ZOOARCHAEOLOGY OF SAND CANYON PUEBLO, COLORADO

by

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B.A., Simon Fraser University, 1988
M.A., Trent University, 1990

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

in the Department
of
Archaeology

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SIMON FRASER UNIVERSITY

June, 1999

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ABSTRACT

In this study analyses of faunal remains are employed to investigate environmental, economic, social, and ideological factors associated with the emergence of a large aggregated Pueblo town in southwestern Colorado, during the Pueblo III period (*ca.*, A.D. 1100 - 1300). Detailed spatial analyses of fauna recovered from Sand Canyon Pueblo and comparisons to fourteen other sites in the Sand Canyon Locality indicate several distinct patterns consistent with changes in the location, scale, and organization of subsistence and ritual activities from the 'early' to 'late' Pueblo III period. Specifically, utilization of turkey appears to intensify throughout the locality, while the distribution of artiodactyls, birds of prey, and other wild birds become increasingly spatially restricted within and among communities through time. These latter taxa are initially distributed broadly throughout sites in the locality, but by the 'late' Pueblo III period are found to be concentrated within specific structures at Sand Canyon Pueblo.

It is argued here that the changes in frequency and distribution of faunal remains indicate that significant social and economic reorganization accompanied the development of the large aggregated community of Sand Canyon Pueblo. In particular, there appears to be evidence of increased centralization, scale, and perhaps control of ritualized subsistence events, such as communal hunting. These activities appear to have been organized by specific individuals, households, or societies at Sand Canyon Pueblo.

In conclusion it is suggested that increased competition for limited wild resources, due to regional population increases, prompted the need (or desire) to pool labor and knowledge. An integrated communal effort may have been perceived to be a means of reducing risk of subsistence failure in an increasingly competitive economic environment. The coordination of communal ritual events at Sand Canyon Pueblo, may have acted as a mechanism to encourage co-operation, group unity, and community identity within the locality. In turn, this would facilitate activities requiring large groups, such as communal hunts.

DEDICATION

For Sue.

ACKNOWLEDGMENTS

Many people have provided support, direction, and encouragement throughout the course of this study. In particular, I would like to thank Jon Driver for excellent supervision over the last five years and for 'introducing' me to archaeology 15 years ago. Cathy D'Andrea has also been an exceptional supervisor and I am very grateful for her interest and input. I also thank Tim Kohler of Washington State University for acting as external examiner and providing many challenging questions and valuable comments. I am indebted to Roy Carlson for his role as SFU examiner, but even more so for giving me my first job in archaeology many years ago. Phil Hobler was chair of the examination committee and has also been influential and supportive throughout my undergraduate and graduate studies.

This research was conducted with the cooperation and assistance of Crow Canyon Archaeological Center researchers and staff. I would like to thank all of the individuals who have been involved in the Sand Canyon Archaeological Project over the last 15 years especially Bruce Bradley, Mark Varien, Melita Romasco, Sandy Thompson, Richard Wilshusen, and Melissa Churchill. Thanks are also owed to all of the faculty and staff of the Department of Archaeology at Simon Fraser University, especially Jack Nance, Brian Hayden, Andrew Barton, Barb Winter, Dave Burley, Shannon Wood, John Breffit, Linda Bannister, Lynda Przybyla, Ann Sullivan, and Robyn Ward Banerjee, all of whom have provided valuable assistance over the years.

Many graduate and undergraduate students have provided inspiration and encouragement especially Terry Brennan, Mike Brand, Natalie Munro, Mirjana Roksandic, Farid Rahemtulla, Rudy Reimer, Tom Arnold, Pei Pei Chu, Brian Pegg, Jay King, Lori White, Robin Chatan, Lanna Crucefix, Rachel Sydenham, Sharon Solomon, Illy Allen, Paul Ewonus, Julie Park, Judy Mclellan, and Terry Spurgeon. Other motivating and supportive individuals include Richard Brolly, Geordie Howe, Mike Rousseau, Karen Preckel, Laurie Beckwith, Ross Jamieson, Stephen Sliwa, Heather Pratt, Marianne Berkey,

Arnoud Stryd, and Jim Cruickshank. Financial and moral support were also provided by my good friends and former business partners Ian Franck and Peter Merchant.

I would also like to thank my family, particularly: Mom, Dad, Stephen, Shannon, Adam, Jacob, Ann, Brian, Corey, Nathan, Sarah, Kathy, and Dale. Finally, I am greatly indebted to Sue Woods for her support and patience.

This study was funded in-part by a grant from the Social Sciences and Humanities Research Council of Canada.

