthus*-type	Brassicaceae-type	*Descurania*-type	*Echinocereus fendleri*-type	*Opuntia*-type	*Cleome*-type	*Atriplex canenesce*-type	Cheno-am	*Cycloloma*-type	Malvaceae-type	*Sphaeralcea*-type	*Portulaca*-type	Rosaceae-type	*Prunus virginiana*-type	*Rosa woodsii*-type	Solanaceae-type	*Physalis*-type	**SEED DENSITY (n/l)**	**SEED RICHNESS****	**TOTAL SEED AND CHARCOAL RICHNESS****
Structure 1307																																	
Hearth 1	7	7	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	0.1	1.4	3	9
Structure 1308																																	
Hearth 2	2	1.8	-	-	-	-	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	1.7	-	-	-	-	0.6	11.4	5	11
Hearth 4	4	3.5	1	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0	5.7	-	-	-	1.4	-	-	-	-	0.3	9.4	6	
Non-structure 1310																																	
Secondary Refuse	16	13	0	-	-	P	0.3	P	-	-	1	-	-	-	-	-	-	P	P	-	3.1	-	-	p	0.3	-	-	-	-	1.8	7.1	11	17
Non-structure 1320																																	
Secondary Refuse	21	15	1	P	-	0.3	P	-	-	P	3	1	0.5	-	-	-	-	0.3	-	-	29	-	-	0.2	8.2	P	-	-	-	1.1	44.3	14	21
Non-structure 1321																																	
Secondary Refuse	8	7.3	0	-	-	0.3	-	-	-	-	0	-	-	-	-	-	-	1.1	0.1	-	0.8	-	-	-	-	-	-	-	-	0.3	2.9	7	14

*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

The 1300 block charcoal assemblage contained frequently recovered taxa, as well as less common plants such as mountain mahogany, serviceberry/peraphyllum, four-wing saltbush, cottonwood/willow, oak, and bitterbrush (Table 24). The latter six were present in less than 5.3 % of the samples analysed. Numerous non-wood parts were recovered from the 1300 block with the most commonly recovered being juniper twigs at 33.3%. The high ubiquity of juniper twigs was to be expected considering that juniper charcoal was recovered from 80.7% of the samples. Corn cupules were present in 96.5% and cob fragments were recovered from 8.8% of the 1300 block samples analysed.

Table 24 - 1300 Block Charcoal Ubiquity *(%)

Taxon	ASSEMBLAGE		
	Total	Hearth	Secondary Refuse
Juniperus-type	80.7		
Ephedra-type			
Pinus-type	42.1		
Artemisia-type	57.9		
Artemisia tridentata-type	10.5		
Chrysothamnus-type	3.5	7.7	2.3
Atriplex-type	3.5	7.7	2.3
Quercus-type	5.3	7.7	4.5
Amelanchier/Peraphyllum-type	3.5	7.7	2.3
Cercocarpus-type	5.3	15.4	2.3
Prunus/Rosa-type			
Purshia-type	1.8	7.7	
Populus/Salix-type	1.8		2.3
Zea mays cupule	96.5	84.6	100.0
Zea mays cob	8.8	7.7	9.1
Cucurbitaceae-type			
Juniperus-type leaf scale			
Juniperus-type twig	33.3	30.8	34.1
Pinus-type bark scale	15.8	7.7	18.2
Pinus-type cone scale			
Pinus-type cone umbo	3.5		4.5
Pinus-type needle	1.8	7.7	
Pinus-type needle fascicle	1.8		2.3
Pinus-type twig			
Pinus-type apical meristem	3.5	15.4	
Yucca baccata pod	3.5		4.5
Artemisia-type leaf	1.8		2.3
No. of Samples	58	13	45

*Charcoal Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

1300 Block Hearths

Flotation samples were collected from three 1300 block hearths (Table 20). One of the most significant aspects of the hearth assemblage was the small proportion of wild plants (Figure 23) and overall low seed densities (Table 23). A single four-wing saltbush utricle and bulrush achenes were identified and represented the only wild taxa in all 13 hearth samples. The utricle was likely attached to a branch of four-wing saltbush. Four-wing saltbush charcoal was also recovered from the same structure and was one of only three contexts that contained saltbush charcoal. Only five weedy taxa were present in 1300 block hearth samples and these include cheno-am, purslane, groundcherry, Indian ricegrass, and one seed of the sedge family. Similar to other architectural block assemblages, cheno-am seeds were the most abundant seed taxon (Table 21). The most ubiquitous seeds in the hearth samples were weedy species with purslane recovered from 30.8% of the samples, and cheno-am from more than twice as many samples, 76.9% (Table 22). Additional weedy species were present in lower frequencies.

As mentioned above 10 charcoal taxa were identified from hearth feature samples (Table 21). These included juniper, pine, sagebrush, serviceberry/peraphyllum, mountain mahogany, rabbitbrush, cottonwood/willow, four-wing saltbush, oak, and bitterbrush. The most ubiquitous were juniper, pine, and sagebrush (Table 24). Four-wing saltbush, bitterbrush, rabbitbrush, and oak were recovered from less than three samples. Corn cupules were present in 84.6% and cob fragments were in 7.7% of the samples. The only example of a pine needle was recovered from a single 1300 block hearth. Plotted cumulative frequency curves have not leveled off for the total, seed, or charcoal assemblages indicating additional hearth samples needed to be collected and analysed to recover the complete suite of taxa (Appendix F).

1300 Block Secondary Refuse

Three secondary refuses were sampled in the 1300 block. A total of 16 seed taxa was recovered from secondary refuse samples (Figure 24). This assemblage contained the only squash seed recovered from the site. Yucca, lemonade berry fruit and seeds, and prickly pear seeds were all present in 1300 block secondary refuse deposits. Cheno-am, purslane, Indian ricegrass, and groundcherry, were the four most abundant seed taxa in 1300 block secondary refuses (Table 21). Identified weedy plants totalled 19 including two unique specimens *e.g.*, the sunflower family and *Panicum*. Two of the three secondary refuses have low seed densities suggesting possible short-term use of the context (Table 23). The most ubiquitous seed taxa were cheno-am 77.3%, Indian ricegrass 45.5%, and groundcherry 43.2% (Table 22).

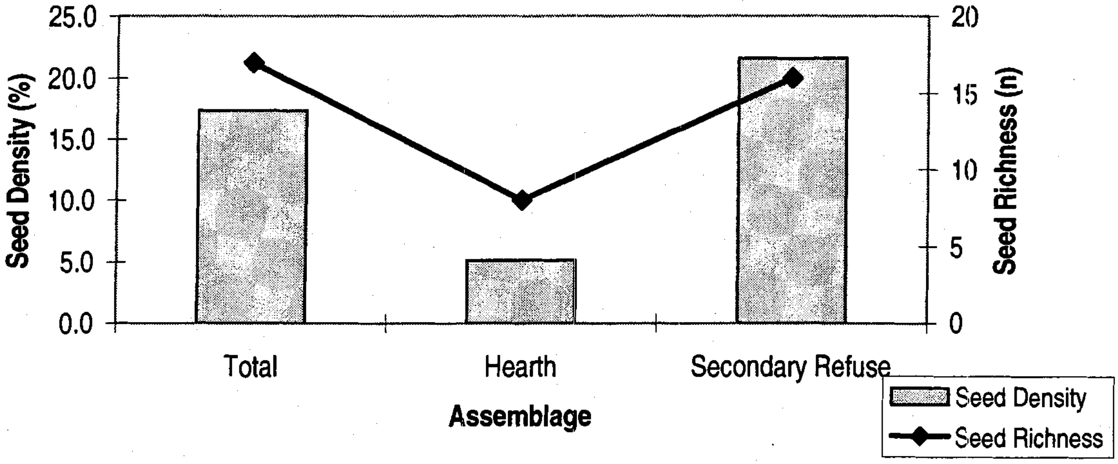

Figure 24 – 1300 Block Seed Density* (n/l) and Richness (n)**
*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

Corn cupules were recovered from all 1300 block secondary refuse samples (Table 24). Juniper, pine, and sagebrush were the most ubiquitous charcoal taxa of the 10 present. Other charcoal taxa such as serviceberry/peraphyllum, mountain mahogany, cottonwood/willow, rabbitbrush, and four-wing saltbush were present in only a single sample (Figure 25). Of the vegetative specimens juniper twig ends and pine bark scales were the most frequently recovered, present in 34.1% and 18.2 % of the samples respectively.

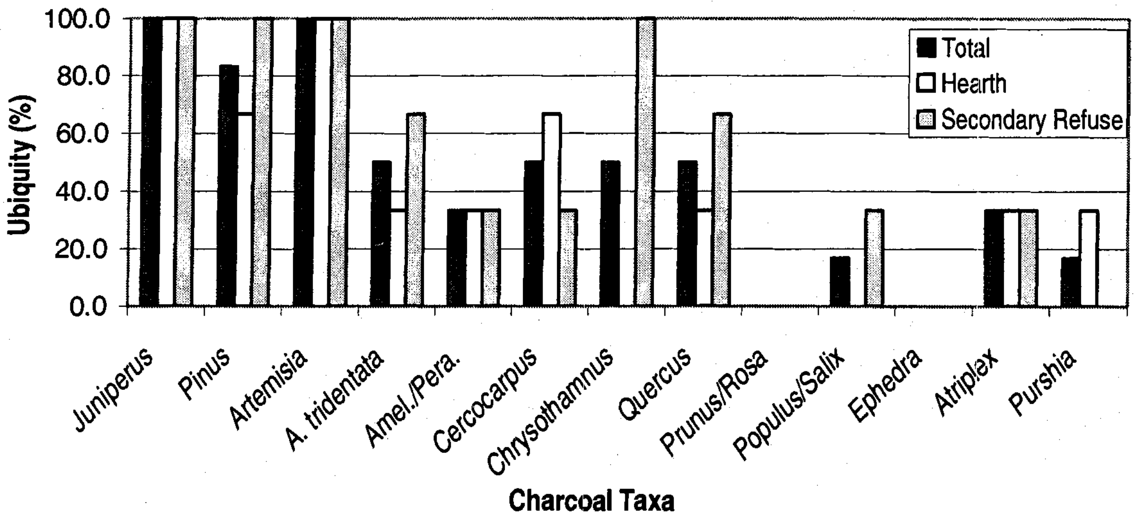

Figure 25 – 1300 Block Charcoal Ubiquity* by Assemblage.
*Charcoal Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

1300 Block Hearth vs. Secondary Refuse

When the three thermal features were compared to the three secondary refuse features there was a clear difference between seed taxa richness. The secondary refuse contexts contain twice as many seed taxa than the hearths. Of note was the absence of yucca seeds from hearth contexts while seeds and pod fragments were present in secondary refuse contexts. With the exception of non-structure 1321, weedy seed species were consistently more abundant than wild. Seed densities amongst hearth and secondary refuse contexts were comparable if non-structure 1320 was excluded (Table 23).

The ubiquity of corn, cheno-am, and purslane were similar in both hearths and secondary refuses (Table 22). However, groundcherry and Indian ricegrass were more frequently recovered in secondary refuse samples than hearths. Overall there were fewer weedy taxa in hearths compared to secondary refuse samples. Non-wood plant parts were also less ubiquitous in hearth samples than in secondary refuse (Table 24).

Temporal Analysis

This section will summarise and compare assemblages that date to two periods of occupation focused upon in this study: the Middle Pueblo II (A.D. 975 - 1050) and the Late Pueblo II (A.D. 1050 – 1150). All samples collected and dated to the Pueblo II period were analysed and included herein. The following temporal analysis is organised in the same manner as the spatial data. The total assemblages for each temporal period will be discussed first, followed by hearth, and secondary refuse assemblages.

Middle Pueblo II (A.D. 975 – A.D. 1050)

The Middle Pueblo II (MPII) assemblage at Shields Pueblo was composed of five contexts: three hearths and two secondary refuse features. Samples from these features totaled 37: 13 from hearths and 24 secondary refuses. The total specimen count was 1294, and 22 taxa were identified (Table 25). The assemblage was comprised of domestic, wild, weedy, charcoal, and unknowns in abundances similar to those found other contexts, 0.6%, 1.2 %, 26.4%, 71.3% and 0.5% respectively (Figure 26). Cumulative frequency curves were plotted for the total, hearth, and secondary refuse assemblages (Appendix F). The seed assemblage's cumulative frequency curves for the complete MPII assemblage was level indicating that an adequate number of samples had been sorted. The total and charcoal assemblage graphs continue to rise which suggests that additional samples needed to be analysed to obtain all possible taxa.

Table 25 - Temporal Summary of Botanical Remains by Assemblage

Taxon	MIDDLE PEUBLO II			LATE PUEBLO II		
	Total	Hearth	Midden	Total	Hearth	Midden
Zea mays	8	5	3	36	17	19
Cucurbita-type				1		1
Gossypium-type				1	1	
Yucca baccata-type	3		3	21	9	12
Cyperaceae-type	5	1	4	9	4	5
Scripus-type	2	1	1	10	6	4
Bromus tectorum-type				1		1
Panicum-type				1		1
Stipa hymenoides-type	18	2	16	73	14	59
Rhus aromatica var. *trilobata*				14	1	13
Asteraceae-type				7		7
Helianthus-type				3	3	
Brassicaceae-type	1	1				
Descurania-type				8		8
Echinocereus fendleri-type				2		1
Opuntia-type	10	1	9	223	185	38
Cleome-type	3	1	2	6	6	
Atriplex canenesce-type				1	1	
Cheno-am	270	223	47	951	355	592
Cycloloma-type				2	2	
Malvaceae-type				3	3	
Sphaeralcea-type	10	9	1	7	4	3
Portulaca-type	9	5	4	245	32	212
Rosaceae-type				1		1
Rosa woodsii-type				1	1	
Prunus virginiana-type				2	1	1
Solanaceae-type				9	9	
Physalis-type	28	2	26	157	19	137
Juniperus-type	98	11	87	691	310	370
Ephedra-type	1	1				
Pinus-type	49	14	35	115	48	67
Artemisia-type	188	137	51	304	115	166
Artemisia tridentata-type	27	20	7	53	32	21
Chrysothamnus-type	15	10	5	38	17	20
Atriplex-type				8	1	7
Quercus-type	3		3	19	6	11
Amelanchier/Peraphyllum-type				16	6	10
Cercocarpus-type	4	2	2	15	13	2
Prunus/Rosa-type				5	1	4
Purshia-type				3	3	
Populus/Salix-type	2		2	35	15	19

Table 25 Continued

Zea mays cupule	474	143	331	1014	379	605
Zea mays cob	1	1		37	8	20
Cucurbitaceae-type				33	23	10
Juniperus-type leaf scale	2	2		2	2	
Juniperus-type twig	17	5	12	111	38	73
Pinus-type bark scale	28	20	8	47	12	35
Pinus-type cone scale				4		4
Pinus-type cone umbo				6		6
Pinus-type needle				1	1	
Pinus-type needle fascicle	2	1	1			
Pinus-type twig	4	4		3	3	
Pinus-type apical meristem				2	2	
Yucca baccata pod				6		6
Artemisia-type leaf	6	5	1	2	1	1
Unknown	6		6	48	19	29
TOTAL No. OF SPECIMENS	1294	627	667	4413	1728	2601

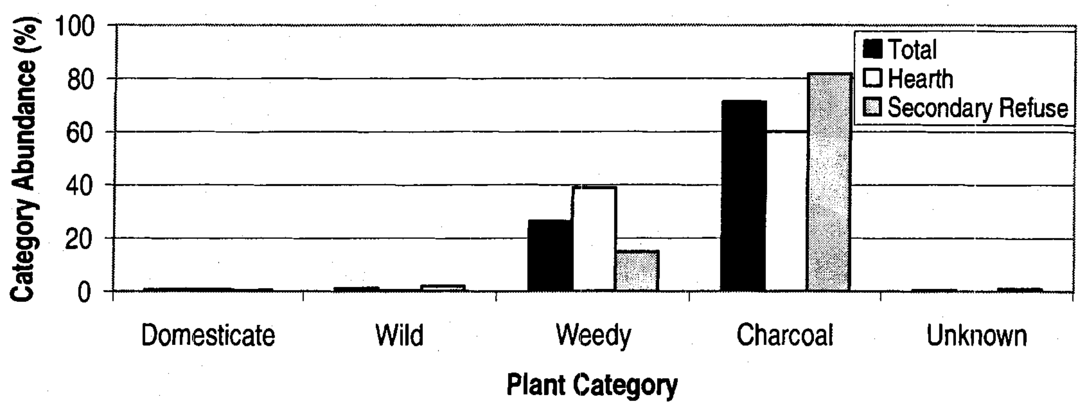

Figure 26 – Middle Pueblo II Plant Category Abundance by Assemblage
*Abundance was calculated by tabulating the number of specimens recovered from each plant category, and then determining what percent of that total each category represents.

Total Assemblage

A total of 367 seeds representing 12 taxa was recovered from MPII samples (Table 26 and Figure 27, respectively). Charcoal and weedy plants compose the major plant categories present in the MPII assemblage (Figure 26). Plant category abundances were similar to those of the architectural block assemblages. The most abundant species include cheno-am 73.6%, groundcherry 7.6%, Indian ricegrass

4.9%, prickly pear 2.7%, and purslane 2.5% (Table 26). These taxa were reported as being used by historic groups as food (Table 7) and have also been recovered from other southwestern archaeobotanical assemblages (Adams 1999; Kent 1981; Murray and Jackson-Craig 2003).

Table 26 - Seed Abundance* (%) and Ranking (#) by Temporal Period and Assemblage Type

Taxon	MIDDLE PUEBLO II			LATE PUEBLO II		
	Total	Hearth	Secondary Refuse	Total	Hearth	Secondary Refuse
Zea mays	2.2	2.0 (3)	2.6	2.0	2.5 (5)	1.7
Cucurbita-type				0.1		0.1
Gossypium-type				0.1	0.1	
Yucca baccata-type	0.8		2.6	1.2	1.3	1.1
Cyperaceae-type	1.4	0.4 (5)	3.4	0.5	0.6	0.4
Scripus-type	0.5	0.4 (5)	0.9	0.6	0.9	0.4
Bromus tectorum-type				0.1		0.1
Panicum-type				0.1		0.1
Stipa hymenoides-type	4.9 (3)	0.8 (4)	13.9 (3)	4.1 (5)	2.1	5.3 (4)
Rhus aromatica var. *trilobata*				0.8	0.1	1.2
Asteraceae-type				0.4		0.6
Helianthus-type				0.2	0.4	
Brassicaceae-type	0.3	0.4 (5)				
Descurania-type				0.4		0.7
Echinocereus fendleri-type				0.1		0.1
Opuntia-type	2.7 (4)	0.4 (5)	7.8 (4)	12.4 (3)	27.5 (2)	3.4 (5)
Cleome-type	0.8	0.4 (5)	1.7	0.3	0.9	
Atriplex canenesce-type				0.1	0.1	
Cheno-am	73.6 (1)	88.8 (1)	40.5 (1)	53.0 (1)	52.7 (1)	53.1 (1)
Cycloloma-type				0.1	0.3	
Malvaceae-type				0.2	0.4	
Sphaeralacea-type	2.7 (4)	3.6 (2)	0.9	0.4	0.6	0.3
Portulaca-type	2.5 (5)	2.0 (3)	3.4 (5)	13.6 (2)	4.8 (3)	19.0 (2)
Rosaceae-type				0.1		0.1
Prunus virginiana-type				0.1	0.1	0.1
Rosa woodsii-type				0.1	0.1	
Solanaceae-type				0.5	1.3	
Physalis-type	7.6 (2)	0.8 (4)	22.4 (2)	8.7 (4)	2.8 (4)	12.3 (3)
Total No. of Seeds	367	251	116	1795	673	1115

*Abundance was calculated by tabulating the number of specimens recovered from each taxa.

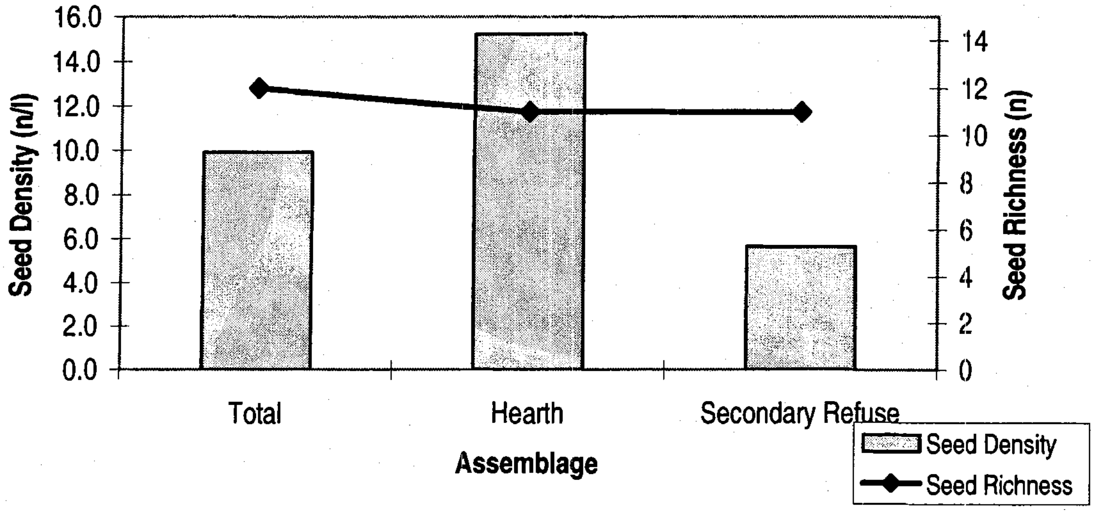

Figure 27 – Middle Pueblo II Seed Density* (n/l) and Richness (n).**
*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

Seed density and richness varied among MPII contexts with structure 234 having the highest density, 26.7 seed/l and non-structure 1310 having the highest richness count. The most ubiquitous identified taxon from MPII contexts was cheno-am which was recovered from 68.6% of the samples (Table 27). The frequent recovery of these seeds may be due to their tough pericarp and/or the high number of seeds produced on each individual plant. The next most commonly recovered taxa were groundcherry, Indian ricegrass, purslane, corn, and prickly pear. Flotation samples from this time period also yielded the only example of a four-wing saltbush bract at the site.

Table 27 - Seed Ubiquity* (%) by Temporal Period and Assemblage

Taxon	MIDDLE PUEBLO II			LATE PUEBLO II		
	Total	Hearth	Secondary Refuse	Total	Hearth	Secondary Refuse
Zea mays	17.1	23.1	13.0	18.3	16.1	23.2
Cucurbita-type				0.8		1.8
Gossypium-type				0.8	1.8	
Yucca baccata-type	8.6		13.0	11.7	7.1	17.9
Cyperaceae-type	14.3	15.4	13.0	4.2	3.6	5.4
Scripus-type	5.7	7.7	4.3	5.0	5.4	5.4
Bromus tectorum-type				0.8		1.8
Panicum-type				0.8		1.8
Stipa hymenoides-type	34.3	15.4	43.5	15.0	10.7	21.4
Rhus aromatica var. *trilobata*				5.0	1.8	8.9
Asteraceae-type				1.7		3.6
Helianthus-type				1.7	3.6	
Brassicaceae-type				0.8	1.8	
Descurania-type				3.3		7.1
Echinocereus fendleri-type				1.7		1.8
Opuntia-type	14.3		21.7	17.5	19.6	17.9
Cleome-type	5.7		8.7	5.8	12.5	
Atriplex canenesce-type	2.9	7.7				
Cheno-am	68.6	76.9	60.9	78.3	82.1	85.7
Cycloloma-type				0.8	1.8	
Malvaceae-type				2.5	5.4	
Sphaeralcea-type	2.9		4.3	10.0	16.1	5.4
Portulaca-type	20.0	30.8	13.0	29.2	23.2	37.5
Rosaceae-type				0.8		1.8
Prunus virginiana-type				1.7	1.8	1.8
Rosa woodsii-type				0.8	1.8	
Solanaceae-type				1.7	3.6	
Physalis-type	40.0	23.1	47.8	19.2	16.1	25.0
Unknown	11.1	7.7	12.5	20.8	14.3	30.4
Total No. of Samples	36	13	24	120	56	56

*Seed Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

The charcoal assemblage for the MPII flotation samples totalled 11 taxa including those frequently recovered from other contexts and rare taxa such as bitterbrush and four-wing saltbush (Table 28). Of the MPII samples analysed 80.0% contained juniper charcoal and 97.1% produced corn cupules (Table 28). The high frequency of cupules may be the result of their dense composition and/or the repeated use of cobs as a hearth fuel. During times of food abundance cobs may have been tossed into the fire and burned as fuel (Ortman 1998). The high frequency of juniper charcoal also explains the ubiquity of juniper twigs recovered from MPII samples. The twigs were likely attached to wood brought onto the site and, although tentative, suggest that a stand of living trees was located within proximity to the site during the MPII period.

Table 28 - Charcoal Ubiquity (%) by Temporal Period and Assemblage

Taxon	MIDDLE PUEBLO II			LATE PUEBLO II		
	Total	Hearth	Secondary Refuse	Total	Hearth	Secondary Refuse
Juniperus-type	80.0	92.3	69.6	80.8	71.4	96.4
Ephedra-type				0.8	1.8	
Pinus-type	34.3	61.5	17.4	35.8	33.9	42.9
Artemisia-type	57.1	46.2	60.9	66.7	67.9	71.4
Artemisia tridentata-type	14.3	30.8	4.3	6.7	3.6	10.7
Chrysothamnus-type	8.6		13.0	18.3	19.6	17.9
Atriplex-type	2.9	7.7		1.7		3.6
Quercus-type	8.6	7.7	8.7	8.3	5.4	10.7
Amelanchier/Peraphyllum-type	2.9	7.7		8.3	8.9	8.9
Cercocarpus-type	8.6	15.4	4.3	3.3	5.4	1.8
Prunus/Rosa-type		7.7		1.7	1.8	1.8
Purshia-type	2.9	7.7				
Populus/Salix-type	2.9		4.3	9.2	10.7	7.1
Zea mays cupule	97.1	84.6	100.0	83.3	76.8	94.6
Zea mays cob	2.9	7.7		10.8	8.9	12.5
Cucurbitaceae-type				1.7	1.8	1.8
Juniperus-type leaf scale				2.5	5.4	
Juniperus-type twig	22.9	30.8	17.4	26.7	19.6	37.5
Pinus-type apical meristem	5.7	15.4				
Pinus-type bark scale	17.1	7.7	21.7	18.3	14.3	25.0
Pinus-type cone scale				0.8		1.8
Pinus-type cone umbo	2.9			1.7		
Pinus-type needle	2.9	7.7				3.6
Pinus-type needle fascicle	2.9		4.3	0.8	1.8	0.0
Pinus-type twig				2.5	5.4	
Unknown				4.2	5.4	3.4
No. of Samples	36	13	24	120	56	56

*Charcoal Ubiquity was calculated be determining the number of samples a taxon was present in as a proportion of the total number of samples.

Middle Pueblo II Hearths

Flotation samples from three hearths located in two MPII structures were examined. All four-plant categories were detected in these flotation samples in the following proportions: 60.0% charcoal, 38.9% weedy, 0.8% domesticate, 0.3% wild, and nil % unknown (Figure 26). This pattern of distribution, charcoal composing the largest portion of the assemblage followed by weedy, wild, domesticate, and unknown taxa, is repeated throughout all assemblages regardless how samples are grouped.

Cheno-am, globemallow, and purslane were the three most abundant taxa present in MPII hearths (Table 26). The total richness count of identified seeds was 11 (Figure 27). However when determining if the sample size was adequate to characterize taxa richness (Appendix F), the hearth seed assemblage did not level off suggesting that too few samples were analysed to recover all possible taxa in the MPII hearth assemblage. The most ubiquitous seed taxon was cheon-am (Table 27). Bulrush and the only non-charcoal specimen of four-winged saltbush were also recovered from a hearth dating to this period.

A total of 10 wood species were identified in MPII hearths (Table 25). These include juniper, pine, sagebrush, and mountain mahogany to name a few. Juniper charcoal was the most commonly recovered charcoal followed by pine and sagebrush (Table 28). Most notable in the MPII hearths was the presence of less ubiquitous taxa such as chokecherry/wild rose, four-wing saltbush, and bitterbrush. A MPII hearth also contained the only bitterbrush charcoal specimen recovered from the Pueblo.

Middle Pueblo II Secondary Refuse

Two secondary refuses comprised of 23 samples in total, date to the Middle Pueblo II period. Similar to MPII hearths, charcoal was the most abundant plant category identified followed by weedy, and wild plants (Figure 26). Secondary refuse contexts yielded 667 specimens representing 19 taxa (Table 25). The richness count for identified seeds, 11, was same as that of the MPII hearth contexts (Figure 27), however secondary refuse assemblage contained yucca seeds which were absent from hearth samples. Secondary refuse charcoal richness was one greater than MPII hearths totaling eight taxa. Identified taxa included all those present in MPII hearths as well as oak and cottonwood/willow charcoal. When plotted cumulative frequency curves were still rising suggesting additional samples needed to be collected and analysed to recover the complete suite of taxa (Appendix F).

Amongst the two secondary refuse deposits sampled, cheno-am and groundcherry seeds were the most abundant (Table 26). Seed density measures were low in comparison to the MPII hearth assemblage (Figure 27). Again, cheno-am seeds were the most frequently recovered weedy taxon followed by groundcherry and Indian ricegrass, which were recovered from 47.8% and 43.5% of the secondary refuse samples respectively (Table 27). A single representative of bulrush and globemallow were also identified. Secondary refuse samples produced similar frequencies of charcoal as MPII hearths (Table 28). Juniper (69.6%), sagebrush (60.9%), and pine (17.4%) were the most ubiquitous charcoal in MPII secondary refuses. Corn cupules were recovered from every secondary refuse sample analysed, but unlike the hearth samples no cob segments were recovered.

Late Pueblo II Assemblage (A.D. 1050 – A.D. 1150)

The bulk of the flotation samples (120) analysed for this study are derived from contexts dating to the LPII time period. Hearth and secondary refuse contexts both encompassed 56 samples each and the remaining 8 samples were from other contexts such as pits, posts, and a bench located within LPII structures. A total of 4413 identified specimens representing 39 taxa were recovered from LPII flotation samples (Table 25). The total assemblage was composed of charcoal 58.2%, weedy 33.6%, wild 6.2%, unknown 1.1%, and 0.9% domesticates (Figure 28). This distribution was similar to that of MPII assemblages at the site with the exception of the weedy and charcoal abundances. The weedy plants comprise a larger proportion of the total assemblage in the LPII than the MPII and charcoal represents a larger proportion of the MPII than the LPII. When the number of identified taxa was plotted against the number of identified specimens the resulting graphs for the total assemblage did not level out (Appendix F), indicating that additional samples needed to be sorted to adequately characterise the LPII assemblage's richness. The same was true for the seed and charcoal assemblages.

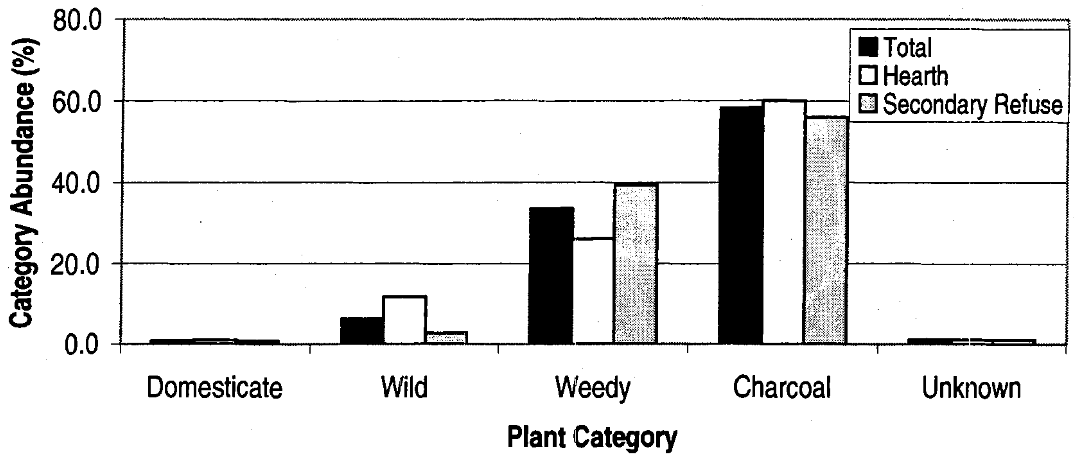

Figure 28 – Late Pueblo II Plant Category Abundance* (%)*Abundance was calculated by tabulating the number of specimens recovered from each plant category, and then determining what percent of that total each category represents.

Total Assemblage

The LPII seed assemblage totaled 27 taxa (Figure 29) and consisted of corn, yucca, prickly pear, purslane, groundcherry, and Indian ricegrass. Flotation samples from contexts dated to this time period included the only examples of 13 taxa including squash, cotton, hedgehog cactus, lemonade berry, winged pigweed, sunflower, Asteraceae, wild rose, chokecherry, *Bromus*, and *Panicum* to name a few. All these species were grown and/or harvested as food sources according to ethnohistorical data (Table 7).

Cheno-am, purslane and groundcherry were the most abundant and ubiquitous weed seed taxa recovered from LPII samples (Tables 26 and 27). A number of both wild and weedy taxa such as lemonade berry, hedgehog cactus, sunflower, and tansy mustard were recovered from less than 5.0% of the samples. Although the count of lemonade berry specimens was high, 14, the specimens were present in only 5.0% of the 120 samples. Seed density and richness values ranged from 0 to 79.3 seeds/l and 0 to 15 seed taxa respectively.

A total of 2570 charcoal specimens representing 15 different taxa was recovered from LPII flotation samples. In addition to the recovery of juniper, pine, and sagebrush charcoal, rare charcoal taxa, such as chokecherry/wild rose, ephedra, and four-wing saltbush, were identified in LPII samples. The most frequently recovered charcoal taxa from LPII samples were juniper 80.8%, sagebrush 66.7%, and pine 35.8% (Table 28). In addition to juniper charcoal being ubiquitous, 26.7% of LPII samples yielded juniper twig ends. Corn cupules were recovered from 83.3% of LPII flotation samples.

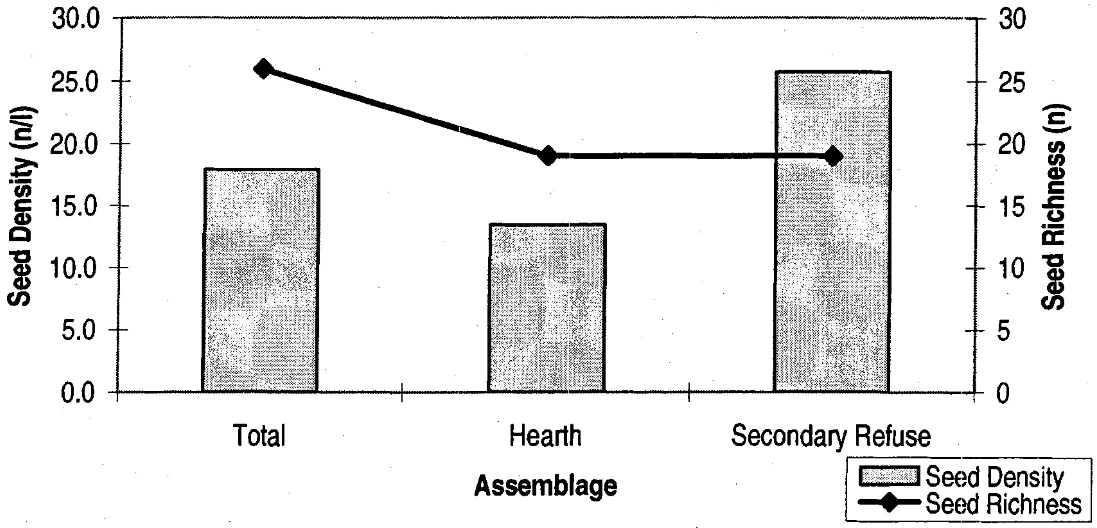

Figure 29 – Late Pueblo II Seed Density* (n/l) and Seed Richness (n) by Assemblage.**
*Seed density was calculated by dividing the total number of identified seeds by the total sediment volume. ** Seed richness was tabulated by determining the total number of identified taxa.

Late Pueblo II Hearths

Hearths within seven structures and one extramural surface, all dating to the LPII period were analysed. The samples yielded domesticated, wild, and weedy seed taxa. Charcoal was the most abundant plant category identified (Figure 28). Cheno-am was the most abundant seed recovered, followed by prickly pear, purslane, and groundcherry, (Table 26). The richness count for identified seeds totalled 20 (Figure 29). Plotted cumulative frequency curves indicated that too few samples were sorted to adequately characterise assemblage richness (Appendix F). Identified seed taxa include corn, yucca, prickly pear, beeweed, cheno-am, sunflower, purslane and groundcherry. Identified hearth charcoal totaled 14 taxa, and the associated cumulative frequency curve indicates that a sufficient number of contexts was sampled to adequately reflect the LPII hearth charcoal assemblage.

Cheno-am seeds were the most frequently recovered taxon, present in 82.1% of the 56 flotation samples (Table 27). Hearth samples also contained infrequently recovered taxa such as cotton, lemonade berry, winged pigweed, wild rose, and chokecherry. Juniper charcoal was the most frequently recovered wood charcoal from LPII hearth contexts at 71.4% (Table 28). Those charcoal taxa recovered less frequently from LPII hearths include mountain mahogany, oak, chokecherry/wild rose, and ephedra. The most ubiquitous vegetative specimen was cupules 76.8%. Also recovered from LPII hearths at a frequency of 1.8% were Cucurbitaceae rind fragments.

Late Pueblo II Secondary Refuse

A total of 56 samples from eight LPII secondary refuse contexts was examined and the resulting assemblage totalled 2601 (Table 25). Richness value of seeds for this assemblage was 19 (Figure 29). Accounting for the high seed richness count was the presence of squash, hedgehog cactus, Asteraceae, tansy mustard, and groundcherry seeds. The first four seed taxa were recovered only from LPII secondary refuse contexts. An interesting point to note was the presence of yucca fruit capsule fragments, the only specimens recovered from the site. Since the capsule is normally the portion of the plant that was consumed, its presence in the archaeobotanical assemblage is suspect. One possible explanation is that the banana was unpalatable or accidentally burned during processing. Identified taxa were plotted against identified specimens for LPII secondary refuse contexts and the resulting graph indicate that enough samples were analysed to sufficiently characterise the charcoal assemblage richness (Appendix F). However, the seed slope does not level off; therefore additional samples need to be collected and sorted.

Similar to other contexts reported herein, weedy taxa were the most abundant seed taxa recovered. Cheno-am, purslane, groundcherry, and Indian ricegrass were the four most abundant taxa identified from LPII secondary refuse samples (Table 26). These samples frequently contained cheno-ams, purslane, corn, groundcherry, and Indian ricegrass (Table 27). Less ubiquitous species include squash, chokecherry, globemallow, and individual specimens of *Bromus tectorum* and *Panicum*.

Of the 11 wood species identified, juniper charcoal was the most ubiquitous 96.4% (Table 28). Juniper charcoal was followed by sagebrush, 71.4%, and pine 42.9%. Corn cupules were recovered from 94.6 % of samples and they constituted the most frequently recovered vegatative taxa. Low ubiquity charcoal taxa include mountain mahogany, chokecherry/wild rose and four-wing saltbush. As mentioned above, yucca fruit pod fragments were recovered from two, or 3.6% of the samples.