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CHAPTER 1

INTRODUCTION AND RESEARCH DESIGN

Introduction

Common to recent overviews of Anasazi prehistory is the discussion of recurrent cycles of extreme population growth and decline at a regional or sub-regional scale. accompanied by trends toward increasing population aggregation (Cordell 1984; Cordell and Gumerman 1989; Minnis and Redman 1990; Leonard and Reed 1993; Gumerman 1994). Larson *et al.* (1996:217) describe late Anasazi prehistory as a thousand year period of economic and cultural "boom and bust". characterised by repeated experiments in village aggregation. intensification of agricultural production. increased emphasis on storage. development of complex exchange networks. and appearance of stratified social systems; followed by (often sudden) regional abandonments. This pattern of community aggregation. growth and decline has been the subject of considerable recent archaeological research and discussion. particularly in the Anasazi Culture Area (*e.g.*. Gumerman 1988; Larson and Michaelson 1990; Fish *et al.* 1994; Larson *et al.* 1996; Potter 1997). The pattern is evident at various times and places throughout the Southwest (Dean *et al.* 1994) but is perhaps most clearly manifest in the archaeological record of the Northern San Juan Region at the end of the Pueblo III period (*ca.* A.D. 1250 to 1300).

Recent archaeological research in the Sand Canyon Locality (see Figures 1 and 2) by Crow Canyon Archaeological Center and associated researchers has attempted to address the emergence of aggregated communities during the Pueblo III period (Lipe 1992a). This dissertation presents analyses of faunal remains recovered from 15 excavated Pueblo III sites in the Sand Canyon Locality in an attempt to identify. describe and explain the role of environmental. economic. social. and ideological factors in the cultural changes that occurred within this locality immediately prior to abandonment of the Northern San Juan Region (*ca.* A.D. 1280). In addition to standard comparisons of taxon frequencies between sites. the study presents a detailed analysis of the spatial distribution of faunal remains within Sand Canyon Pueblo. one of two large 'Pueblo towns' located in the locality. This intra-site spatial analysis is used to elucidate social and economic characteristics of faunal resource use and distribution at the site. Inferences based on these analyses are presented as potentially region-wide phenomena which may have been important contributing factors in the emergence, growth and decline of aggregated communities in the Northern San Juan Region.

Physical Setting

The Sand Canyon locality is situated in the approximate geographic center of the Northern San Juan Region (Figure 1). As defined by Cordell and Gumerman (1989), the Northern San Juan Region occupies the drainages of the northern tributaries of the San Juan River from Comb Ridge in southwestern Utah to the upper San Juan Valley in southwestern Colorado. The region lies within the central portion of the Colorado Plateau which extends throughout southern Utah, Colorado, and northern Arizona and New Mexico.

The modern regional environment ranges from Montane forest to desert in character (Costello 1954; MacMahon 1994). Climate and vegetation vary primarily according to elevation. Open ponderosa pine-Douglas fir forests occupy the flanks of the mountains which form the eastern boundary of the region, at elevations between 2600 and 2900 m. Pinyon-juniper woodland covers many of the higher mesas and canyon slopes between 1700 and 2600 m, intermingled with hardwood brush and oak thickets in the upper third of this elevation range. Extensive sage flats and high desert grasslands cover most of the lower elevations (below 2000 m), especially in the western half of the region. Sagebrush is common throughout much of this zone, although greasewood (in high alkaline soils) and saltbrush (in drier, well-drained, less alkaline soils) are predominant at lower elevations. Stands of cottonwood and other riparian shrubs and grasses grow along natural and artificial watercourses and around springs (Costello 1954; MacMahon 1994).

Animal communities throughout the region are not as clearly stratified as the vegetation. Some animals such as mule deer, coyote, and raptors range throughout all vegetation zones, while others occupy more restricted habitats. Species common to mountainous areas include pika, marmot, elk, bighorn sheep and blue grouse, while