Conclusion

The foregoing analysis has transformed the archaeobotanical results acquired during flotation analysis into useful measures such as richness, density, ubiquity, and abundance. These measures will be used in chapter seven to further characterise Shields Pueblo's archaeobotanical assemblage and investigate spatial and temporal variation within the assemblage. Also to be addressed within chapter seven are possible factors causing this variation.

CHAPTER SIX
'SPECIES AREA CURVE' SUB-SAMPLING EXPERIMENT

Introduction

This chapter will focus exclusively on the sub-sampling experiment which is investigation into the use of the 'species area curve' sub-sampling technique. Included in this chapter are previous sub-sampling research, the experimental methodology, results, and quantification. The quantification method to be used is presence/absence, since the focus of the sub-sampling experiment was to determine what, if any, species were being missed by using the 'species area curve' technique of sub-sampling.

Previous Sub-sampling Research

The issue of sample size for palaeoethnobotanists can be addressed at number of different levels: site, feature, and individual flotation samples (Adams and Gasser 1980; Lennstrom and Hastorf 1992). The level of sampling addressed in this study is the latter, specifically the light fractions. Although the other larger levels of sampling are important, the time required to adequately address these categories of sampling far exceeded the scope of this thesis.

One of the main constraints determining the number of flotation samples to analyse is budgetary. The amount of time spent analysing a sample varies depending upon the sample size and condition of the remains. Analysts have employed a number of sub-sampling techniques, such as splitting by volume or weight or *via* a riffle box (Van der Veen and Fieller 1982) thus reducing the amount of time spent on a sample. The main problem with any sample splitting technique arises when the analyst attempts to estimates the total remains. Using these above techniques, total counts may be exaggerated. For example, total counts are determined by multiplying the identified remains by the either the remaining unanalysed weight or volume *e.g.,* 100 ml light fraction in total, 50 ml analysed, identified remains are doubled to account for 50 ml of unanalysed material. The problem with using this technique is that sometimes rare taxa might be missed (Pearsall 2000). Furthermore splitting samples which are rich in plant remains may only slightly reduce the overall sorting time.

Few published experiments have been conducted to determine the effects of sampling techniques on total plant assemblages. Numerous studies have been conducted to test recovery rates of different flotation methods (Hunter and Gassner 1998; Kaplan and Maina 1977; Pearsall 1989; Wagner 1982), but few deal with the resulting light fractions. Green's (Pearsall 2000) experiment split light fractions into four parts and analysed and recorded the individual results. Upon completion Green noted that the entire sample needed to be analysed to recover all seed taxa present and that rare taxa were recovered only from the last of the four sub-samples. This experiment demonstrates the need to determine early on in a project the number of sub-samples that need to be analysed to recover the data required to answer proposed questions. For the above experiment the number of sub-samples required could be roughly determined if the experiment is repeated a number of times.

The flotation sampling technique used at Crow Canyon Archaeological Centre (CCAC) involved taking small sub-samples of specific particle sizes until no new taxa were recovered for three consecutive sub-samples. A set volume, 5.0 ml, was selected as the minimum volume each fraction size must contain before any sub-sampling may occur. The size of the sub-sample volume was based on the amount of light fraction that can be packed contiguously under a field of view without any parts overlapping (Bohrer and Adams 1977). Sub-samples were then taken until no new taxa were recovered. This sub-sampling technique known as 'species area curve' is commonly used by ecologists (Mueller-Dombois and Ellenbery 1974; Pianka 1974), and self-regulates the analyst as to when to stop sorting the sample.

The 'species area curve' sampling technique is similar to one used by zooarchaeologists known as 'sampling to redundancy' (Dunnell 1984; Leonard 1987; Lyman and Ames 2004; Lepofsky 2005 personal comm.). Sampling to redundancy works on a similar premise that samples are taken incrementally until no additional variables are identified. The identified variable is plotted against the number of samples analysed and if the resulting curve reaches a plateau, the sample size is deemed adequate. The experiment reported herein will evaluate the 'species area curve' sampling technique to determine its ability to provide researchers with a complete picture of an archaeobotanical assemblage and determine if any data are being lost through the use of this method.

Methodology

Flotation samples from 16 contexts comprised the scope of this study. Using a table of random numbers, one sample was selected from each context for inclusion in this sub-sampling experiment. Each flotation sample was analysed using the same protocol used for all other flotation samples in this thesis, however one additional step was added. Previously, sub-sampling of a particular mesh size ceased after three consecutive sub-samples were sorted and no new taxa were recovered. However for this investigation sub-samples continued to be taken, and the taxa and the number of specimens that were recovered from each additional sub-sample were recorded, until no light fraction remained. The results of these additional sub-samples were then compared to the 'species area curve' method of sub-sampling to determine if botanical remains were being missed. Appendix H includes the results of a single sample to demonstrate the recording protocol of this experiment.

Sub-sampling Experiment Results

This section will discuss the results of the sub-sampling experiment. First the total experiment results are discussed and then only those samples in which new taxa were recovered when analysed in their entirety. These samples were emphasised because the objective of this experiment was to determine what data were missed by using the 'species area curve' method, thus the inclusion of those samples where no data were missed would be redundant. Individual Sample results can be found in Appendix I.

Species Area Curve

To determine the nature of the total plant assemblage the identified remains from all 16 samples were combined. The 'species area curve' method yielded 25 taxa, 9 charcoal and 17 seed, and a total of 547 specimens (Table 29). Specimens from domestic, wild, and weedy plants were identified. Corn was the only domesticate recovered. Wild plants consisted of yucca, prickly pear, sedge, four-wing saltbush, and lemonade berry. Cheno-am, purslane, and groundcherry were the most frequently recovered weedy species, but less frequently recovered taxa such as winged-pigweed, Indian ricegrass, and beeweed were also present. The distribution of the plant categories is similar to that of other Shields Pueblo's PII archaeobotanical assemblage with the seed specimens dominated by weedy plants,

Table 29 – Presence/Absence of Plant Taxa by Analysis Technique.

TAXON	ANALYSIS TECHNIQUE	
	SPECIES AREA CURVE	TOTAL SAMPLE
Zea mays	X	X
Yucca baccata-type	X	X
Cyperaceae-type	X	X
Scripus-type	X	X
Stipa hymenoides-type	X	X
Rhus aromatica var. *trilobata*	X	X
Asteraceae-type	X	X
Brassicaea-type	X	X
Opuntia-type	X	X
Cleome-type	X	X
Cheno-am	X	X
Cycloloma-type	X	X
Sphaeralcea-type		X
Portulaca-type	X	X
Physalis-type	X	X
Unknown Poaceae 1	X	X
Unknown Poaceae 2		X
Unknown Seed 2	X	X
Juniperus-type	X	X
Pinus-type	X	X
Artemisia-type	X	X
Chrysothamnus-type	X	X
Atriplex-type	X	X
Quercus-type	X	X
Amelanchier/Peraphyllum-type	X	X
Cercocarpus-type	X	X
Specimen Total	547	714

X – species presence

plants, 26.9%, while wild and domestic specimens form only 2.9% and 1.1% of the total assemblage respectively (Figure 30). Charcoal specimens formed the bulk of the identified remains composing 68.7% of the total assemblage.

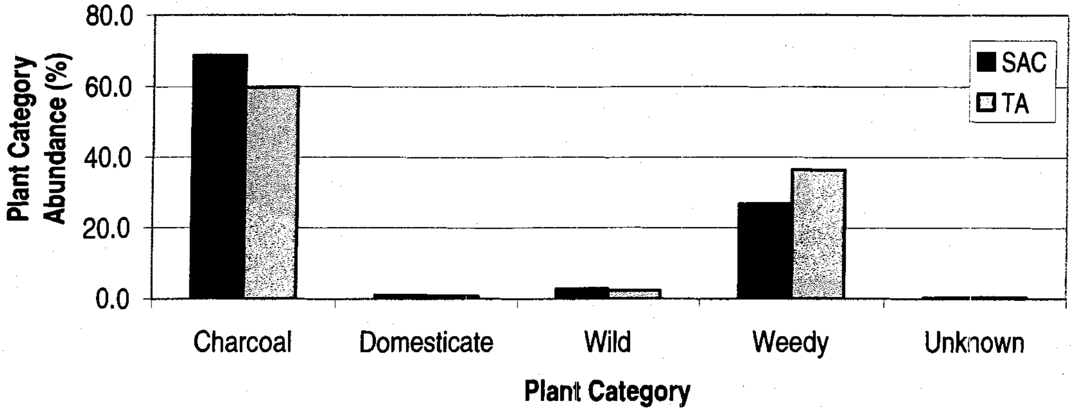

Figure 30 – Plant Category Abundance* by Analysis Technique
*Plant category abundance was calculated by tabulating specimen count for each plant category and determining the percentage of the total assemblage.SAC – Species Area Curve, TA – Total Assemblage

If these were the only samples collected from the site a few general conclusions about plant use could be made. The presence of corn kernels indicates that the inhabitants grew and consumed this crop. Weedy plants typically found in disturbed environments such as fallow fields, field edges, and along pathways were collected and brought back to the Pueblo. Wild plants identified include succulents such as yucca and prickly pear cactus, and the fruit of the lemonade berry bush. Charcoal species indicated that the Pueblo's inhabitants utilised both trees and shrubs for fuel and as a source of construction material. Pine, juniper, and sagebrush were the most frequently recovered species while shrub species including rabbitbrush, chokecherry/peraphyllum, mountain mahogany, oak, and four-wing saltbush.

Complete Analysis of the Sample

When the same samples were analysed in their entirety the number of identified taxa increased to 27. The two additional seed taxa were globemallow and an unknown grass. Of these taxa, globemallow, was commonly recovered (8.3%) from Shields Pueblo flotation samples that were not included in this experiment. The number of specimens also increased to 714. The additional specimens was almost one-third of those recovered using the 'species area curve' method. Of particular interest is the number of additional cheno-am seeds, 45, recovered from sample 12, nearly double that recovered using the 'species area curve' technique.

The distribution of the plant types when the samples were analysed in their entirety is similar to that of the 'species area curve' method (Figure 30). Charcoal specimens dominated the identified remains followed by weedy, wild, and domesticate. Of note is the decrease in the proportion of charcoal in the assemblage of samples completely analysed. The decrease in the charcoal proportion is likely due to the increased number of cheno-am and other weedy seeds. The high proportion of weedy taxa was expected considering these types of plants often have high seed counts and was the most frequently recovered plant type in PII samples.

Species Area Curve *vs.* Total Sample Analysis

Overall the two sorting methods produced similar results, especially for the distribution of plant categories (Figure 30). Charcoal yielded the highest number of identified specimens followed by weedy, wild, and domesticates. Both methods resulted in the recovery of a variety of remains, which could be classified into the aforementioned categories. The additional remains identified when the samples were completely analysed include corn, cheno-am, purslane, groundcherry, Indian ricegrass, lemonade berry, and juniper. Also present were two taxa not previously recovered: globemallow and an unknown grass. Although additional taxa were recovered when the samples were analysed in their entirety, their presence did not change the proportions or contribute greatly to the overall interpretation of the remains.

An additional 167 specimens were identified when samples were analysed in their entirety. This did not significantly change the overall values for the distribution of the plant categories, and the individual distribution of the wild and weedy seed species did not alter – weedy plants remained more abundant then wild. When the assemblages from the two sampling methods were compared it became apparent that completely sorting a sample does not yield enough new data to warrant the use of this method (Table 30).

Table 30 – Summary of Sub-sampling Experiment Results

SAMPLE NUMBER	SPECIES AREA CURVE		COMPLETE ANALYSIS	
	NIT	NISP	NIT	NISP
1	11	56	11	62
2	3	56	4	67
3	8	39	8	42
4	7	37	7	37
5	4	6	4	6
6	0	0	0	0
7	5	24	5	25
8	3	19	3	29
9	4	6	4	6
10	8	45	8	54
11	7	46	9	51
12	8	87	10	169
13	4	21	5	23
14	6	23	6	24
15	7	29	9	45
16	8	53	8	74
TOTAL	25	547	27	714

NIT = Number of Identified Taxa (includes seed and charcoal taxa)
NISP = Number of Identified Specimens

When each of the 16 samples were studied individually the number of taxa missed by using the 'species area curve' method increases (Appendix I). Five of the samples, numbers 2, 11, 12, 13, and 15, contained taxa that were only recovered when the sample was analysed in its entirety. These missed species include corn, cheno-am, groundcherry, an unknown grass, globemallow, and purslane. In the event that archaeologists collected only one flotation sample from each context and the archaeobotanist was not sorting the entire sample, data would be missed by using the 'species area curve' method. However, Shields Pueblo archaeologists frequently collected more than one sample from each context, thus increasing the potential for rare taxa to be recovered using the 'species area curve' method.

The majority of the identified seed specimens were recovered from three of the five sieve sizes: 1.4 mm, 0.71 mm, and 0.250 mm. The types of remains such as wild and weedy, were also roughly distributed among these same sieves. Domesticated seed specimens were recovered from the larger sieves such as 2.8 mm and 1.4 mm, but were rarely collected from the smaller sieves. Wild taxa were most frequently found in the 1.4 mm and 0.71 mm sieves, while weedy taxa were present in the two smallest sieves. This distribution pattern is manifested in both the 'species area curve' and total sample analysis assemblages. The majority of the seed recovered using the 'species area curve' method were found in the three previously mentioned sieve sizes, and as expected the additional taxa and specimens identified by sorting flotation samples in their entirety were primarily recovered from these same three sieves. Specifically the 1.4 mm and 0.710 mm sieves yielded 140 specimens or 82.4% of the total additional specimens recovered when samples were completely sorted. The two additional taxa were collected from the 0.710 mm screen. The productivity of the smaller sieves is interesting and suggests that the flotation light fraction present in these sieves deserves extra attention.

Conclusion

This chapter discussed the sub-sampling experiment methodology, and results as well as previous sampling experiments. Previous experiments primarily focused on flotation recovery rates. The focus of this sub-sampling experiment compared the 'species area curve' sub-sampling technique for sorting light fractions to that of analysing light fractions in their entirety. The results indicated that when the 16 samples were analysed in their entirety they yielded two additional weedy taxa, one of which (Unknown Poaceae 2) was the only representative recovered from any Shields Pueblo PII sample. An additional 167 specimens were also recovered when samples were completely sorted. The two additional taxa and the majority of the additional specimens were recovered from the two smallest sieve sizes, 0.71 mm, and 0.25 mm. The impact of these additional specimens on the interpretation of the remains will be addressed in the next chapter.

CHAPTER SEVEN
DISCUSSION

Introduction

This chapter focuses on the research questions posed in the beginning of this thesis. The questions will be addressed individually and key findings will be presented at the summation of each question. An overall summary of the results of this archaeobotanical investigation and the significance of this study, as well as potential areas of future research will be presented in the final chapter of this thesis.

1. What is the nature of Shields Pueblo's Pueblo II (A.D. 900 – A.D. 1150) plant assemblage?

The following discussion will summarise the complete archaeobotanical assemblage recovered from Shields Pueblo Pueblo II period. Species richness, abundance, and ubiquity measures for the total assemblage will be presented and discussed. The final portion of this discussion will compare Shields Pueblo's archaeobotanical assemblage to that of seven contemporaneous sites located within the Monument/McElmo drainage unit.

Archaeobotanical remains recovered from the analysis of 156 Shields Pueblo flotation samples identified a total of 43 taxa representing a number of different plant communities (Table 31). The 43 taxa, represented by various plant parts, belong to domestic, wild, and weedy plants. Four domesticated plants were identified: corn, cotton, squash, and Cucurbitaceae specimens. The specimens of these plants included seeds, fibers, cupules, and cob and rind fragments. Identified domesticates were reported foodstuffs in ethnohistorical accounts and they, and/or their byproducts, were used for ceremonial, medicinal, and utilitarian purposes.

Table - 31 Monument/McElmo Drainage Unit Plant Communities and Identified Shields Pueblo Taxa

Plant Community	Plant	Shields Pueblo
Pinyon-Juniper Woodland	Pine	X
	Juniper	X
	Indian Ricegrass	X
	Dropseed grass	
	Western Wheatgrass	
	Junegrass	
	Skunkbush	
	Sagebrush	X
	Gambel Oak	X
	Rabbitbrush	X
	Mountain Mahogany	X
	Serviceberry	X
	Yucca	X
	Prickly Pear Cactus	X
	Hedgehog Cactus	X
Sagebrush/Salbush	Sagebrush	X
	Saltbush	X
	Rabbitbrush	X
	Winterfat	
	Greasewood	
	Indian Ricegrass	X
	New Mexican Privet	
	Grama Grass	
	Dropseed grass	
	Galleta	
	Fendlergrass	
Grasslands	Grama Grass	
	Indian Ricegrass	X
	June Grass	
	Dropseed grass	
	Saltbush	X
	Sagebrush	X
	Winterfat	
	Wild Rose	X
	Sumac	
	Yucca	X
	Rabbitbrush	X
Gambel Oak Scrubland	Mountain Mahogany	X
	Wild Rose	X
	Sumac	
	Serviceberry	X

X - Presence

Wild taxa identified include succulents such as yucca, hedgehog and prickly pear cacti as well as various shrubs and bushes. In addition to the fruit of succulents being a valuable and dependable food source, leaves and pads were collected for utilitarian purposes. Fibers extracted from yucca leaves were woven into sandals, containers, and cordage. Cactus pads were consumed only during times of food shortage (Whiting 1966). Today, cattle are feed cactus pads when grazing is limited. Fruit and charcoal from bushes including wild rose, chokecherry, lemonade berry, and four-wing saltbush were present in the Pueblo's archaeobotanical assemblage. Their occurrence indicates that in addition to open pinyon-juniper woodlands, where succulents tend to thrive, taxa from the sagebrush/saltbush plant community were being harvested for food and for fuel (Table 31).

Weedy taxa were the most abundant category of plants recovered from Shields Pueblo's flotation samples (Figure 31). A total of 16 weedy species were identified, these include important taxa such as cheno-am, purslane, and Indian ricegrass to name a few. In comparison to weedy species, only nine wild taxa were recovered. The low raw counts possessed by the wild taxa is also reflected in their low category abundance (Figure 31).

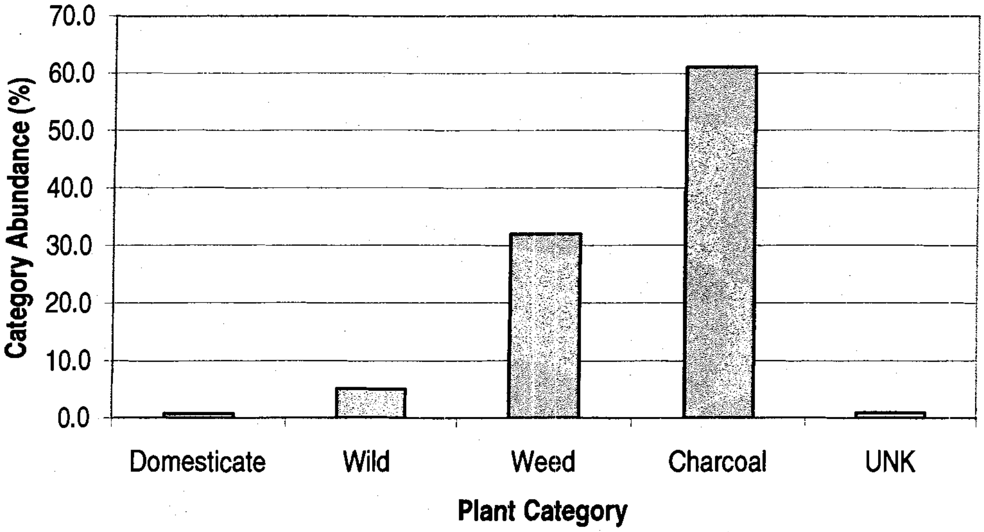

Figure 31 – Shields Pueblo Plant Category Abundance
* Plant category abundance was calculated by the totalling the number of seeds for each category, and determining the percent of the total assemblage they represent.