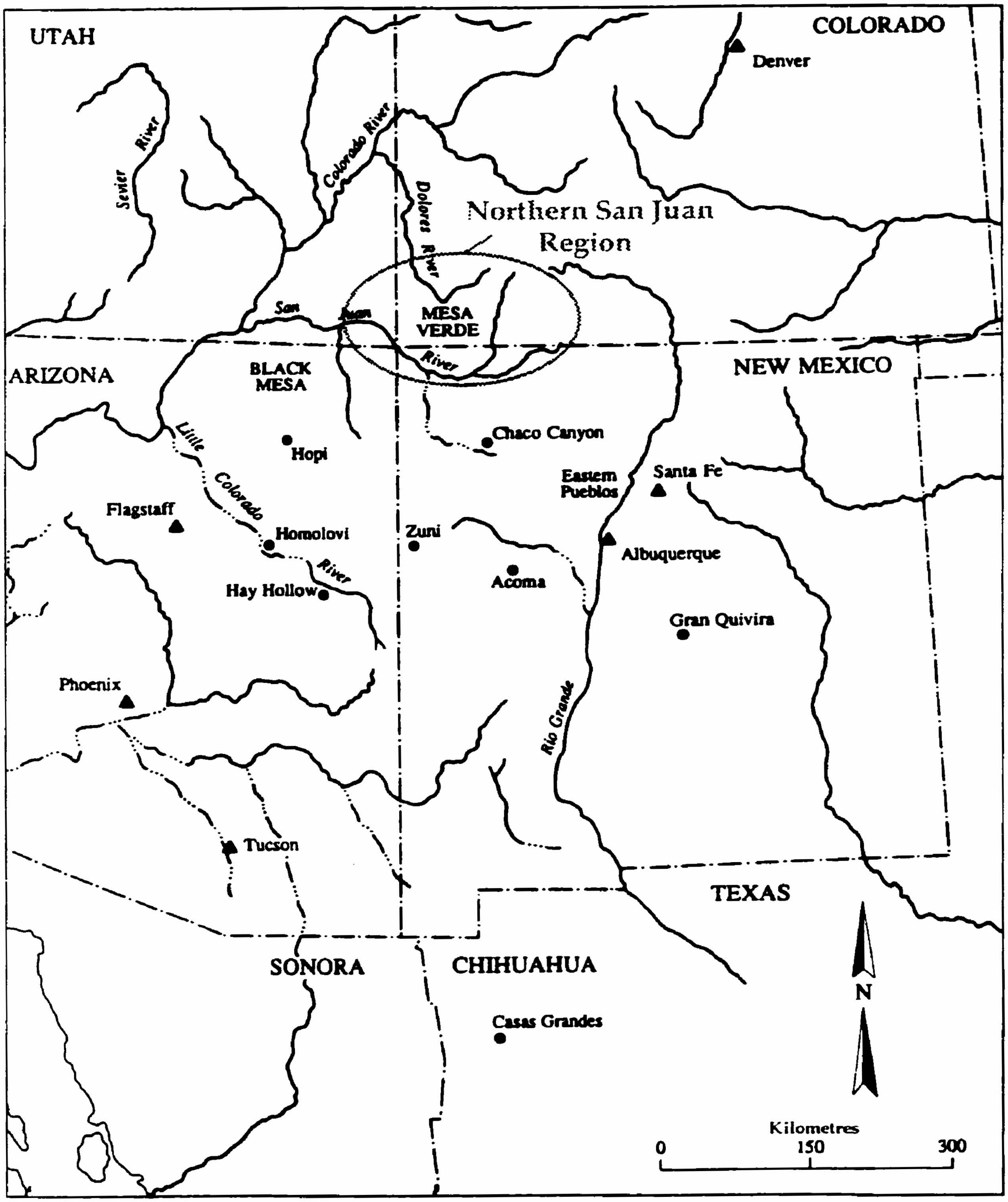

Figure 1. Location of the Northern San Juan Region (base map adapted from Lipe 1992a, with permission of the publisher).

mountain lion (or cougar) and bobcat have more extensive territories which include both high mesa and mountain environments (MacMahon 1994). Mid to lower elevations are populated by a wide variety of rodents and birds as well as cottontails, hares, medium and small carnivores, bats, snakes, toads and lizards. Pronghorn (antelope) occur primarily in open terrain most common in the drier southern portions of the region (MacMahon 1994).

The Sand Canyon Locality

The Sand Canyon Locality includes an area of approximately 200 km^2 on the McElmo Dome in southwestern Colorado. Specifically, it is defined as the area within a 7.5-km radius of two large Pueblo III habitation sites: Sand Canyon Pueblo and Goodman Point Pueblo (Lipe 1992a:2). The locality is truncated by McElmo Creek on the south and Yellow Jacket Creek on the north (see Figure 2). Definition of this area was intended to approximate the basic sustaining territory for at least one Pueblo III period Anasazi community, based on the hypothesis that the large sites are community or supracommunity centers, and that the boundaries of their social and economic sustaining areas are likely to have been located approximately halfway between neighboring centers (Lipe 1992a:3). The 7.5 km radius was thus based on half the average distance (15 km) between the six large Pueblo III aggregate sites that are nearest to Sand Canyon and Goodman Point pueblos.

Plant communities vary considerably according to the terrain within the locality. Modern vegetation on the rolling mesa top of McElmo Dome is heavily influenced by historic and modern farming activities, though prehistorically this area would presumably have supported Anasazi fields scattered among pinyon-juniper woodland. Numerous rugged canyons draining south into McElmo Canyon dissect the southern side of McElmo Dome. These areas support pinyon-juniper forests on their upper slopes interspersed with hardwood brush and localized riparian communities. Lower elevation areas are sparsely forested, populated primarily with sage brush and desert grasses. Bedrock outcrops are common along the lower benches and canyon bottoms, particularly near McElmo Creek where erosion due to water and wind continually removes sediment.

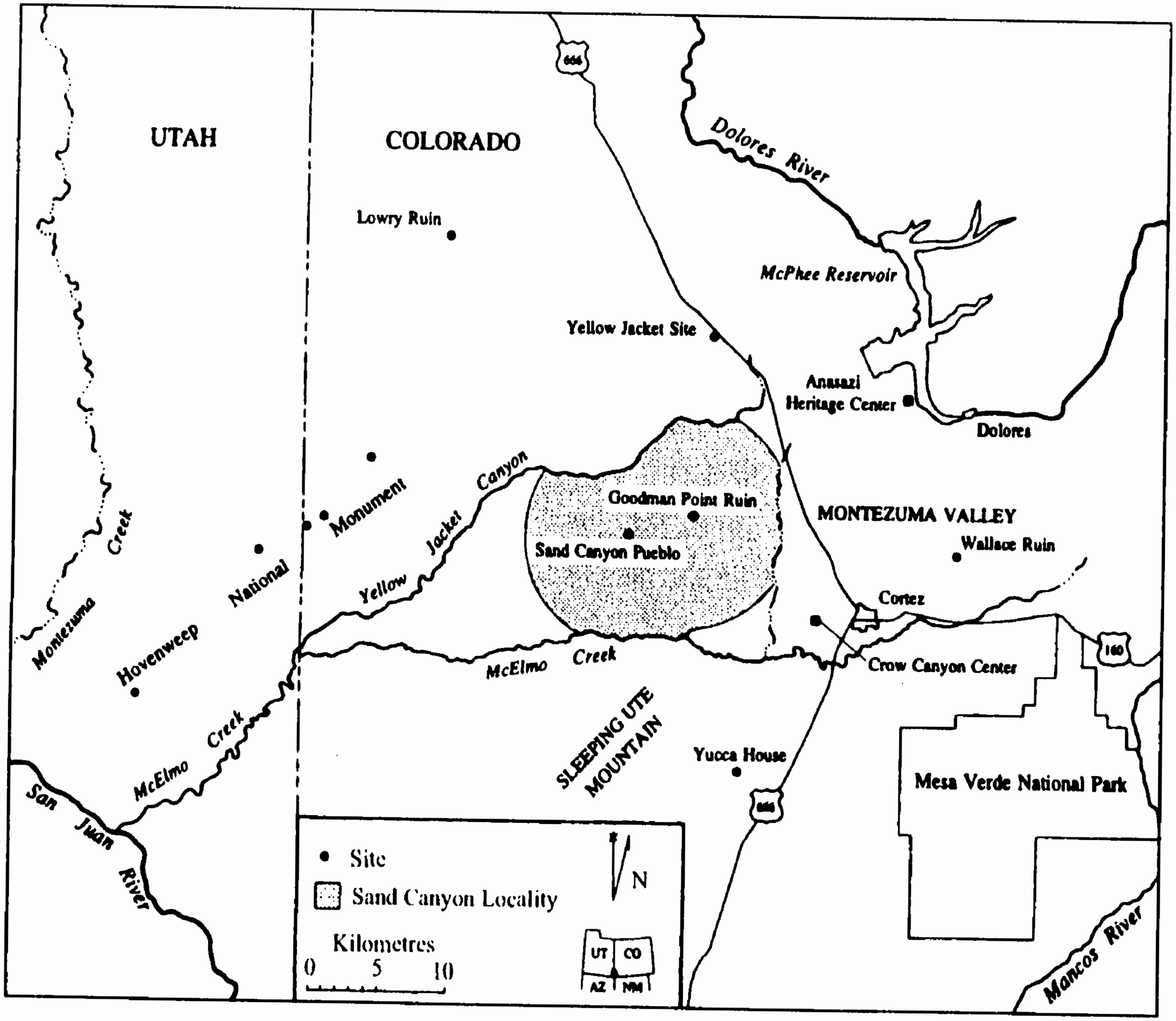

Figure 2. Location of the Sand Canyon Locality (from Lipe 1992a, used with permission of the publisher).

Cultural Setting

The culture history of the Anasazi, as currently understood, has been reviewed and discussed extensively by several scholars (*e.g.*, Cordell 1984; Cordell and Gumerman 1989; Rohn 1989; Minnis and Redman 1990) and will not be described in detail here. Instead this section is limited to briefly presenting pertinent cultural characteristics and developments of the Pueblo III period in the Northern San Juan Region.