A total of 16 charcoal taxa were identified at the Pueblo. The most frequently recovered species include juniper, pine, sagebrush, rabbitbrush, and serviceberry/peraphyllum (Figure 32). Less frequently encountered taxa are comprised of mountain mahogany, oak, chokecherry/wild rose, cottonwood/willow, ephedra, four-wing saltbush, and bitterbrush. Different components of these species were used as fuel, for construction, for tools and basketry, for ceremonial purposes, and as medicine. The presence of numerous non-wood specimens, such as twig ends and needles alludes to the possibility that a source of living trees, specifically pine and juniper, existed in proximity to the Pueblo during the PII occupation.

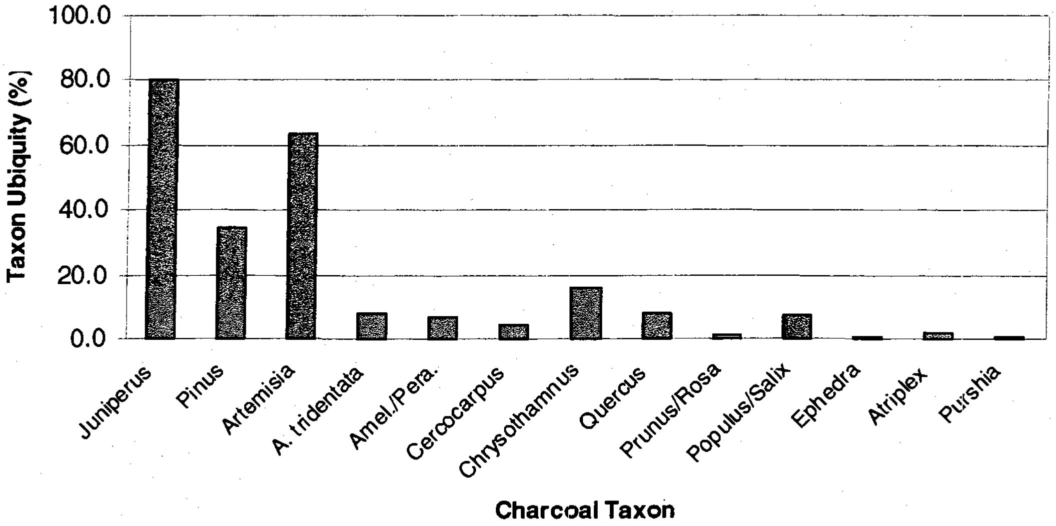

Figure 32 – Shields Pueblo Charcoal Ubiquity*
* Ubiquity frequencies were calculated by determining the number of samples a taxon was present in as a percentage of all the samples.

Shields Pueblo's archaeobotanical assemblage indicates that the inhabitants were agriculturists as well as foragers. They primarily farmed corn, squash, and beans, although the latter is known from other sites (Adams 1993; Mathews 1986). The Puebloans relied upon yearly precipitation, winter snow and late summer monsoons to germinate and provide the moisture required for their crops to reach maturity (Matson 1991; Van West and Dean 2000). In addition to these crops, inhabitants collected available wild and weedy plants. These plants have been reported in ethnohistorical accounts as being used for food, medicine, and raw materials (Elmore 1944; Stevenson 1896; Whiting 1939).

The proliferation of weedy plants in the Pueblo's assemblage was expected. A single weedy plant is capable of producing large quantities of seeds. Weeds prefer disturbed growing environments and were likely present in or around agricultural fields, secondary refuses, or paths. These taxa would have provided a complimentary food resource, which depending upon its location, could have been collected while travelling to tend agricultural fields.

High seed density, abundance, and ubiquity measures indicate that a number of weedy plants were routinely collected and brought into contact with fires at Shields Pueblo. Of the 17 identified weedy taxa, cheno-am seeds were the most abundant and ubiquitous (Figure 33). The broad spatial distribution of weedy plants such as cheno-am at the Pueblo further supports the widespread use of this resource by the inhabitants. Weedy taxa with low seed measures, *e.g.* abundance and ubiquity values, may reflect the fortuitously transport of the plant onto the site.

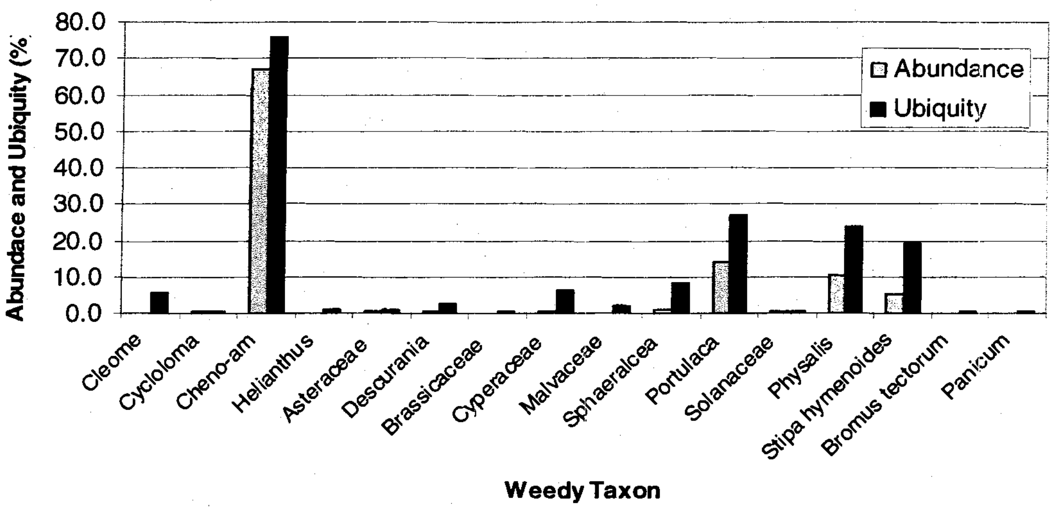

Figure 33 – Shields Pueblo Weedy Taxa Abundance* and Ubiquity**
* Abundance was calculated by the totalling the number of seeds for each category, and determining the percent of the total assemblage they represent.

** Ubiquity frequencies were calculated by determining the number of samples a taxon was present in as a percentage of all the samples.

Wild plants from a number of different plant communities were identified in Shields Pueblo's PII samples (Table 31). Overlap of wild species amongst communities prevents the identification of single source plant community. However, it should be noted that the majority of plants could be collected from two communities, pinyon-juniper woodlands and grasslands. Identified wild species included xeric plants such as hedgehog and prickly pear cacti, as well as a variety of fruit bushes. The fruit bushes include lemonade berry, wild rose, chokecherry, and four-wing saltbush. Prickly pear cactus seeds were the most ubiquitous and abundant wild taxa (Figure 34). The presence of bulrush achenes, although limited, suggests that the inhabitants had access to a water source, most likely the one located to the south of the Pueblo on Goodman Point (Kuckelman 2005).

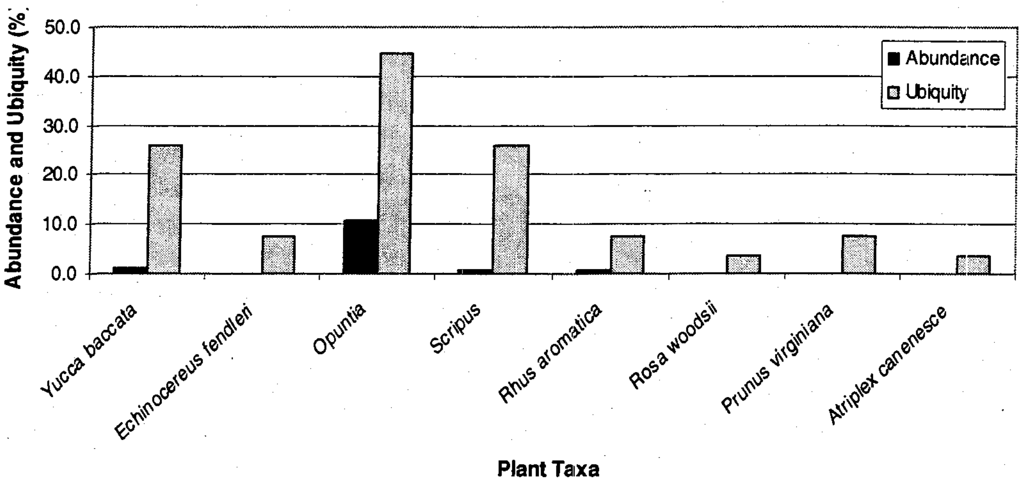

Figure 34 - Shields Pueblo Wild Taxa Abundance* and Ubiquity**
* Abundance was calculated by the totalling the number of seeds for each category, and determining the percent of the total assemblage they represent.
** Ubiquity frequencies were calculated by determining the number of samples a taxon was present in as a percentage of all the samples.

Species recovered from Shields Pueblo can be used to identify during which seasons the site was occupied. Plants, particularly seeds and fruits, can be used as indicators to determine if a site was occupied for a single or multiple seasons. Taxa recovered from Shields Pueblo include plants which fruit in the spring, summer, and fall. Tansy mustard and Indian ricegrass, a cool season grass (Doebley 1985), were the first plants available to the Pueblo's inhabitants following winter. During the summer the inhabitants collected the fruits of several wild and weedy plants including hedgehog and prickly pear cacti, beeweed, cheno-am, globemallow, purslane, and groundcherry. Non-domesticated plants recovered from Shields Pueblo that are fall occupation indicators include bulrush, winged pigweed, purslane, and groundcherry. The latter two species were also collected in the late summer. The presence of the aforemention taxa coupled with the extent of construction at the Pueblo suggest the inhabitants occupied the site year around.

In summary, Shields Pueblo's inhabitants utilised a wide range of botanical resources including domesticated and non-domesticated plants. The domesticated plants comprised of corn, squash, and cotton. Inhabitants collected wild succulents and fruit from various bushes as well as numerous weedy species. Plant communities utilised vary from grasslands to pinyon-juniper woodlands and illustrate the diversity of the inhabitant's plant collecting practices. These plant communities were used to fulfill not only their dietary, but also material needs.

Comparison

This following section will compare Shields Pueblo's PII archaeobotanical assemblage to that of seven sites: Gnatsville (Kent 1991), Mustoe (Gould 1982), Paintbrush (Varien 1999), Pinyon (Varien 1999), Kenzie Dawn Pueblo (Varien 1999), Hanson Pueblo (Morris *et al.* 1993), and Yellow Jacket (Kuckleman 2004) which occur within the same drainage unit, Monument-McElmo, as the Pueblo (Table 32). The architectural construct, excavation scope, features, and flotation sample volumes all varied between each site and with Shields, thus only plant presence absence will be considered.

Overall, Shields Pueblo contained the richest archaeobotanical assemblage of all the sites (Table 32). This may be in part due to the large number of flotation samples analysed from the Pueblo and/or the differing sampling methods employed by researchers both at the site and in the laboratory. Each site contained evidence of corn, but only Shields Pueblo had specimens of cotton and squash. Interestingly, beans were not present at any of the nine sites. The absence of this domesticate in the archaeobotanical assemblages likely reflects food preparation techniques and not consumption. Beans were primarily boiled prior to consumption rather than being roasted and as such the likelihood of their exposure to fire, and potential preservation in the archaeobotanical record is dramatically reduced (Whiting 1966).

Table - 32 Presence/Absence of Taxa of Contemporaneous Sites Located within the Monument/McElmo Drainage

Taxon	Shields Pueblo	Gnatsville	Mustoe	Paintbrush	Pinyon	Kenzie Dawn	Hanson	Yellow Jacket
Zea mays	X	X	X	X	X	X	X	X
Cucurbita	X							
Gossypium	X							
Yucca baccata	X			X			X	X
Cyperaceae	X							
Scripus	X					X		X
Poaceae								
Bromus tectorum	X							
Panicum	X							
Sporabolus		X						
Stipa hymenoides	X	X					X	X
Rhus aromatica var. *trilobata*	X							
Asteraceae	X	X						
Helianthus	X	X					X	
Brassica	X							
Descurania	X							
Echinocereus fendleri	X	X						X
Opuntia	X	X				X	X	
Cleome	X	X		X	X			
Atriplex canenesce	X							
Cheno-am	X	X		X	X	X	X	
Cycloloma	X							

Table 32 continued

Malvaceae	X	X						
Sphaeralcea	X						X	X
Eriogonum							X	
Polygonum				X				
Portulaca	X	X		X				X
Rosaceae	X							
Prunus virginiana	X							
Rosa woodsii	X							
Solanaceae	X							
Nicotiana					X			
Physalis	X	X			X	X	X	X
Boehmeria		X						
Juniperus	X	X	X		X	X	X	X
Ephedra	X						X	
Pinus	X	X	X	X		X	X	X
Artemisia	X			X		X	X	X
Artemisia tridentata	X							X
Chrysothamnus	X							
Atriplex	X							
Quercus	X			X	X		X	X
Amelanchier/Peraphyllum	X			X		X	X	X
Cercocarpus	X			X	X	X	X	X
Prunus/Rosa	X						X	
Purshia	X					X		X
Populus/Salix	X			X	X		X	

X - Presence; Sources: Adams 1991; Gould 1982; Kent 1991; Kuckleman 2003; Morris *et al.* 1993; Varien 1999

Wild taxa present in samples from the seven sites and Shields Pueblo include yucca, as well as hedgehog and prickly pear cacti. When low ubiquity taxa recovered from Shields Pueblo are excluded, the nine wild plant assemblages become more homogeneous, with one exception. Lemonade berry was present only at Shields Pueblo even though taxa which occupy the same plant community were identified in flotation samples from a number of the contemporaneous sites.

Cheno-am, groundcherry, purslane, beeweed, and Indian ricegrass were the five most common weedy taxa at the nine sites. However, a few anomalies were evident. For example Gnatsville produced two weedy taxa, *Boehmeria* and *Sporabolus*, which were not present at Shields Pueblo, or any of the other sites. Wild tobacco was only recovered from Pinyon Pueblo; the leaves of this plant were used in numerous ceremonies and smoked in reedgrass cigarettes (Adams 1990). The extremely small size of tobacco seeds, roughly 0.25 mm, may explain the absence of this taxon from Shields Pueblo as light fractions smaller than 0.25 mm were not sorted.

Of the four plant categories, the charcoal assemblages of the nine sites were quite similar. Juniper and pine charcoal were present at all but one site, demonstrating the repeated use of these trees by the Anasazi in the Monument/McElmo drainage. Sagebrush, serviceberry/peraphyllum, mountain mahogany, oak, cottonwood/willow, and bitterbrush were present in at least half of the sites archaeobotanical assemblages including Shields Pueblo (Table 32). Of note is the presence of rabbitbrush and four-wing saltbush solely in Shields Pueblo samples. Seed and charcoal taxa recovered from contemporaneous sites, indicates that the Anasazi collected plants from communities that contained rabbitbrush and four-wing saltbush(Table 32). However these specific taxa appear to have only been collected by Shields Pueblo inhabitants. Both taxa are reported to be used as fuel, as well as for ceremonial, utilitarian, and medicinal purposes (Stevenson 1915; Whiting 1966). Ephedra charcoal was only recovered from Shields and Hanson Pueblo. The limited presence of this wood was expected since ethnographies indicate that this plant was rarely used as a fuel by historic groups and primary boiled for medicine (Elmore 1944; Whiting 1966). Overall, the wood charcoal assemblage of Paintbrush Pueblo, Kenzie Dawn, Hanson Pueblo and Yellow Jacket Pueblo shared a majority of the charcoal taxa identified at Shields Pueblo.

Upon analysis of Shields Pueblo's archaeobotanical assemblage and comparison of it to those of contemporaneous sites a number of conclusions can be drawn. The Anasazi were agriculturalists who grew corn, squash, and likely beans. They collected a variety of wild xeric plants such as yucca and prickly pear cactus as well as fruiting bushes including lemonade berry, chokecherry, and wild rose. They also gathered weedy plants growing in disturbed soils, possibly along pathways or in fallow fields. The most abundant and ubiquitous weed was cheno-am. Groundcherry, purslane, and Indian ricegrass were also present in the site's archaeobotanical assemblage. The combination of wild and weedy plants, in addition to corn and squash, indicate that the Anasazi diet was varied and did not focus solely on the crops they grew (Brand 1994). Furthermore, the identified non-domestic taxa indicate that a number of different plant communities were utilised by the inhabitants for their dietary and material requirements. These communities include Pinyon/Juniper woodlands, grasslands, and sagebrush/saltbush.

Shields Pueblo's inhabitants collected plants similar to those of contemporaneous pueblos; however, due to more effective sampling methods, the Pueblo's assemblage contained the highest number of identified taxa. The charcoal assemblages are the most similar, when taxa of low frequency were removed from Shields Pueblo's assemblage. The seed and charcoal assemblages of the nine sites illustrates that the Anasazi did not limit their collection to a single plant community, but took advantage of all that the surrounding landscape contained. The contemporaneous sites assemblages support the concept that the Anasazi, including those living at Shields Pueblo, were farmers, who collected wild and weedy plants to supplement their diet, provide fuel, and fulfill material needs.

2. *What, if any, spatial and/or temporal variation exists in the Pueblo II period plant assemblage?*

This section will address spatial and temporal variation which is present in the Shields Pueblo archaeobotanical assemblage. Spatial variation will be discussed by individual architectural block and feature. Temporal variation will be addressed following the spatial variation and in the same manner. Also to be discussed are possible reasons for the variation that exists in the Pueblo's archaeobotanical assemblage.

Spatial Variation

Comparison of individual architectural blocks revealed noticeable variation in taxa richness. The 200 block contained only half the number of plant taxa present in the 100 and 1300 blocks. At first glance differences in species richness, especially wild and weedy plants appear to reflect differential plant collection by inhabitants of the blocks. However, the more likely explanation for this variation in species richness is sample size. Flotation sample size was highly variable between each architectural block. Samples collected from the 100, 200, and 1300 blocks totalled 81, 17, and 58 respectively. Additionally, only hearth features were sampled within the 200 block, whereas hearths and secondary refuses were sampled in the other two architectural blocks.

Assuming seed density reflects intensity of activities associated with past fires, these measures varied between the three blocks (Figure 35). Of particular interest is the 1300 block seed density. This block produced the highest seed density measure of the three blocks, but contained the second lowest number of flotation samples. This could suggest that activities involving plants and fire *e.g.* parching, cooking occurred with greater intensity in this area of the Pueblo. The 200 block also possessed a high seed density value, however only hearths were sampled from this block. The high density measures of the 1300 and 200 blocks suggests that hearths within these two blocks were most likely used to process plants for consumption.

The ubiquity of weedy taxa such as cheno-am, purslane, Indian ricegrass, and groundcherry within each block illustrates the repeated use of these species by Pueblo inhabitants (Figure 36). These weedy plants may have grown in disturbed soil near the Pueblo and supplemented the inhabitant's diet.

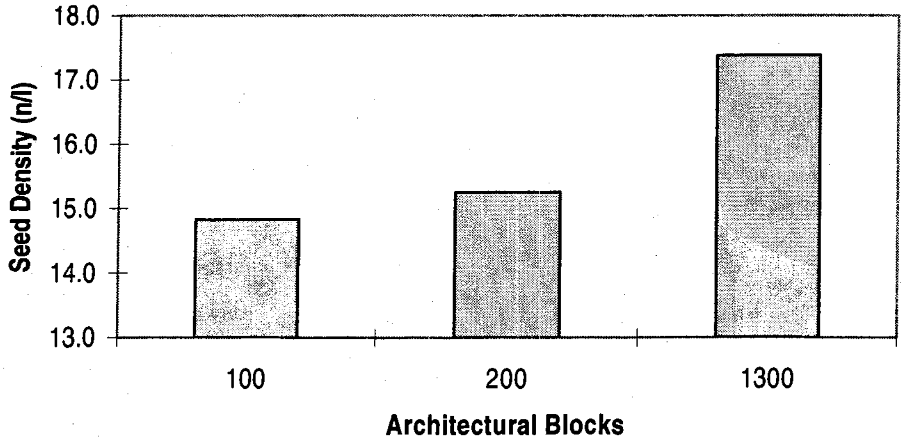

Figure 35 - Seed Density* of 100, 200, and 1300 Architectural Blocks
*Seed density was calculated by determining the number of seeds recovered per litre of sediment.

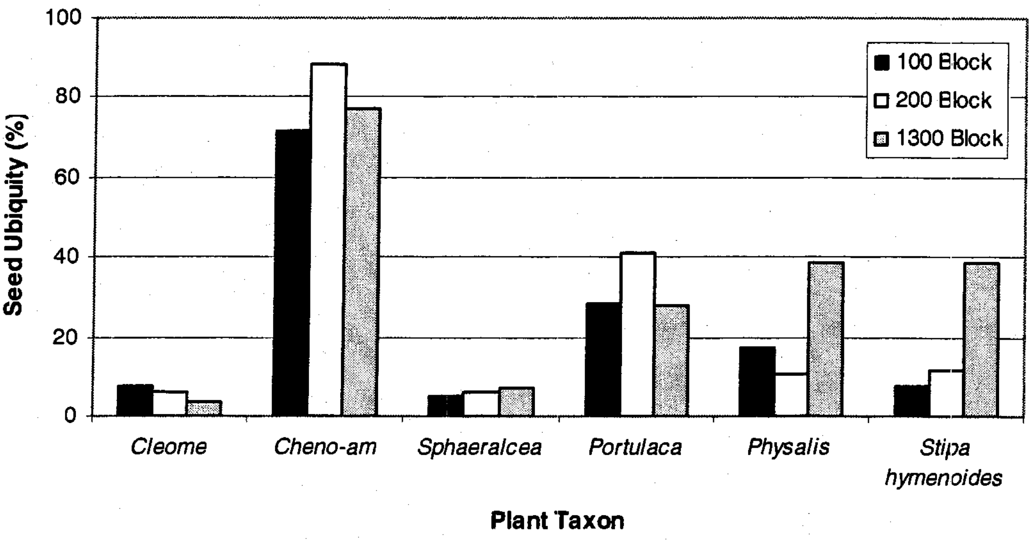

Figure 36 - Seed Ubiquity* of Taxa Present in 100, 200, and 1300 Blocks.
*Ubiquity frequencies were calculated by determining the number of samples a taxon was present in as a percentage of all the samples.

High corn cupule ubiquity in hearth and secondary refuse assemblages for the 100, 200, and 1300 blocks indicates that the entire pueblo had access to this food resource. The presence of corn cupules in hearths is likely the result of cobs being used as fuel after grains were removed. The use of this byproduct as fuel rather than a food source (Minnis 1988), implies that a sufficient amount of corn was being grown to feed Shields Pueblo's Anasazi. This idea is further supported through isotopic studies of the region, which indicate that there was no change in carbon isotope levels from Basketmaker III through to the abandonment of the region (Decker and Tieszen 1989).

Inhabitants of the 1300 and 100 blocks appear to have collected plants from all four of the local plant communities (Table 31), whereas the 200 block inhabitants could have collected all identified taxa from just two, Pinyon/Juniper Woodland and Sagebrush/Saltbush (Petersen and Adams 1999). The plants collected from these biotic communities are listed in historic ethnographies as sources of food, fuel, construction material, medicine, and material for ceremonial activities. Identified cool season grasses collected from grasslands, in addition to presence of summer and fall fruiting wild plants indicates that the Anasazi occupied this site for a minimum of three seasons, but likely lived in the Pueblo year round.

The charcoal assemblages for the three architectural blocks varied not only in richness, but also ubiquity. As mentioned above, inadequate sample size is the most likely explanation for species richness differences; however the ubiquity measures should be unaffected. The charcoal assemblage for the individual architectural blocks suggest that the inhabitants were selective in the fuels they collected (Figure 37). The 200 block inhabitants appear to have preferred sagebrush over both pine and juniper wood, a noticeable contrast to the 100 and 1300 blocks. Based on historic ethnographies sagebrush wood is a known source for fuel, tool making, and for ceremonial purposes (Elmore 1944; Stevenson 1915; Wyman and Harris 1951). The presence of other taxa in this block's assemblage known to be used for ceremonial purposes, such as globemallow (Stevenson 1915), suggests that ceremonial activities may have occurred within the 200 block.

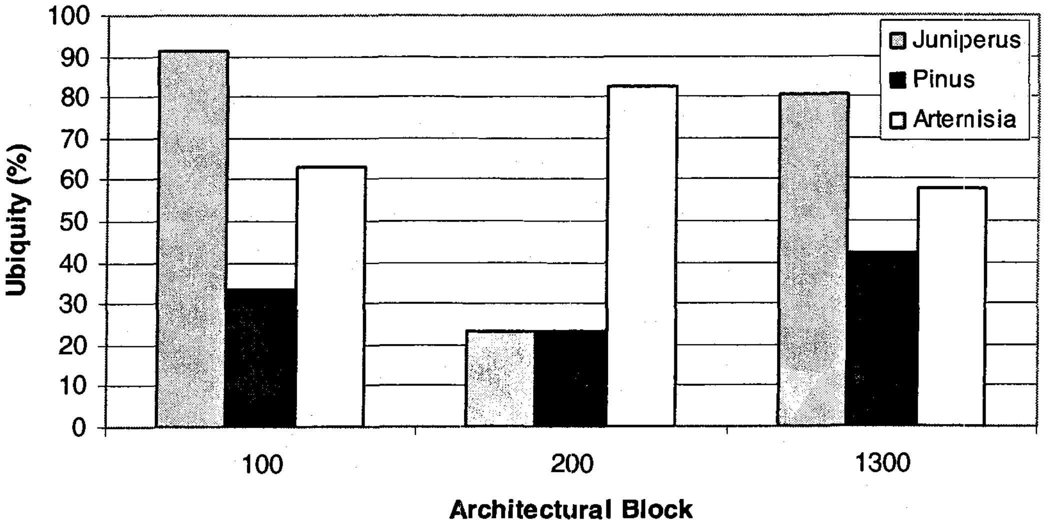

Figure 37 - *Juniperus, Pinus,* and *Artemisia* Charcoal Ubiquity* for the 100, 200, and 1300 Blocks.
*Ubiquity frequencies were calculated by determining the number of samples a taxon was present in as a percentage of all the samples.

Hearth assemblages for the architectural blocks further support the conclusion that the inhabitants collected plants from a number of different communities. If the number of taxa present for specific plant communities is used as a means of ranking the use of that community, 100 block inhabitants collected plants primarily from the pinyon/juniper woodland, grassland, and oak scrubland, followed by the sagebrush/saltbush community. Inhabitants of the two other blocks collected plants from the sagebrush/saltbush community over other available environs. Each architectural block is located approximately an equal distance from the plant communities; therefore, travel time is not a likely explanation for this variation (Petersen and Adams 1999; Varien 1999). Furthermore, controlled access to specific plant communities is not reason for the variation since plants from all four communities were present in each of the blocks' hearth assemblages.

One feature which differs significantly from others sampled at the Pueblo was non-structure 129 hearth, an extramural surface fire in pit. The hearth contained a total of 23 taxa, the greatest number of any 100 block hearth, as well as any feature at the site. The seed density was also the greatest of any feature, 79.3 seeds/l, at the Pueblo. This hearth contained the only specimen of cotton recovered from Shields Pueblo, as well as a seed belonging to squash. Other unique taxa recovered from this feature included chokecherry, lemonade berry, globemallow, yucca, and sunflower seeds, and oak charcoal. Low specimen counts of taxa recovered from this hearth and the presence of species which were only found within this feature, suggests that this hearth was used in a manner different from others found at the site. The location and identified plant assemblage suggests that this hearth may have been used to dispose of trash rather than for cooking, perhaps this feature is a burned refuse area rather than a hearth. The hearth is not located within a structure and inhabitants from the entire Pueblo had access to it and may have used it to discard unwanted material.

Temporal Discussion

The following discussion will focus on the temporal variation present in Shields Pueblo's archaeobotanical assemblage. The two periods investigated were: the Middle Pueblo II period (MPII) dating from A.D. 975 – 1050 and the Late Pueblo II Period (LPII), dating from A.D. 1050 –1150. The complete, hearth, and secondary refuse assemblages will be examined and discussed, and plausible reasons for any identified variation presented.

The MPII period assemblage overall produced of a total of 22 seed taxa whereas the LPII contained nearly double at 39. The added species present in the LPII period include not only wild and weedy taxa, but three additional domesticated plants: squash, squash family, and cotton. The cumulative frequency curves (Appendix F) for both assemblages fail to level indicating that the species richness variation identified is likely due to differences in sample size.

Plant category proportions for the two periods varied (Figure 38). The increased abundance of wild and weedy categories in the LPII may reflect a heavier reliance on non-domesticated plants. Reason for this shift could be attributed to environmental shifts in the LPII which would have made farming difficult and the inclusion of wild and weedy plants necessary (Van West and Dean 2000). A similar pattern has been documented in other palaeoethnobotanical studies in the Southwest (*e.g.*, Adams and Bowyer 2002; Matthews 1986; Murray and Jackson-Craig 2003)

A drop in the abundance of charcoal in the LPII could indicate a decrease in locally available wood sources. Ubiquity measures of shrubs *e.g.* sagebrush, rabbitbrush, and lemonade berry, increase in the LPII suggesting that the collection of these plants as fuel and for material needs became more frequent (Figure 39). This shift may also reflect an increase in aridity. Sagebrush charcoal ubiquity also increased from the MPII to the LPII. This species ubiquity may have changed as pinyon/juniper woodlands became depleted in the LPII and inhabitants sought alternate fuel sources *i.e.* decrease in trees and increase in shrubs. However, pine and juniper ubiquity values were constant or increased in the LPII; therefore, the depletion of these trees does not appear to be the cause for the increase in sagebrush ubiquity. Sagebrush is an early successional plant, spreading into fallow or abandoned fields. If one assumes that agricultural fields were located in relative proximity to habitation sites, a change in sagebrush ubiquity may reflect a change in land use surrounding the Pueblo, as fields located close to the Pueblo were abandoned possibly as a result of soil exhaustion or the result of climatic deterioration.

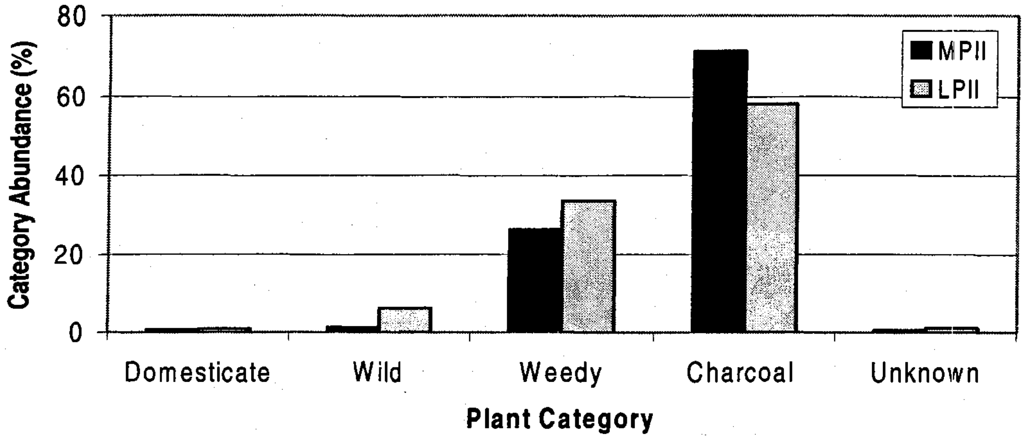

Figure 38 – Plant Category Abundance for Middle Pueblo II (MPII) and Late Pueblo II (LPII) Assemblages.
* Abundance was calculated by the totalling the number of seeds for each category, and determining the percent of the total assemblage they represent.

Temporal variation in corn cupule ubiquity could indicate a change in how corn cobs were being disposed. If cupules were incorporated into the archaeobotanical record through the burning of cobs as fuel, then a decrease in their ubiquity may represent a shift in this practice. Corn cupule ubiquity decreases from the MPII to the LPII by nearly 14.0%. This drop in ubiquity, coupled with the start of a period of prolonged drought in the LPII (Van West and Dean 2000), may reflect the use of corn cobs as a source of food rather than fuel (Minnis 1989). A decrease in corn yields due to climatic shifts could have forced the Anasazi to process all available food sources including cobs. The grinding of cobs as a famine food is recorded in historic plant enthographies and may be one possible explanation for their decreased ubiquity in the LPII archaeobotanical record.

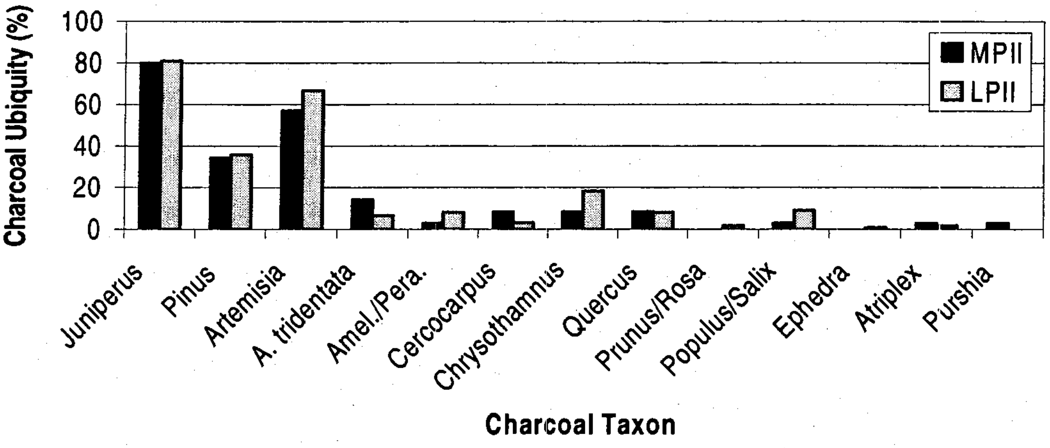

Figure 39 – Charcoal Ubiquity* of Middle Pueblo II (MPII) and Late Pueblo II (LPII) Assemblages.
*Ubiquity was calculated by determining the number of samples
a taxon was present as a percentage of the total sample assemblage.

Weedy taxa were the most ubiquitous and abundant plants recovered from both periods. These species include cheno-am, groundcherry, purslane, and Indian ricegrass. Prickly pear was the sole wild plant that consistently ranked in the top five based on abundance for both periods. Those taxa identified to the genus level which were present in both the MPII and LPII assemblages frequently possessed higher abundance values in the LPII, with the exception of cheno-am, globemallow, and Indian ricegrass. The higher LPII values may reflect an increase collection/use of these resources during this period.

The pattern of seed measures being greater in LPII is repeated when comparing ubiquity data. Those seed taxa identified to genus, and present in both the assemblages, were more ubiquitous in 6 out of 10 cases in the LPII (Figure 40). The exceptions were bulrush, groundcherry, and Indian rice grass, which were more abundant in the MPII. Seed abundance and ubiquity measures of those species recovered from both assemblages indicate that a number of taxa were being collected and incorporated into the archaeobotanical record in great abundance and with increased frequency in the LPII. Also evident in the LPII is an increase in the ubiquity of plants that can tolerate aridity *e.g.,* yucca, prickly pear, and purslane. These changes may be the result of the inhabitants adjusting to changing social and environmental conditions such as environment degradation and population growth occurring in the LPII.

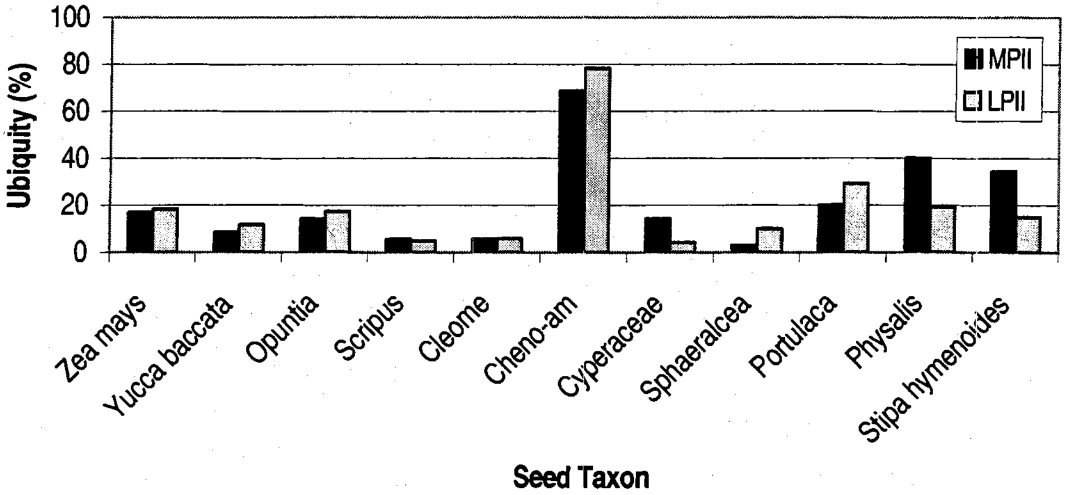

Figure 40 – Seed Ubiquity* of Taxa Present in both the Middle Pueblo II (MPII) and Late Pueblo II (LPII) Assemblages.
*Ubiquity was calculated by determining the number of samples a taxa was present as a percentage of the total sample assemblage.

Seed taxa recovered from hearths were richer in the LPII than MPII, however sample size is likely the factor for this variation. MPII hearths were comprised of 13 samples *versus* 56 for LPII. Wild taxa were more abundant and ubiquitous in LPII contexts than their earlier counterparts and weedy species present in both assemblages were more abundant in LPII hearths with the exception of cheno-am and globemallow. Seed ubiquity values were also greater in LPII hearths for all but cheno-am. The increased abundance and ubiquity of weedy and wild taxa in LPII hearths suggest a marked and repeated reliance of these plants towards the end of the PII period.

The distributions of domesticate and charcoal categories of LPII and MPII hearths were similar, however wild and weedy category abundance varied (Figure 41). This shift in wild and weedy plant abundance may reflect a preference MPII inhabitants had for weedy plants, or they may have collected weedy plants due to their close proximity to their fields and/or habitation sites, or increase in disturbance of soil due to farming. The increase in wild plants in the LPII is interesting, however a number of those wild, and in a number of cases weedy, species were represented by only a few specimens. Therefore, although there is an increase in the number of seed taxa identified their abundance and ubiquity measures suggest that this is a chance occurrence. Studying Shields Pueblo's Pueblo III (PIII) archaeobotanical assemblage may indicate if this change in taxa abundance continues through time and if the collection of these plants becomes more abundant and ubiquitous. If these measures do increase in the PIII then the increased species richness present in the LPII may be an early indicator of dietary changes that become more prominent in the PIII.

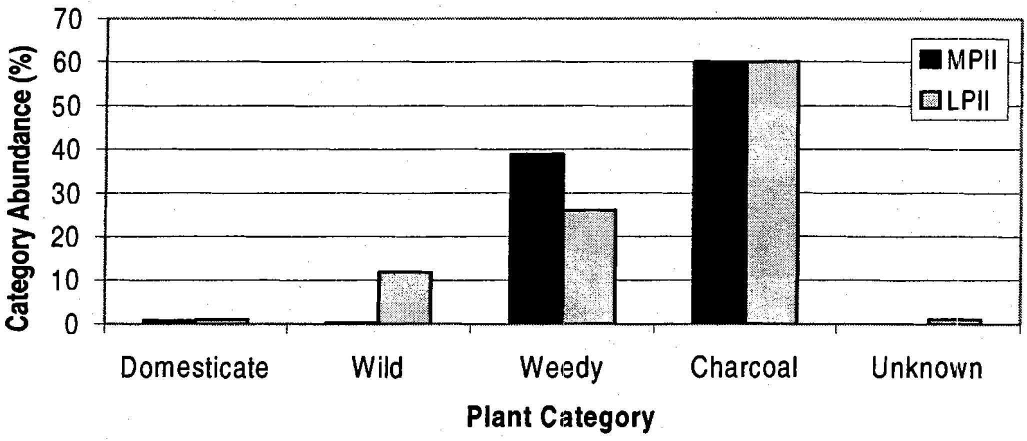

Figure 41 – Plant Category Abundance of Middle Pueblo II (MPII) and Late Pueblo II (LPII) Hearths.
* Abundance was calculated by the totalling the number of specimens for each category, and determining the percent of the total assemblage they represent.