Cultural Chronology

A generalized cultural chronology for the 'late' prehistory of the Northern San Juan Region has been proposed by Rohn (1989). Rohn's chronology makes use of the conventional Basketmaker and Pueblo cultural historical sequence developed as the "Pecos Classification" (Kidder 1927) for use throughout the American Southwest. His application of this framework to the Northern San Juan Region is presented in Table 1. The research presented here is exclusively concerned with the Pueblo III period as defined by Rohn (*i.e.*, *ca.* A.D. 1100 to 1300).

Table 1. Northern San Juan cultural-historical sequence (after Rohn 1989:152).

Northern San Juan Period	Approximate Time Span
Post Pueblo	A.D. 1300 to A.D. 1550
Pueblo III	A.D. 1100 to A.D. 1300
Pueblo II	A.D. 900 to A.D. 1100
Pueblo I	A.D. 750 to A.D. 900
Basketmaker III	A.D. 450 to A.D. 750
Basketmaker II	500 B.C. to A.D. 450
Pre-Basketmaker	6000 B.C. to 500 B.C.

Pueblo III Developments

There is considerable debate regarding the complexity of sociopolitical, ideological and economic systems in prehistoric Pueblo communities. The debate ranges from the belief that southwestern cultures were largely egalitarian (Graves *et al.* 1982; Graves and Reid 1984; Reid 1985; Johnson 1989; Reid and Whittlesey 1990), to those who see evidence of social stratification at several times and places (Upham 1982; Upham and Plog 1986; Lightfoot and Upham 1989; Wilcox 1991; Larson *et al.* 1996). Much of this debate has focused on the Pueblo II "Chacoan phenomenon" (Irwin-Williams 1972; Vivian 1990) which, to some researchers, represents the high point of social complexity in the American Southwest. More recently attention has turned to the very large aggregated communities common to the later Pueblo periods (Pueblo III and Pueblo IV) and the social and economic systems that produced them.

It is generally accepted that by the beginning of the Pueblo III period Chacoan influences which had dominated the region during Pueblo II times, had waned in the Northern San Juan; however, it is not clear what kinds of regional and local-level social or ideological systems followed the Chacoan phenomenon (Lipe 1992a). The Pueblo III period is believed to have been a time of substantial cultural change throughout the Northern San Juan Region, as demonstrated by dramatic changes in settlement patterns (Cordell and Gumerman 1989:11; Rohn 1989:158; Lipe 1992a:3). During the Pueblo III period there is a region-wide shift from a settlement system consisting of many small, highly dispersed habitation sites to increasingly clustered settlements centered around very large central pueblos. Specifically, during late Pueblo II and early Pueblo III times habitation sites consisted primarily of single or small groups (*i.e.*, 2 to 4) of "unit-type pueblos" or "Prudden Units" (habitation complexes consisting of a small room block adjacent to a single kiva, an associated courtyard area, and refuse middens [Prudden 1918]). Such sites were distributed broadly across the mesa tops and canyons of the region (Prudden 1918; Rohn 1989; Adler 1992).

Beginning by about A.D. 1150 larger habitation sites containing groups of unit pueblos become abundant throughout the region (Rohn 1989:158; Adler 1992). This pattern of increased settlement aggregation grew steadily and by A.D. 1200 'pueblo towns' with residential populations estimated at over 2,500 people began to emerge as focal points for smaller surrounding habitation sites (Rohn 1983, 1989). The largest of these sites included one hundred or more kivas and associated room blocks, as well as site enclosing walls, multi-storied circular and semicircular towers, great kivas, plazas, water reservoirs and other specialized structures (Rohn 1983, 1989; Bradley 1992).

The above mentioned settlement pattern change is, of itself, a phenomenon worthy of investigation but is made even more intriguing because of the subsequent abandonment of virtually all pueblo settlements in the region by A.D. 1300. It is estimated that during the mid-thirteenth century the Anasazi population of the Northern San Juan Region was in the many tens of thousands, yet, by A.D. 1300 the Anasazi had abandoned the entire area (Rohn 1989:166; Lipe 1992b; Dean *et al.* 1994). Collectively, these changes appear to reflect significant socioeconomic processes that apparently affected the entire region.

Previous Research in the Sand Canyon Locality

Because the cultural processes occurring during the Pueblo III period appear to be most discernible archaeologically in the form of settlement pattern changes it is appropriate that research should emphasize investigation of settlement complexes rather than single sites. As argued by Lipe (1992a:3), intensive locality-level investigations of both large and small settlements promise to be the most productive means of contributing to an understanding of the Pueblo III cultural phenomena. Accordingly, Crow Canyon Archaeological Center (CCAC) of Cortez, Colorado and associated researchers have been undertaking an intensive research program in the Sand Canyon locality since 1983. The long-term research goals of the Sand Canyon Archaeological Project are defined as:

> "1. to define the community or communities that occupied the Sand Canyon locality during the Pueblo III period in terms of their settlement system, socio-cultural organization and sustaining environments;
>
> 2. to identify social, cultural, and environmental changes that took place in the Sand Canyon locality during the Pueblo III period, with a special focus on the abandonment of the locality in the late 1200s; and
>
> 3. to relate the locality's patterns of organization and change to larger patterns in the Pueblo Southwest, as well as to theoretical frameworks that

promote understanding and interpretation of both locality and area-wide configurations" (Lipe 1992a:3).