Overall the charcoal category abundance was the same for hearths of both periods; however a greater number of charcoal taxa were identified in the LPII period. Those charcoal species present in both assemblages were more ubiquitous in the MPII than the LPII with the exception of sagebrush and serviceberry/peraphyllum. The increased ubiquity of sagebrush in comparison to pinyon and juniper in the LPII may reflect a shift in availability of these trees (Figure 42). Sagebrush was present in LPII hearth samples with almost the same frequency as juniper, however pine ubiquity drops significantly from MPII to LPII.

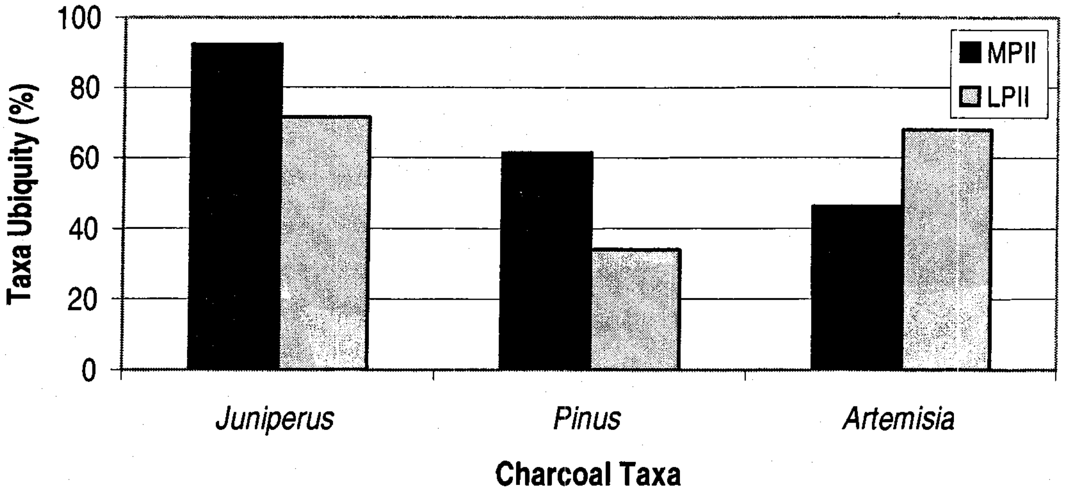

Figure – 42 *Juniperus, Pinus,* and *Artemisia* Charcoal Ubiquity* of the Middle Pueblo II (MPII) and Late Pueblo II (LPII) Hearth Assemblages.
*Ubiquity was calculated by determining the number of samples a taxa was present as a percentage of the total sample assemblage.

The shift in ubiquity values for these three taxa suggests that inhabitants were collecting sagebrush more frequently in the LPII than in earlier times. What caused this shift may be tied to a decline in pine availability, or the encroachment of sagebrush in abandoned fallow fields, therefore making it more readily available, or it may represent a purposefully shift in wood preference by the Pueblo's inhabitants.

Contrary to hearths, secondary refuse assemblages represent a greater time depth and also a mixing of behavious, thus providing information on long-term plant use habits. Plant category abundances for secondary refuse assemblages show distinct differences from both periods (Figure 43). Charcoal forms a greater proportion of the MPII secondary refuse assemblage than the LPII. It was also greater than the assemblages recovered from middle and late PII hearths. The greater abundance of this category in the MPII implies that hearth fuel was not lacking for the inhabitants at that time. Corn cupule ubiquity, which varied only slightly in hearth assemblages, drops significantly in the LPII secondary refuse assemblage, roughly 20%. This drop suggests that although present in the final fires of hearths dated to both periods, as the period progresses the frequency with which cobs were being burned was decreasing.

The increase abundance of LPII weedy category in comparison to the MPII is clearly apparent. Although weedy plants constitute a smaller proportion of the LPII hearth assemblage, they form a significantly larger proportion of the secondary refuse assemblage. Alternatively wild plants appear to have played less of a role in inhabitant's diets over time based on their low category abundance in both middle and late PII refuses.

The ranking of seed taxa, based on abundance measures, in secondary refuses dated to the MPII and LPII were similar (Table 33). Cheno-am, groundcherry, Indian rice grass, prickly pear, and purslane ranked, although in varying order, in the top five in both assemblages. The abundance of these taxa in secondary refuses dated to both periods indicates that these five plants were routinely targeted for collection by inhabitants. Ubiquity measures of these same species were among the highest of those identified and further support the importance of these taxa. All five of these plants are reported in historic ethnographies as foodstuffs (Stevenson 1914; Swank 1932; Whiting 1966).

Table 33 – Secondary Refuses Seed Taxa Ranking by Abundance

Rank	Middle Pueblo II	Late Pueblo II
1	Cheno-am	Cheno-am
2	Groundcherry	Purslane
3	Indian Ricegrass	Prickly Pear
4	Prickly Pear	Groundcherry
5	Purslane	Indian Ricegrass

Charcoal ubiquity of the most frequently recovered charcoal *e.g.* juniper, pine, and sagebrush, varied in MPII and LPII secondary refuse assemblages (Figure 43). The rank order of the charcoal based on ubiquity remained constant, however the ubiquity of the charcoal changed. Pine charcoal was more frequently recovered from LPII secondary refuses than MPII. Those charcoal taxa present in both assemblages were more ubiquitous in the LPII, with the exception of mountain mahogany.

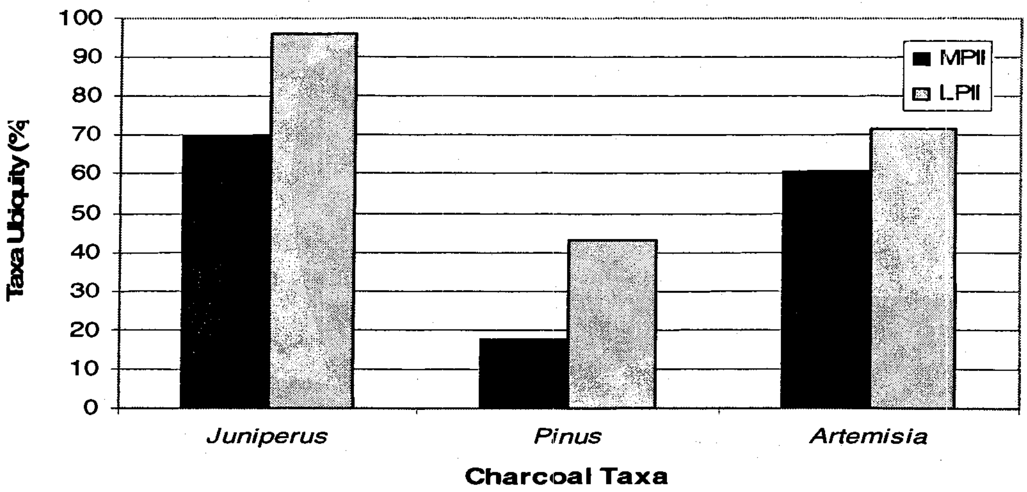

Figure 43 – Middle Pueblo II (MPII) and Late Pueblo II (LPII) *Pinus, Juniperus,* and *Artemisia* Charcoal Ubiquity*
*Ubiquity was calculated by determining the number of samples a taxa was present as a percentage of the total sample assemblage.

The increase ubiquity of these species in the LPII suggests that these charcoals were being collected with greater frequency than in the MPII. And although the hearth assemblages suggest a decrease in pine and juniper ubiquity in the last fires dated to the LPII, secondary refuses indicate that these taxa were used to a greater degree by the inhabitants in the LPII than the MPII. The increased ubiquity of pine and juniper in the LPII indicates that these trees were locally available at the terminus of the PII and that the Anasazi were still relying upon them as their main source of fuel.

Summary

A number of conclusions can be drawn from the spatial and temporal variation present in Shields Pueblo's archaeobotanical assemblage. Throughout the PII period, inhabitants of the 100, 200, and 1300 architectural blocks grew and/or had access to corn. Although the ubiquity varied between blocks, corn routinely was recovered from 79% or more of the samples analysed. A decrease, 14%, of cupules in contexts dated to the LPII may reflect a drop in corn yields or a change in the use and/or disposal of corn cobs. A decrease in cupule ubiquity over time is also evident at other sites in the study area including Yellow Jacket Pueblo (Murray and Jackson-Craig 2003).

Wild and weedy plants were routinely collected by the inhabitants of all three blocks in both periods. The ubiquity and abundance of weedy taxa, such as cheno-am, tansy mustard, purslane, indicates the importance placed on these taxa by the Pueblo inhabitants. These taxa were also recovered from numerous sites in close proximity to Shields Pueblo (Adams 1993, 1999; Adams and Bowyer 2002; Matthews 1986; Morris *et al. 1993;* Murray and Jackson-Craig 2003; Rainey and Jezik 2002) as well as other sites in the northern American Southwest (Doebly 1981; McBride 1993; Toll 1981, 1983; Wetterstrom 1986). The widespread and repeated occurrence of taxa such as cheno-ams, purslane, ricegrass, yucca, prickly pear and hedgehog cacti, and groundcherry in archaeobotanical assemblages throughout the region illustrates the mixed foraging/farming subsistence strategy used by the Anasazi to fulfill their dietary needs.

The most distinct architectural block was the 200. This block contained the least number of identified seed taxa, however it is the charcoal assemblage that is most interesting. The inhabitants of this block appear to have preferred sagebrush wood over all other available species. The variation in this block's hearth assemblage suggests that activities associated with the last hearth fires of the 200 block may reflect activities other than food processing such as ceremonial practices (Elmore 1944, Swank 1932; Whiting 1966).

The LPII assemblage indicates an increase in abundance and ubiquity of those taxa identified in both assemblages, especially wild and weedy plants. This suggests a broadening of the diet, perhaps to adapt to environmental fluctuation (Van West and Dean 2000; Minnis 1985a). An additional explanation for the increase in ubiquity and abundance of weedy taxa over time may be linked to greater anthropogenic disturbance (Adams 2004; Adams and Bowyer 2002; Ford 1984). Soil disturbance, as a result of clearing vegetation from land to expand farm fields, encourages the growth of weedy taxa. These economic annuals could be harvested with domestic crops and used to supplement the Anasazi's diet (Brand 1994; Matthews 1986; Toll 1983).

As populations grew in the PII, and continued to grow in the PIII period, expansion and intensification of maize agriculture would have been required to support the growing population in the region (Adler 2002), as well as at Shields Pueblo. Coupled with population growth were climatic shifts and a shortening of the growing season (Van West and Dean 2000), these factors would have placed added pressure on maize agriculture. The increased ubiquity of drought tolerant plants in the LPII assemblage may reflect decline in taxa that are water sensitive. Also the increased number of species in the LPII, albeit likely due to sample size, may reflect a broadening of the inhabitant's diet and studying the abundance of these taxa in the Pueblo's PIII archaeobotanical assemblage could prove or refute this conclusion.

3. What data, if any, are missed by sub-sampling light fraction using the 'species area curve' method?

Sixteen flotation samples from a variety of contexts were randomly selected for inclusion in this experiment. The archaeobotanical assemblage resulting from the 'species area curve' technique identified a total of 547 specimens representing 25 taxa. However, when the 16 samples were completely analysed an additional 2 taxa and 167 specimens were recovered. The sole identified domesticate was corn. Wild plants recovered from both assemblages include yucca, bulrush, prickly pear, lemonade berry, and saltbush. Numerous weedy taxa were also identified such as cheno-am, purslane, groundcherry, beeweed, and Indian ricegrass. The samples also yielded eight species of charcoal including pine, juniper, sagebrush, rabbitbrush, and saltbush.

If samples were grouped by context, four taxa were missed from secondary refuses whereas only two taxa were missed from hearths when using the 'species area curve' method. This suggests that samples from secondary refuse contexts should be sub-sampled more thoroughly or completely sorted (Figure 44). The majority of the taxa and specimens recovered, when sub-sampled, continued to be taken until no light fraction remained, occurred in three particle size categories 1.2 mm, 0.71 mm, and 0.25 mm. The distribution of the plant remains in these categories indicates that these three particle sizes should be sub-sampled more intensively to ensure the recovery of all possible taxa.

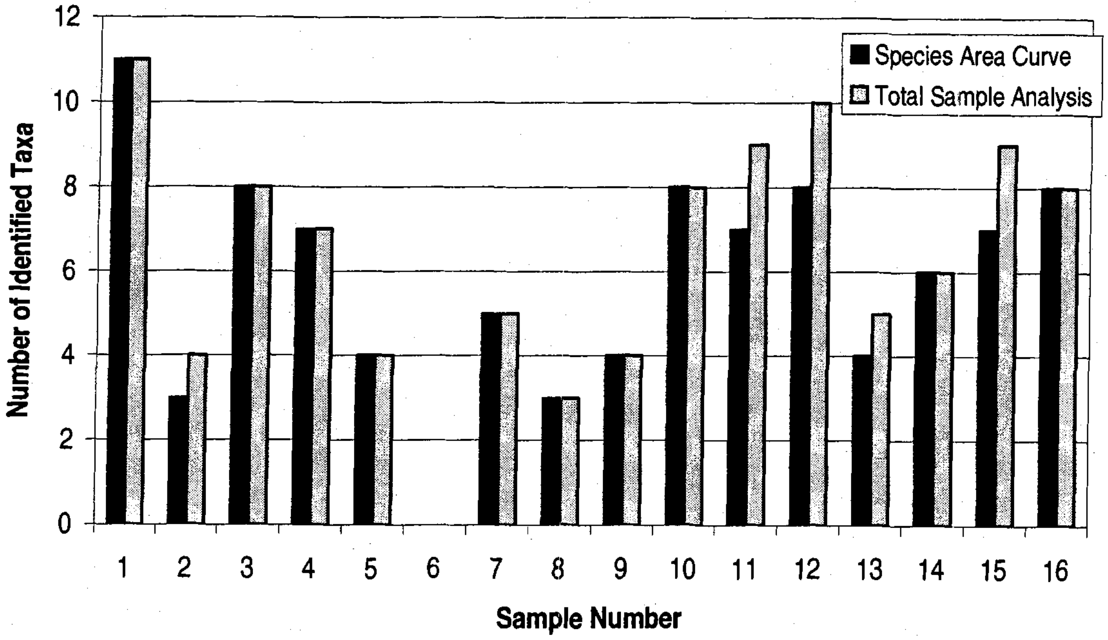

Figure 44 - Species Richness by Analysis Method
Note- samples 4, 10, 11, and 12 are secondary refuses.

If the 16 samples are considered individually five samples contained five taxa which the 'species area curve' sub-sampling method would have missed (Figure 44). However, when the assemblages of these five samples were compared to others, not included in this experiment but collected from the same context, all but one of the missed taxa, unknown grass 2, were recovered. This suggests that at the very minimum two 1 litre samples from each context should be analysed to reduce the chance of missing taxa when using the 'species area curve' method of sub-sampling.

A number of conclusions can be drawn from the results of this experiment. First, the "species area curve" method of sub-sampling is an adequate technique to characterise the general nature of a site's archaeobotanical assemblage. Second, secondary refuse contexts should be intensively sub-sampled or sorted completely as these samples yield more missed taxa than hearth samples included in this study. Thirdly, light fraction from sieves smaller than 1.2 mm should be sampled thoroughly or analysed completely; especially since weedy and wild taxa tend to accumulate in these sieves. The number of additional sub-samples should be increased to reduce the number of taxa that are missed when applying the 'species area curve' sub-sampling technique to these sieve sizes.

Conclusion

The research questions discussed in the beginning of this thesis are individually addressed in detail in this chapter. Archaeobotanical analysis of Shields Pueblo flotation samples has produced a detailed picture of not only the plants present in the samples, but also the different plant communities utilised by the Pueblo inhabitants. A total of 43 domesticated, wild and weedy taxa was recovered from PII samples and represent environments ranging from open grasslands to pinyon/juniper woodlands. Spatial variation at the Pueblo, particularly in the 200 block, suggest that activities other than those associated with food processing occurred in some of the last fires of PII period hearths. Temporal variation at the Pueblo is interesting and may reflect adjustment by the Anasazi to climatic shifts, shortening growing seasons, and population growth. The final portion of this chapter addresses the methodological component of this thesis. The 'species area curve' sub-sampling experiment results indicate that this method of sampling is a suitable technique to use to obtain an overall view of an archaeobotanical assemblage. However, this technique does have its pitfalls and should be used with a certain measure of caution.

CHAPTER EIGHT
CONCLUSION

Shields Pueblo

The analysis of Shields Pueblo flotation samples provided insight into plant use at the Pueblo during the PII period. Shields Pueblo's archaeobotanical assemblage demonstrated that the inhabitants practiced a mix of subsistence strategies. Domesticated crops such as corn and squash were grown and wild and weedy plants such as succulents and grasses were collected from a variety of surrounding plant communities. In addition to the collection of identified plants for food, historic ethnographies indicate that identified taxa were also collected for utilitarian, medicinal, and ceremonial purposes.

Spatial and temporal species richness variation present in the Pueblo's archaeobotanical assemblage is tied to inadequate sampling of the site. However, differences in other measures such as seed density, ubiquity, and abundance, as well as charcoal ubiquity illustrate the presence of variation in the archaeobotanical assemblage. Of the spatial variation detected, differences in charcoal ubiquity amongst the three architectural blocks studied was the most intriguing and suggests that inhabitants of one block, the 200, selected sagebrush over all other available wood sources.

Temporal variation between the Middle Pueblo II (MPII) and the Late Pueblo II (LPII) suggests that the inhabitants were adjusting to changes to their surrounding environment. Decreased corn cupule ubiquity and increased abundance and ubiquity of wild and weedy plants in the LPII suggest that the inhabitants were modifying their diet to suit their evolving needs. Shifts in the environment and expanding populations in the PII are two plausible reasons for this temporal variation.

Sub-sampling Experiment

This simple experiment determined that the 'species area curve' method of sub-sampling was an adequate means of recovering a comprehensive archaeobotantical assemblage, providing more than one sample was sorted from each context. If only a single sample from a context was sorted using the 'species area curve' sub-sampling method, plant taxa were missed, thus data were lost. Flotation samples should be sorted in their entirety to recover all possible taxa from contexts where only a single sample is available. If the focus of a research question requires total counts, the entire sample should be sorted rather than a portion and the resulting counts extrapolated. Sub-sampling techniques may reduce the time spent at the microscope, however rare taxa could be missed and over estimation of total specimen counts may occur. However if the objective of the research is solely to identify the suite of plants used and numerous samples will be sorted, then the 'species are curve' sub-sampling method is a suitable technique.

Research Contribution

The research undertaken for this thesis contributes to archaeobotany in the Southwest and on a more general level in two key ways. First, the research provides a detailed and comprehensive account of plants utilised by the Anasazi at Shields Pueblo during the Pueblo II period. Archaeobotanical research conducted at contemporaneous sites has been limited in scope, whereas the scope of Shields Pueblo's assemblage provides researchers with a strong basis for comparison. Information gathered from historic enthographies when coupled with the identified plants provided insight into plausible uses and activities associated with the recovered plants. Comparison of the archaeobotanical remains to plants present in surrounding environs gave insight into the plant communities targeted by the inhabitants.

The second contribution of this research pertains to the sub-sampling experiment. The results of this experiment indicate the importance of determining a sampling strategy early on in a project and to consider how the resulting data will be used to answer posed research questions. It also provided insight into how sampling methods can affect the resulting archaeobotanical assemblage and present guidelines to consider when using the 'Species Area Curve' sampling technique.

Future Research

The following are a number of possible areas for future research. Not all the topics were formulated from the work conducted within the scope of this thesis, some pertain to archaeobotany research in general.

First, the continued excavation and collection of sediment samples from Pueblo II sites in the Monument/McElmo drainage will provide data on which a wider regional comparison can be made regarding Anasazi plant use in the central Mesa Verde region during this period. Comparison of Shields Pueblo to Goodman Point Pueblo, a large site located directly south of Shields and currently being investigated by Crow Canyon Archaeological Center, may provide insight into plant use within these closely situated and contemporaneous communities. Furthermore, comparison of Shields Pueblo PII plant assemblage to those of earlier and later occupations at the Pueblo will provide insight into long-term plants use at the Pueblo as well as determine if variation identified in the PII exists in other periods of occupation.

Secondly, previous research has focused on using the location of a hearth and its archaeobotanical remains to determine the function of a hearth and/or structure (Kent 1981). An alternative application would be focusing on the different construction styles of hearths. Hearths sampled at the Pueblo were constructed in a variety of manners *e.g.,* earthen, slab-lined, and plastered. Comparison of plant remains collected from hearths of different construction in addition to their location may provide further insight into a hearth or structure's purpose.

Thirdly, the continuation of the 'species area curve' sub-sampling experiment but encompassing a larger sample population would be beneficial to archaeobotanical research in general. This experiment was limited in its scope and the inclusion of additional contexts and a greater number of samples may identify new potential problems or benefits of this technique, as well as support or refute the conclusions drawn within this thesis.

The final topic is an archaeobotanical 'housekeeping' issue. Inevitably most archaeobotanical reports include the family category Poaceae, where the majority of grass caryopses are lumped. Establishing a standarised set of grass identification guidelines and the formulation of the resulting data into a large database, possibly web based, may reduce the number of specimens placed in this catchall category. The systematic collection, charring, and morphological description of grasses by researchers in their respective geographic regions of study, combined with an unidentified caryopses database, may result in some headway being made on this issue.

Conclusion

Archaeobotanical studies in the American Southwest have provided researchers with a wealth of information on the Anasazi and their relationship with plants. The goal of the research undertaken within this thesis was to gain insight into the Pueblo II period and evaluated sub-sampling methods. The resulting thesis contributes to the current archaeobotanical knowledge, in addition to planting ideas for areas of future research.

APPENDICES

Appendix A	Flotation Analysis Results by Individual Sample
Appendix B	Crow Canyon Archeaological Center Water Flotation Process
Appendix C	Common and Scientific Names of Identified Taxa
Appendix D	Archaeobotanical Assemblage by Individual Context
Appendix E	Archaeobotanical Assemblage by Flotation Sample
Appendix F	Spatial and Temporal Cumulative Frequency Curves
Appendix G	Sub-sampling Experiment Flotation Analysis Form
Appendix H	Sub-sampling Experiment Individual Sample Summary

Note: Appendices can be found on the enclosed CD-ROM and are accessible using Adobe Acrobat Reader.

REFERENCE LIST

Adams, K. A.

1980 *Pollen, Parched Seeds and Prehistory: A Pilot Investigation of Prehistoric Plant Remains from Salmon Ruin, A Chacoan Pueblo in Northwestern New Mexico.* Eastern New Mexico University Contributions in Anthropology Vol. 9. Llano Estacado Center for Advanced Professional Studies and Research, New Mexico.

1990 Prehistoric reedgrass (*Phragmites*) "cigarettes" with tobacco (*Nicotiana*) contents: a case study from Red Bow Cliff Dwelling, Arizona. *Journal of Ethnobiology* 9(2):200-205.

1993 Carbonized Plant Remains. In *The Duckfoot Site, Volume 1, Descriptive Archaeology*, edited by R. Lightfoot and M. C., pp. 195-220. Occasional Paper No. 3. Crow Canyon Archaeological Center, Cortez, Colorado.

1994 A regional synthesis of *Zea mays* in the prehistoric American Southwest. In *Corn and Culture in the Prehistoric New World*, edited by S. Joannessen and C.A. Hastorf, pp. 273-302. Westview Press, Boulder, Colorado

1998 *Plant Remains from State Route 87 Sites.* Ms. on file, Statistical Research, Inc., Tucson, Arizona.

1999 Macrobotanical Remains. In *The Sand Canyon Archaeological Project: Site Testing*, edited by M. D. Varien. CD-ROM, Version 1. Crow Canyon Archaeolgoical Center, Cortez, Colardo

2000 Looking Back Through Time: Southwestern U.S. Archaeobotany at the New Millennium. In *Ethnobiology at the Millennium Past Promise and Future Prospects*, edited by Richard I. Ford Anthropological Papers Museum of Anthropology, University of Michigan Number 91, The Museum of Anthropology, Ann Arbor, Michigan.

2004 Anthropogenic Ecology of the North American Southwest. In *People and Plants in Ancient Western North America*, edited by Paul E. Minnis pp. 167-204. Smithsonian Books, Washington.

2004a *Archaeobotanical Analysis: Principles and Methods.* Available: http://www.crowcanyon.org/plantmethods. Date of use: 05/11/2003.

Adams, K. A. and V.E. Bowyer

1998 *Plant Use in the Sand Canyon Locality, A.D. 1180-1280.* Ms. On file, Crow Canyon Archaeological Center, Cortez, Colorado.

2002 Sustainable Landscape; Thirteenth-Century Food and Fuel Use in the Sand Canyon Locality. In *Seeking the Center Place; Archaeology and Ancient Communities in the Mesa Verde Region*, edited by Mark D. Varien and Richard H. Wilshusen, pp.123-142. The University of Utah Press, Salt Lake City, Utah.

Adams, K. A. and R. E. Gasser

1980 Plant microfossils from archaeological sites: research considerations and sampling techniques an approached. *The Kiva* 45(4):292-300.

Adams, Karen R., and Shawn Murray

2004 *Identification Criteria for Plant Remains Recovered from Archaeological Sites in the Central Mesa Verde Region* [HTML Title]. Available: http://www.crowcanyon.org/plantID. Date of use: 15/02/2005.

Adams, K. A. and K. L. Petersen

1999 Environment. In *Colorado Prehistory: A Context for the Southern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp.14-49. Colorado Council of Profession Archaeologists, Denver, Colorado.

Adler, M. A.

1986 *Report on Non-collection Reconnaissance of Goodman Point Ruin.* Crow Canyon Archaeological Center, Cortez, Colorado.

1990 *Communities of Soil and Stone: An Archaeological Investigation of Population Aggregation Among the Mesa Verde Region Anasazi, A.D. 900 – 1300.* Ph.D. dissertation, University of Michigan. Ann Arbor, Michigan.

1992 The Upland Survey. In *The Sand Canyon Archaeological Project: A Progress Report*, edited by W.D. Lipe, pp. 11-23. Occasional Paper No. 2. Crow Canyon Archaeological Center, Cortez, Colorado.

1996 *The Prehistoric Pueblo World, A.D. 1150 – 1350.* University of Arizona Press, Tucson, Arizona.

Anderson, E.

1950 Food, cultivated. In *The Stratigraphy and Archaeology of Ventana Cave, Arizona*, edited by E. W. Haury, pp. 161-163. The University of Mnew Mexico Press, New Mexico.

Anderson, E. and Blanchard
1942 Prehistoric Maize from the Canon del Muerto. *American Journal of Botany* 29:832-835.

Bartlett, R. A.
1962 *Great Survey of the American West.* Univeristy of Oklahoma Press, Norman, Oklahoma.

Bayman, J. M., M R. Palacios-Fest, and L. W. Huckell
1997 Botanical signatures of water storage duration in a Hohokam reservoir. *American Antiquity* 62(1):103-111.

Billman, B. R., C. M. Berg, E. Hansen, J.G. Ellis, and P.M. Lambert
1997 Site Descriptions. In *The Archaic Period Occupation of the Ute Mountain Ute Piedmont,* edited by B. R. Billman, pp. 3.1-3.317. Publications in Archaeology No. 21 (draft report). Soil Systems Inc., Phoenix, AZ.

Billman, B. R., P. M. Lambert, R. Leonard
2000 Cannibalism, Warfare, and Drought in the Mesa Verde Region During the Twelfth Centry A. D. *American Antiquity* 65(1): 145-178.

Blinman, E., C. J. Phagan, and R. H. Wilshusen
1988 *Dolores Archaeological Program: Supporting Studies: Additive and Reductive Technologies* U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver.

Bodner, C. C. and R. M. Rowlett
1980 Separation of bone, charcoal, and seeds by chemical flotation. *American Antiquity* 45:110-116.

Bohrer, V. L.
1962 Nature and interpretation of ethnobotanical materials from Tonto National Monument. In *Archaeological Studies at Tonto National Monument, Arizona,* by Charlie R. Steen, Lloyd M. Pierson, Vorsila L. Bohrer, and Kate Peck Kent, pp. 75-114. Southwestern Monuments AssociationTechnical Series Vol. 2, Globe, Arizona.

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

1975 The Prehistoric and Historic Role of the Cool-Season Grasses in the Southwest. *Economic Botany* 29:199-207.

1986 Guideposts in ethnobotany. *Journal of Ethnobiology* 6:27-43.

Bohrer, V.L. and K. R. Adams
1977 Ethnobotanical techniques and approaches at Salmon Ruin, New Mexico. *Eastern New Mexico University Contributions in Anthropology* 8(1):1-215.

Brand, M.
1994 *Prehistoric Anasazi Diet: A Synthesis of Archaeological Evidence.* Unpublished master's thesis University of British Columbia, Vancouver, B.C.

Breternitz, D. A.
1986 Archival Excavation: Notes on Early Basketmaker III Sites in Mancos Canyon, Colorado. *The Kiva* 51:263-264

1993 The Dolores Archaeological Program: In Memoriam. *American Antiquity* 58(1):118-125.

Breternitz, D. A., A. H. Rohn, Jr., and E. A. Morris
1986 *Dolores Archaeological Program: Final Synthetic Report,* U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver.

Brown, D. E.
1982 Biotic communities of the American Southwest – United States and Mexico. *Desert Plants* 4(1-4) Special Issue.

Burns, B. T.
1983 *Simulated Anasazi Storage Behavior Using Crop Yields reconstructed from Tree Rings: Dates A.D. 652-1968.* Ph.D. dissertation, University of Arizona. University Microfilms, Ann Arbor, Michigan.

Callaway, D., J. Janetski, and O.C. Stewart
1986 Ute. In *Handbook of North American Indians, Vol. 11, Great Basin,* edited by Warren L. d;Azevedo. Smithsonian Institution, Washington, D.C.

Castetter, Edward F.
1935 *Uncultivated Native Plants Used as Sources of Food.* Ethnobiological Studies in the American Southwest No. 1. University of New Mexico, Albuquerque.

Cattanach, George S., Jr.
1980 Refuse. In *Long House, Mesa Verde National Park, Colorado* edited by George S. Cattanach Jr., pp. 369-398. Publications in Archaeology 7H, Wetherill Mesa Studies. National Park Service, US Department of the Interior, Washington, D.C

Chamberlin, R. V.
1906 Some Plant Names of the Ute Indians. *American Anthropologist* 11:27-40.

Chisholm, Brian, and R. G. Matson
1994 Carbon and Nitrogen Isotopic Evidence on Basketmaker II Diet at Cedar Mesa, Utah. *Kiva* 60:239-255.

Chomko, Stephen A. and Gary W. Crawford
1978 Plant husbandry in prehistoric eastern North America: new evidence for its development. *American Antiquity* 43(3):405-408.

Churchill, Melissa
2002 *The Archaeology of Woods Canyon Pueblo: A Canyon-Rim Village in Southwestern Colorado* [HTML Title]. Available: http://www.crowcanyon.org/woodscanyon. Date of use: 18/08/2003.

Colsen, Elizabeth
1979 In good years and in bad: Food strategies of self-reliant societies. *Journal of Anthropological Research* 35:18-29.

Colton, M. F.
1965 *Hopi Dyes.* Museum of Northern Arizona, Flagstaff, Arizona.

Cordell, Linda
1997 Archaeology of the Southwest. 2nd edition. Academic Press, New York.

Coulam, Nancy J., and Peggy R. Barnett
1980 Paleoethnobotanical Analysis. In *Sudden shelter*, edited by Jesse D. Jennings, Alan B. Schroedl, and Richard N. Holmer, pp. 171-194. Anthropological Papers 103. University of Utah, Salt Lake city, Utah.

Cutler, H. C.
1966 *Corn, Cucurbits and Cotton from Glen Canyon.* Anthropological Papers 80, Glen Canyon Series 30. University of Utah Press, Salt Lake City, Utah.

Cutler, H. C. and W. Meyer
1965 Corn and cucurbits from Wetherill Mesa. In *Contributions of the Wetherill Mesa Archaeological Project*, pp. 136-152. Memoir 19, Society for American Archaeology.

Cutter, and Whittaker
1976 History and Distribution of the Cultivated Cucurbits in the Americas. *American Antiquity 26:269-285.*

Dean, J. S.
1996 Demography, Environment, and Subsistence Stress. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest,* edited by J. A. Tainter and B. B. Tainter, pp. 25-56. Santa Fe Institute Studies in the Sciences of Complexity, Proceedings vol. 24. Addison-Wesley, Reading, Massachusetts.

Dean, J.S., R. C. Euler, G. J. Gumerman, F. Plog, R. H. Hevly, and T. V. Karlstrom
1985 Human Behavior, Demography, and Paleoenvironment on the Colorado Plateaus. *American Antiquity* 50(3):537-554.

Decker, K. W. and L. L. Tieszen
1989 Isotopic Reconstruction of Mesa Verde Diet from Basketmaker III to Pueblo III. *Kiva* 55(1):33-47.

Doebley, J. F.
1985 "Seeds" of Wild Grasses: A Major Food of Southwester Indians. *Economic Botany* 38(1):52-64.

Donaldson, Marcia L.
1982 Flotation Analysis Samples from six Archaeological Sites in the Gallo Wash Mine Lease. In *Prehistoric Adaptive Strategies in the Chaco Canyon Region, Northwestern New Mexico: 1. Introduction, Environmental Studies, and Analytical Approaches,* edited by Alan H. Simmons, pp. 143-172. Navajo Nation Papers in Anthropology 9. Navajo Nation cultural Resource Management Program, Window Rock, Arizona.

Duff, I. A. and S.C.Ryan
1998 *The 1998 Field Season at Shields Pueblo (5MT3807), Montezuma County, Colorado.* Crow Canyon Archaeological Center, Cortez, Colorado.

2000 *The 1999 Field Season at Shields Pueblo (5MT3807), Montezuma County, Colorado.* Crow Canyon Archaeological Center, Cortez, Colorado.

2001 *The 2000 Field Season at Shields Pueblo (5MT3807), Montezuma County, Colorado.* Crow Canyon Archaeological Center, Cortez, Colorado.

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

Dunnell, R. W.

1984 The Ethics of Archaeological Significance Decisions. In *Ethics and Values in Archaeology*, edited by E. L. Green, pp. 62-47. Free Press, New York.

Elmore, F. H.

1944 *Ethnobotany of the Navajo.* The University of New Mexico Bulletin with the School of American Research. University of New Mexico Press, Albuquerque, New Mexico.

Ekren, E.B. and F. N. Houser

1965 *Geology and Petrology of the Ute Mountains Area, Colorado.* Professional Paper 481. U.S. Geological Survey.

Eubanks, M. W.

2001 The Mysterious Origin of Maize. *Economic Botany* 55(2):492-514/

Fewkes, J. W.

1896 A Contribution to Ethnobotany. *American Anthropologist* 9:14-21.

1919 Prehistoric Villages, Castles, and Towers of Southwestern Colorado. *Bulletin No.* 70. Bureau of American Ethnology, Washington, D.C.

Fish, Suzanne K.

2004 Corn, Crops, and Cultivation in the North American Southwest. In *People and Plants in Ancient Western North America*, edited by Paul E. Minnis, pp. 115-166. Smithsonian Books, Washington.

Force, E. R. and W.K. Howell

1997 *Holocene Depositional History and Anasazi Occupation in McElmo Canyon, Southwestern Colorado.* Arizona State Museum Archaeological Series No. 188. University of Arizona Press, Tucson, Arizona.

Ford, Richard I.

1984 Ecological Consequences of Early Agriculture in the Southwest. In *Papers on the Archaeology of Black Mesa, Arizona*, vol. 2, edited by Stephan Plog and Shirley Powell, pp. 127-138. Southern Illinois University Press, Carbondale.

Fowler, C. S.

1986 Subsistence. In *Handbook of North American Indians, Vol. 11, Great Basin*, edited by W. L. d'Azevedo. Smithsonian Institution, Washington, D.C.

Fry, G. F. and H. J. Hall

1986 Human Coprolites. In *Archaeological Investigations at Antelope House*, edited by Don P. Morris. National Park Service, Washington, D.C.

Gould, R. R.
1982 *The Mustoe Site: The Application of Neutron Activation Analysis in the Interpretation of a Multi-component Archaeological Site.* Ph.D. dissertation, Department of Anthropology, University of Texas, Austin.

Grant, R. G., B. S. Jackson, J. R. Kiniry, and G. F. Arkin
1989 Water deficit timing effects on yield components in maize. *Agronomy Journal* 81:61-65.

Gregory, David
1999 *Excavations in the Santa Cruz Floodplain: The Middle Archaic Component at Los Pozos.* Anthropological Papers 20. Center for Desert Archaeology, Tucson.

Gremillion, Kristen J. (editor)
1997 *People, Plants, and Landscapes: Studies in Paleoethnobotany.* University of Alabama Press, Tuscaloosa.

Gumerman, G. J.
1988 *The Anasazi in a Changing Environment.* Cambridge Univeristy Press, Cambridge.

Guthe, A. K.
1949 Preliminary Report on Excavations in Southwestern Colorado. *American Antiquity* 15(2):144-154.

Hall, R. L. and G. Fry
1975 Human Coprolites from Antelope House: Preliminary Analysis. *The Kiva* 41(1):87-96.

Hallasi, J. A.
1979 Archeological Excavation at the Escalante Site, Dolores, Colorado, 1975 and 1976. In *The Archaeology and Stabilization of the Dominguez and Escalante Ruins,* by A.D. Reed, J. A. Hallasi, A. S. White, and D. A. Breternitz, pp. 197-425. Cultural Resource Series No. 7. Bureau of Land Management, Colorado State Office, Denver.

Harshberger, John W.
1896 The Purposes of Ethnobotany. *Botanical Gazette* 21:146-154.

Hogan, Patrick E.
1980 The Analysis of Human Coprolites from Cowboy Cave. In *Cowboy Cave,* edited by Jesse D. Jennings, pp. 201-211. Anthropological Papers 104. University of Utah Press, Salt Lake City, Utah.

Hough, W.
1897 The Hopi in Relation to Their Plant Environment. *American Anthropologist* 10:33–44.

Hill, D.V.
1985 Pottery Making at the Ewing Site (5MT927). *Southwestern Lore* 51(1):19-31.

Huckell, Lisa W. and Mollie S. Toll
2004 Wild Plant Use in the North American Southwest. In *People and Plants in Ancient Western North America*, edited by Paul E. Minnis, pp. 37-114. Smithsonian Books, Washington.

Hunter, A. A. and B. R. Gasser
1998 Evaluation of the Flote-Tech machine-assisted flotation system. *American Antiquity* 63:143-156.

Hurley, W.
2000 A Retrospective on the Four Corners Archaeological Program. *CRM* 23(1):25-28.

Jones, Volney H.
1935 The Vegetative Remains of Newt Kash Hollow Shelter. In *Rockshelters in Menifee County, Kentucky*, edited by William S. Webb and William D. Funkhouser, pp. 147-165. University of Kentucky Reports in Anthropology and Archaeology 3(4).

Jones, V. H. and R. L. Fonner
1954 Plant Materials from Sites in Durango and La Plata Areas, Colorado. In *Basket-Maker II Sites near Durango, Colorado*, by Earl H. Morris and Robert F. Burgh, pp. 93-115. Publication 604. Carnegie Institution of Washington, Washington, D.C.