The investigations coordinated by CCAC in the Sand Canyon locality have included environmental studies, intensive and sample-based surface surveys, oral history, and excavations at 15 Pueblo III sites including intensive excavations at Sand Canyon Pueblo, the largest thirteenth-century site in the locality (Bradley 1992).

Field Investigations

The studies began with four years (1985 through 1988) of intensive survey conducted in the central portion of the Sand Canyon locality, as well as along the lower portion of Sand Canyon (Adler 1992; Gleichman and Gleichman 1992). These surveys resulted in the identification of 482 archaeological sites, representing a minimum of 753 cultural components (based on temporally diagnostic ceramic and architectural features). Of these, 130 sites were determined to contain Pueblo III components.

In 1988 a site testing program designed to collect representative data on small and medium-sized Pueblo III sites identified during the survey programs was begun. The testing program was specifically designed to sample sites from both the upper and lower Sand Canyon site "clusters" (Varien *et al.* 1992). It was also designed to sample sites from the three major physiographic settings that characterize the area. These were defined as mesa top, cliff shelters, and benches within canyons. Sites were selected according to size and function. Specifically small habitation sites were targeted, that is, sites containing between one and four kivas, associated room blocks and middens. In addition an attempt was made to select sites that varied in age within the Pueblo III period.

This sampling strategy resulted in selection of 14 small sites (1-3 kivas) for testing: six on the mesa top, three on the canyon bench, and five cliff shelters (see Figure 3). Collectively this group of sites is estimated to represent 10% of the Pueblo III sites in the Sand Canyon Locality. In addition, one medium sized (12-15 kivas) site (Castle Rock Pueblo) in McElmo Canyon also was tested. Each selected site was excavated using a stratified random sampling scheme, supplemented by a few judgmentally placed test units. Sample stratification was by feature types, defined as: room blocks, kivas, towers, middens, courtyards, inner periphery areas and outer periphery areas (Varien *et al.* 1992:47-48). Approximately 1% (of total site area) of each site was sampled, with the total number of excavation units distributed evenly among the strata. This had the effect of providing more intensive investigation of smaller sampling strata such as kivas and room blocks relative to larger strata such as peripheral areas. In addition to these test excavations three sites were selected for more intensive investigation, in an effort to improve understanding of community organization in the locality (Varien *et al.* 1992; Huber and Lipe 1992). These included the Green Lizard Site, a small canyon bench habitation site located in Sand Canyon, Castle Rock Pueblo (mentioned above), and Sand Canyon Pueblo.

Results of the surveys and subsequent excavation programs indicated that within the locality there is a distinct change in settlement patterns from early to late Pueblo III (Adler 1992:21). During early Pueblo III times (approximately A.D. 1150 to 1230) settlements were small, typically consisting of single unit pueblos, and were dispersed broadly across the mesa top (McElmo Dome). During late Pueblo III times (A.D. 1230 to 1280) most of the small sites on the mesa top appear to have been abandoned. Small sites along the sides of Sand Canyon and the other minor drainages become more common. Construction of Sand Canyon Pueblo, a large multi-unit pueblo at the head of Sand Canyon, seems to have begun about A.D. 1250. This site soon grew to be the largest in the locality consisting of approximately 420 surface rooms, 90 kivas, 14 towers, a D-shaped bi-walled structure and a great kiva. During the occupation of Sand Canyon Pueblo, the number of small sites occupied in and around upper Sand Canyon appears to have continued to decrease (Adler 1992).