Kane, A. E., W. D. Lipe, T. A. Kohler, and C. K. Robinson
1988 *Dolores Archaeological Program: Research Designs and initial Survey Results.* U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver.

Kaplan, Lawrence
1965 Beans of Wetherill Mesa. *American Antiquity* 31:153-15

Kaplan, L. and S. L. Mania
1977 Archaeological botany of the Apple Creek site, Illinois. *Journal of Seed Technology* 2:40-53.

Kent, S.
1991 Excavations at a Small Mesa Verde Pueblo II Anasazi Site in Southwestern Colorado. *The Kiva* 57:55-75.

Kohler, Timothy A., and Meredith H. Matthews

1988 Long-Term Anasazi Land Use and Forest Reduction: A Case Study from Southwestern Colorado. *American Antiquity* 53:537-564.

Krebs,C.

1989 *Ecological Methodology*. Harper & Row Publishers: New York.

Kidder, A. V.

1927 Southwestern Archaeological Conference. *Science* 66:489-491.

Kohler, T. A.

1992 Fieldhouses, Villages, and the Tragedy of the Commons in the Early Northern Anasazi Southwest. *American Antiquity* 57:617-635.

1993 News from the Northern American Southwest: Prehistory on the Edge of Chaos. *Journal of Archaeological Research* 1(4):267-321.

Kuckelman, K.

2003 *The Archaeology of Yellow Jacket Pueblo (Site 5MT5): Excavations at a Large Community Center in Southwestern Colorado* [HTML Title]. Available: http://www.crowcanyon.org/yellowjacket. Date of use: 11/06/2005.

Kuckelman, K., R. R. Lightfoot, and D. L. Martin

2000 Changing Patterns of Violence in the Northern San Juan Region. *Kiva* 66(1):147-160.

Lekson, S. H.

1999 *The Chaco Meridian: Cener of Political Power in the Ancient Southwest*. AltaMira Press, Walnut Creek, California.

Lennstrom, H. A. and C. A. Hastorf

1992 Testing old wives' tales in paleoethnobotany: A comparison of bulk and scatter sampling schemes form Pancan, Peru. *Journal of Archaeological Science* 19:205-229.

Leonard, R. D.

1987 Incremental Sampling in Artifact Analysis. *Journal of Field Archaeology* 14:498-500.

Lepofsky, D., K. D. Kusmer, B. Hayden, and K. P. Lertzman

1996 Reconstructing prehistoric socioeconomies form paleoethnobotanical and zooarchaeological data: An example from the British Columbia Plateau. *Journal of Ethnobiology* 16:31-62.

Lightfoot, R. R., and M. C. Etzkorn (editors)

1993 *The Duckfoot Site, Volume 1: Descriptive Archaeology*. Occasional Paper No. 3 Crow Canyon Archaeological Center, Cortez, CO.

Lipe, W. D.
1999 History of Archaeology. In *Colorado Prehistory: A Context for the Southern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp.51-94. Colorado Council of Professional Archaeologists, Denver, Colorado.

Lipe, W. D. and M. D. Varien
1999 Pueblo II (A.D. 900-1150). In *Colorado Prehistory: A Context for the Southern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 242-289. Colorado Council of Professional Archaeologists, Denver, Colorado.

Lipe, W.D., M. D. Varien, and R.H. Wilshusen
1999 *Colorado Prehistory: A Context for the Southern Colorado River Basin.* Colorado Council of Professional Archaeologists, Denver, Colorado.

Long, Austin, Bruce F. Benz, D. J. Donahus, A. J. T. Jull, and L. J. Toolin
1989 First Direct AMS Dates on Early Maize from Tehuacan, Mexico. *Radiocarbon* 31:1035-1040.

Lyman, R. L. and Kenneth M. Ames
2004 Sampling to Redundancy in Zooarchaeology: Lessons from the Portland Basin, Northwestern Oregon, and Southwestern Washington. *Journal of Ethnobiology* 24(2):329-346.

Magers, Pamela C.
1986 Weaving at Antelope House. In *Archaeological Investigations at Antelope House*, edited by Don P. Morris. National Park Service, Washington, D.C.

Mahoney, N.M., M. A. Adler, and J. W. Kendrick
2000 The Changing Scale and Configuration of Mesa Verde Communities. *Kiva* 66:67-90.

Malville, N. J.
1989 Two Fragmented Human Bone Assemblages from Yellow Jacket, Southwestern Colorado. *Kiva* 55(1):3-22.

Martin, Steve L.
1999 Virgin Anasazi Diet as Demonstrated through the Analysis of Stable Carbon and Nitrogen Isotopes. *Kiva* 64:495-514.

Matthews, Meredith H.
1986 The Dolores Archaeological Program Macrobotanical Data Base: Resource Mix and Availability. In *Dolores Archaeological Program: Final Synthetic Report,* complied and edited by David Breternitz, C. K. Robinson, and T.G. Gross, pp. 184-199. Bureau of Reclamation, U.S. Department of Interior, Denver.

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

Matson, R. G.
1991 *The Origins of Southwestern Agriculture.* University of Arizona Press, Tucson, Arizona.

Matson, R.G. and B. Chisholm
1991 Basketmaker II Subsistence: Carbon Isotopes and Other Dietary Indicators from Cedar Mesa, Utah. *American Antiquity* 56(3):444-459.

McBride, Pamela J.
1993 Description of Anasazi Archeobotanical Remains. In *Across the Colorado Plateau: Anthropological Studies for the Transwestern Pipeline Expansion Project: 15. Subsistence and Environment,* edited by Joseph C. Winter, pp. 443-457. Office of Contract Archaeology and Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.

Miller, N. F.
1988 Ratios in paleoethnobotanical analysis. In *Current Paleoethnobotany: Analystical Methods and Cultural Interpretations of Archaeological Plant Remains,* edited by C. A. Hastorf and V.S. Popper, pp. 72-85. University of Chicago Press, Chicago.

Minnis, P. E.

1981 Seeds in archaeological sites: Sources and some interpretive problems. *American Antiquity* 46:143-152.

1985a *Social Adaptation to Food Stress: A Prehistoric Example.* University of Chicago Press, Chicago, IL.

1985b Domesticating People and Plants in the Greater Southwest. In *Prehistoric Food Production in North America,* edited by R. Ford, pp. 309-340. University of Michigan, Museum of Anthropology Anthropoloical Papers 75, Ann Arbor, Michigan.

1989 Prehistoric diet in the northern Southwest: macroplant remains from Four Corners feces. *American Antiquity* 54(3):543-63.

1996 Notes on economic uncertainty and human behavior in the prehistoric North American Southwest. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest*, edited by J. Teainter and B.B. Tainter, pp.57-78. Santa Fe institute Studies in the Sciences of Complexity, Proceedings Vol. XXIV. Addison-Wesley, Reading, MA.

2004 *People and Plants in Ancient North America.* Smithsonian, Washington, D.C.

Morris, E. H.
1919 Preliminary Account of the Antiquities of the Region Between the Mancos and LaPlata Rivers in Southwestern Colorado. In *Thirty-third Annual Report of the Buraeu of American Ethnology*, pp. 155-206. Washington, D.C.

Morris, J. N., L. Honeycutt, and J. Fetterman
1993 *Preliminary Report on 1990-1991 Excavations at Hanson Pueblo, site 5MT3876.* Indian Camp Ranch Archaeological Report No. 2. Woods Canyon Archaeological Consultants, Yellow Jacket, Colorado.

Mueller-Dombois, D., and H. Ellenberg
1974 *Aims and Methods of Vegetation Ecology.* John Wiley and Sons, New York.

Murray, Shawn S. and Nicole D. Jackson-Craig
2003 Archaeobotanical Remains. In *The Archaeology of Yellow Jacket Pueblo (Site 5MT5): Excavations at a Large Community Center in Southwestern Colorado*, edited by Kristin A. Kuckelman. Available: http://www.crowcanyon.org/yellowjacket. Date of use: 22/9/2004.

Ortman, S. G.
1998 *Corn Grinding and Community Organization in the Pueblo Southwest, A.D. 1150 – 1550.* Ms. on file, Crow Canyon Archaeological Center, Cortez, Colorado.

Osborne, Carolyn M.
1980 Objects of Perishable Materials. In *Long House, Mesa Verde National Park, Colorado*, by George S. Cattanach Jr., pp. 317-367. Publications in Archaeology 7H. Wetherill Mesa Studies. National Park Service, US Department of the Interior, Washington, D.C.

Pearsall, D. M.

1988 Interpreting the Meaning of Macroremain Abundance: The Impact of Source and Context. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, edited by Christine A. Hastorf and Virginia S. Popper, pp. 97-118. University of Chicago Press, Chicago.

2000 *Paleoethnobotany; A Handbook of Procedures*, 2nd edition. Academic Press, San Diego, California.

Petersen, K. L.

1988 *Climate and the Dolores River Anasazi: A Paleoenvironmental Reconstruction from a 10,000 Year Pollen record, La Plata Mountains, Southwestern Colorado.* Anthropological Papers No. 113, University of Utah Press, Salt Lake City.

Petersen, K. L., and J. D. Orcutt

1987 *Dolores Archaeological Program: Supporting Studies: Settlement and Environment*, U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver.

Pianka, E. R.

1974 *Evolutionary Ecology.* Harper & Row, New York.

Pierce, C., K. A. Adams, and J.D. Stewart

1998 Determining the fuel constituents of ancient hearth ash via ICP-AES analysis. *Journal of Archaeological Science* 25:493-503.

Piperno, D. R. and K. E. Stothert

2003 Phytolith Evidence for Early Holocene *Cucurbita* Domestication in Southwestern Ecuador. *Science* 14 February 2003, 299:1054-1057.

Plog, S.

1997 *Ancient Peoples of the American Southwest.* Thames and Hudson, London.

Popper, V. S.

1988 Selecting quantitative measurements in paleoethnobotany. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*, edited by Christine A. Hastorf and Virginia S. Popper, pp. 3-71. University of Chicago Press, Chicago.

Price, A.B., W. D. Nettleton, G.A. Bowman, and V.L. Clay

1988 Selected Properties, Distribution, Source, and Age of Eolian Deposits and Soils of Southwestern Colorado. *Soil Science Society of America Journal* 52:450-455.

Prudden, T.M.
1903 The Prehistoric Ruins of the San Juan Watershed in Utah, Arizona, Colorado, and New Mexico. *American Anthropologist* 5(2):224-288.

Rainey, Katharine D., and Sandra Jezik
2002 Archaeobotanical Remains. In *The Archaeology of Woods Canyon Pueblo: A Canyon-Rim Village in Southwestern Colorado*, edited by Melissa J. Churchill. Available: http://www.crowcanyon.org/woodscanyon. Date of use: 15/12/2003

Rawlings, Tiffany
2006 *Faunal Analysis and Meat Procurement: Reconstructing the Sexual Division of Labor at Shields Pueblo, Colorado.* Unpublished Ph. D. dissertation, Department of Archaeology, Simon Fraser University, Burnaby, B.C.

Reed, A. D.
1979 The Dominguez Ruin: A McElmo Phase Pueblo in Southwestern Colorado. In *The Archaeology and Stabilization of the Dominguez and Escalante Ruins*, by A.D. Reed, J. A. Hallasi, A. S. White, and D. A. Breternitz, pp. I-196. Cultural Resource Series No. 7. Bureau of Land Management, Colorado State Office, Denver.

Roberts, F. H. H.
1935 A Survey of Southwestern Archaeology. *American Anthropologist* 37(1):1-35.

Robinson, C. K., G. T. Gross, and D. A. Breternitz
1986 Overview of the Dolores Archaeological Program. In *Dolores Archaeological Program: Final Synthetic Report*, compiled by D. A. Breternitz, C. K. Robinson, and G. T. Gross, pp. 3-50. U.S. Department of the Interior, Bureau of Reclamation, Engineering and Research Center, Denver.

Rohn, A.H.
1977 *Cultural Change and Continuity on Chapin Mesa.* The Regents Press of Kansas, Lawrence, Kansas.

Robbins, W. W., J. P. Harrington, and B. Freire-Marreco
1916 *Ethnobotany of the Tewa Indians.* Bureau of American Ethnology Bulletin, no. 55. Smithsonian Institution, Washington, D.C.

Rose, M. R., J. S. Dean, and W. J. Robinson
1981 *The Past Climate of Arroyo Hondo, New Mexico, Reconstructed from Tree-Rings.* Arroyo Hondo Archaeological Series Vo. 4. School of American Research Press, Santa Fe.

Scott, L. J.
1979 Dietary Inferences from Hoy House Coprolites: A Palynolgical Interpretation. *The Kiva* 44:257-281.

Simmons, Alan
1986 New Evidence for the Early Use of Cultigens in the American Southwest. *American Antiquity* 51:73-88.

Sobolik, K.D. and D. J. Gerick
1992 Prehistoric medicinal plant usage: a case study from coprolites. *Journal of Ethnobiology* 12(2):203-211.

Smith, Anne M.
1974 *Ethnography of the Northern Utes.* Papers in Anthropology No. 17. Museum of New Mexico Press, Santa Fe.

Smith, J. E. and E. Zubrow
1999 *The 1967 Excavation at Site 5MV1931, Morefield Canyon, Mesa Verde National Park, Colorado.* Wright Paleohydrological Institute, Boulder, Colorado

Stevenson, M. C.
1915 Ethnobotany of the Zuni Indians. *30th Annual Report of the Bureau of American Ethnology*, 1908-1909.

Stewart, J. D. and K. R. Adams
1999 Evaluating visual criteria for identifying carbon- and iron-based pottery paints from the Four Corners region using SEM-EDS. *American Antiquity* 64)4:675-696.

Stiger, M. A.
1977 *Anasazi Diet: The Coprolite Evidence.* Unpublished M.A. thesis, University of Colorado, Boulder, Colorado.

1979 Mesa Verde Subsistence Patterns from Basketmaker to Pueblo III. *Kiva* 44:133-144.

Struever, S.
1968 Flotation techniques for the recovery of small-scale archaeological remains. *American Antiquity* 33:353-362.

Swank, George R.
1932 *The Ethnobotany of the Acoma and Laguna Indians.* Master's thesis, University of New Mexico.

Tainter, J. A. and B. B. Tainter

1996 *Evolving Complexity and Environmental Risk in the Prehistoric Southwest.* Santa Fe Institute Studies in the Sciences of Complexity, Proceedings vol. 24. Addison-Wesley, Reading, Massachusetts.

Toll, Mollie S.

1981 *Macro-Botanical Remains Recovered from Chaco Canyon Coprolites.* Technical Series 38. Castetter Laboratory for Ethnobotanical Studies, Department of Biology, University of New Mexico, Albuquerque.

1983 Changing Patterns of Plant Utilization for Food and Fuel. Evidence from Flotation and Macrobotanical Remains. In *Economy and Interaction alongthe Lower Chaco River: The Navajo Mine Archaeological Program, Mining Area II, San Juan County, New Mexico,* edited by Patrick Hogan and Joseph C. Winter, pp. 331-350. Office of Contract Archaeology and Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.

1988 Flotation Sampling: Problems and Some Solutions, with Examples from the American Southwest. In *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains,* edited by Christine A. Hastorf and Virginia S. Popper, pp. 36-55. University of Chicago Press, Chicago.

1993 *Botanical Indicators of Early Life in Chaco Canyon: Flotation Samples and Other Plant Materials from Basketmaker and Early Pueblo Occupations.* Manuscript on file, National Park Service, US Department of the Interior, Santa Fe.

Turner, C.G. II and J. A. Turner

1992 The First Claim for Cannibalism in the Southwest: Walter Hough's 1901 Discovery at Canyon Butte Ruin 3, Northeastern Arizona. *American Antiquity* 57(4):661-682.

1999 *Man Corn: Cannibalism and Violence in the Prehistoric American Southwest.* University of Utah Press, Salt Lake City, Utah.

Van de Veen, M. and N. Fieller

1982 Sampling Seeds. *Journal of Archaeological Science* 9:287-298

Van Ness, Margaret A.

1986 *Desha Complex Macrobotanical Fecal Remains: An Archaic Diet in the American Southwest.* Unpublished master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

Van Ness, Margaret A. and E. Hansen
1996 Archaic Subsistence in the Glen Canyon Region. In *Glen Canyon Revisited*, by Phil R. Geib, pp. 117-125. Anthropological Papers 119. University of Utah Press, Salt Lake City.

Van West, C. R.
1994 *Modeling Prehistoric Agricultural Productivity in Southwestern Colorado: A GIS Approach.* Report of Investigations No. 67. Department of Anthropology, Washington State University, Pullman, Washington.

Van West, C. R. and J. S. Dean
2000 Environmental Characteristics of the A.D. 900-1300 Period in the Central Mesa Verde Region. *Kiva* 66(1):19-44.

Varien, M. D.
1997 Communities Through Time: Migration, Cooperation, and Conflict. Final Report submitted to The National Geographic Society in fulfillment of Grant #6016-97.

1999 Regional Context: Settlement Patterns, Architecture, and Abandonment. In *The Sand Canyon Archaeological Project: Site Testing*, edited by M.D. Varien. CD-ROM Version 1.0 Crow Canyon Archaeological Center, Cortez, Colorado.

1999a *Sedentism and Mobility in a Social Landscape: Mesa Verde and Beyond.* Univeristy of Arizona Press, Tucson, Arizona.

Varien, M. D., and R. H. Wilshusen (editors)
2002 *Seeking the Center Place: Archaeology and Ancient Communiites in the Mesa Verde Region.* University of Utah Press, Salt Lake City

Wagner, G.
1982 Testing flotation recovery rates. *American Antiquity* 47:127-132.

Ward, C.
1997 The 1997 Field Season at Shields Complex (5MT3807), Montezuma Count, Colorado. Ms. On file, Crow Canyon Archaeological Center, Cortez, Colorado.

Watson, P.
1976 In pursuit of prehistoric subsistence: A comparative account of some contemporary flotation systems. *Mid-Continental Journal of Archaeology*: 1:77-100.

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins
1987 *A Utah Flora.* Great Basin Naturalist Memoirs No. 9. Brigham Young University, Provo, Utah.

Wetterstrom, Wilma

1986 *Food, Diet, and Population at Prehistoric Arroyo Hondo Pueblo, New Mexico.* Arroyo Hondo Archaeological Series 6. School of American Research Press, Santa Fe.

White, T. D.

1992 *Prehistoric Cannibalism at Mancos 5MTUMR-2346.* Princeton University Press, Princeton, New Jersey.

Whitkind, I. J.

1964 *Geology of the Abajo Mountains Area, San Juan County, Utah.* Professional Paper 453. U.S. Geological Survey.

Whiting, A.

1939 *Ethnobotany of the Hopi.* Museum of Northern Arizona Bulletin 15, Flagstaff, Arizona.

1966 *Ethnobotany of the Hopi.* Northland Press, Flagstaff, Arizona

Wilshusen, R. H.

1996 *Estimating Prehistoric Population for the Mesa Verde Region: Using New Methods to Interpret Old Data.* Report prepared for the Colorado Historical Society. Crow Canyon Archaeological Center, Cortez, Colorado.

2002 Estimating Population in the Central Mesa Verde Region. In *Seeking the Center Place: Archaeology and Ancient Communities in the Mesa Verde Region,* edited by Mark D. Varien and Richard H. Wilshusen pp. 101-120. The University of Utah Press, Salt Lake City, Utah.

Winter, Joseph C.

1993 Environment and Subsistence across the Colorado Plateau. In *Across the Colorado Plateau: Anthropological Studies for the Transwestern Pipeline Expansion Project, Parts 4 and 5: 5. Subsistence and Environment,* edited by Joseph C. Winter, pp. 601-648. Office of Contract Archaeology and Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.

Wyman, L. C. and S. K. Harris

1941 The Ethnobotany of the Kayenta Navaho: An Analysis of the John and Louisa Wetherill Ethnobotanical Collection. *University of New Mexico Publications in Biology* 5:1-66.