Faunal Studies

Preliminary analyses of faunal remains recovered from the site excavations (Neusius 1985; Walker 1990; Brand 1991; Munro 1994; Driver 1996; Driver *et al.* 1999) suggest that the changes in settlement patterns noted above were accompanied by changes in animal exploitation (see Figure 4, below). Driver (1996:366) has observed that faunal assemblages from the early Pueblo III sites (on the mesa top) primarily consist of

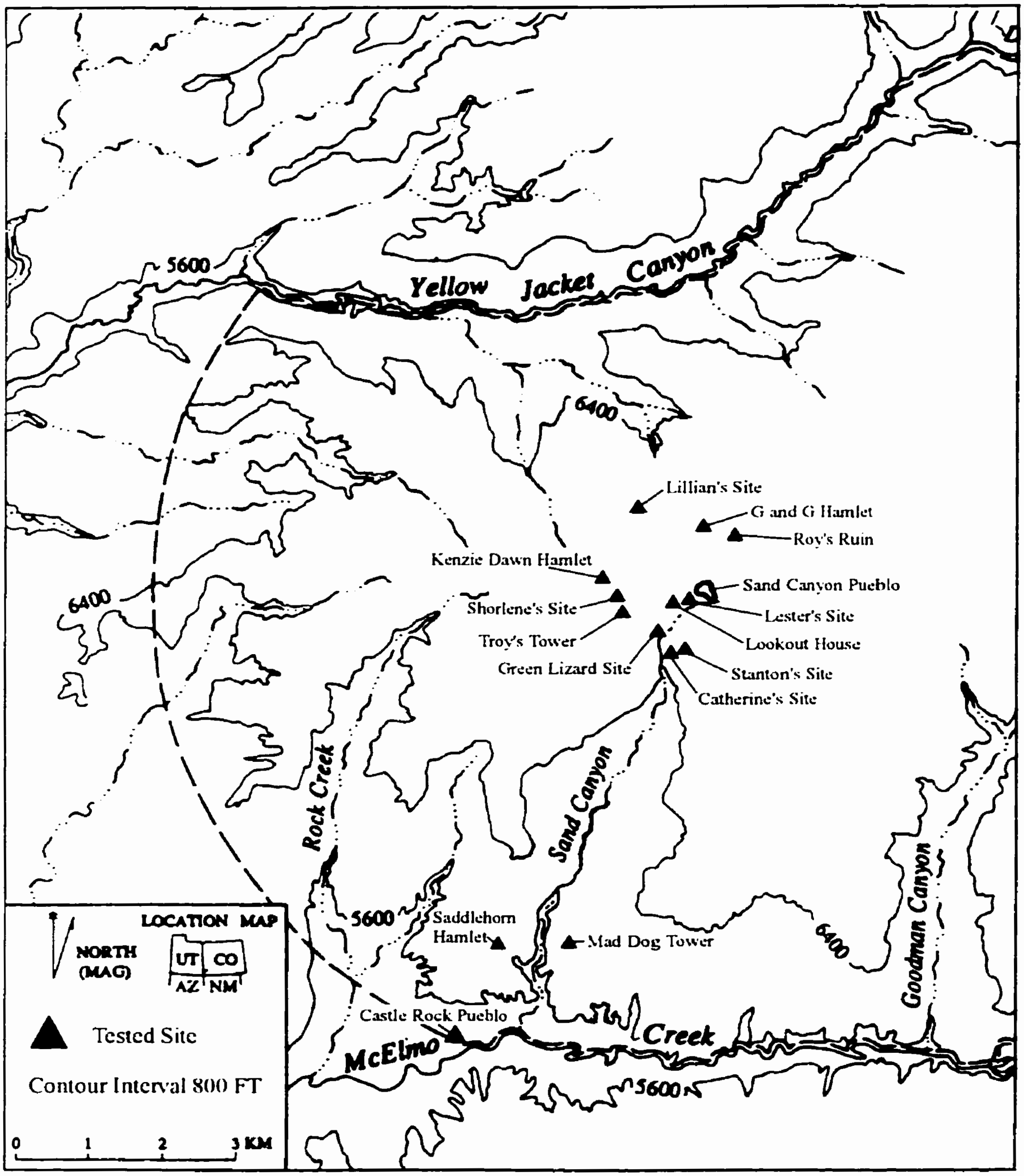

Figure 3. Investigated PIII sites in the Sand Canyon Locality (base map adapted from Lipe 1992a, with permission of the publisher).

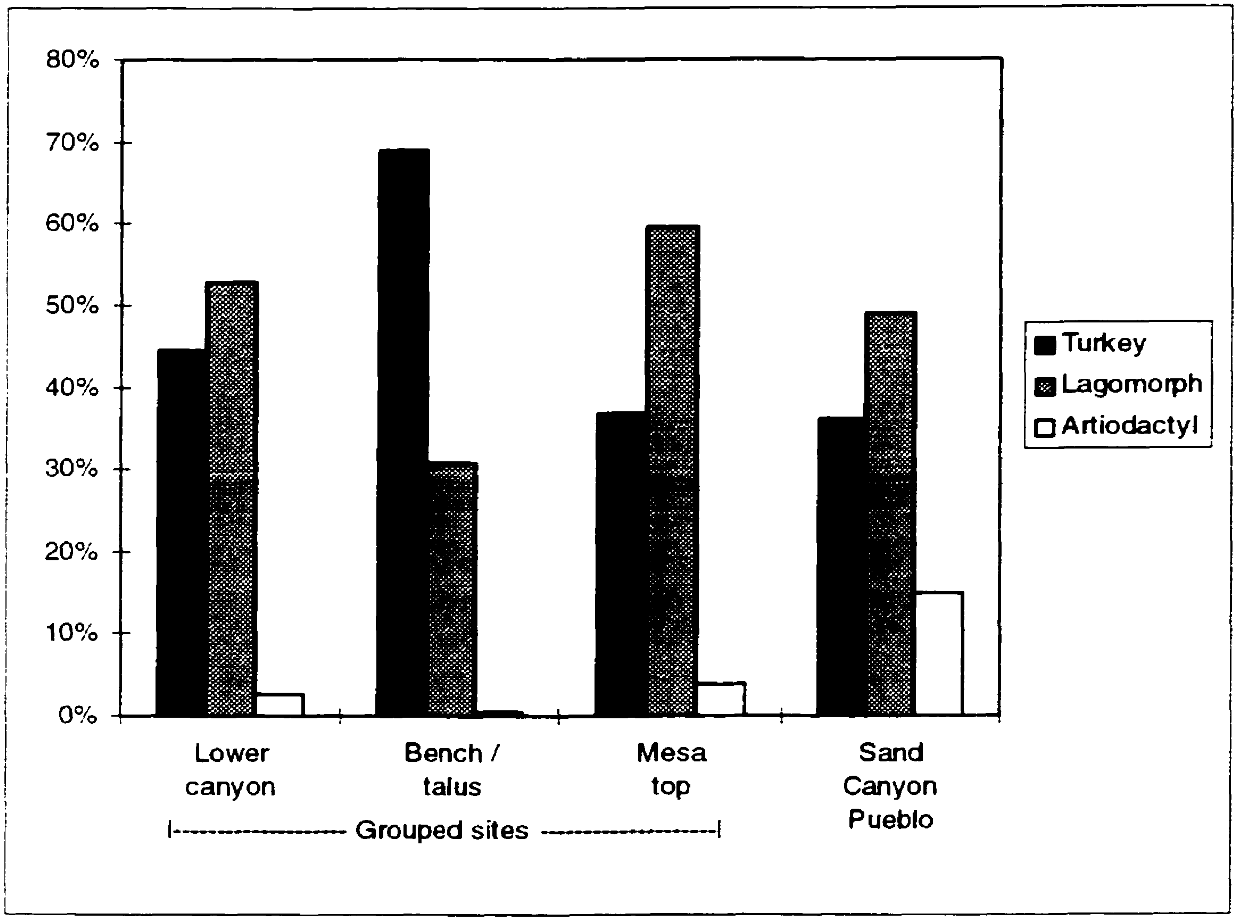

Figure 4. Relative frequency (% NISP) of turkey, lagomorph and artiodactyl remains from excavated sites in the Sand Canyon Locality, grouped by location (after Driver 1996:367).

lagomorph, and turkey remains, though small quantities of artiodactyls are also consistently present. This same pattern also was observed at the later Pueblo III sites located in the lower canyon area. However, the small late Pueblo III sites on the talus slopes and benches in upper Sand Canyon were dominated by turkey, followed by lagomorph, with only traces of artiodactyl. Previous analyses of a small sample of the faunal remains recovered from Sand Canyon Pueblo seem to suggest that this site contains a third assemblage pattern (Driver 1996). At this site artiodactyls are more common than at any of the other late Pueblo III sites. As interpreted by Driver these patterns suggest a relatively uniform use of fauna during early Pueblo III times, followed by three distinct patterns of faunal use at the late Pueblo III sites. In particular, it appears that Sand Canyon Pueblo may have obtained control of access to large game such as deer, bighorn and pronghorn. While he acknowledges that many factors may be responsible for this temporal variation, Driver (1996:371) has argued that increased social complexity may best explain the apparent change in access to animal resources:

> "The aggregation of population resulted in the emergence of powerful individuals or groups (*e.g.*, lineages or corporate groups) who controlled access to certain territory or who claimed the right to exploit certain species, notably deer. At the same time the heads of these groups took over certain ritual activities, possibly creating new integrative ceremonies centered in public architecture. These ceremonies may have required greater quantities of hunted animals, or the emerging elite may have been able to use their greater degree of social control to organise more frequent communal hunts."

Based on the same data, Munro (1994) has come to a somewhat different conclusion. She argues that the changes in taxon frequencies do not reflect preferential access to deer at Sand Canyon Pueblo so much as intensified use of turkey at the other late Pueblo III sites:

> "The occupants of the cliff/talus/bench sites are proposed to have migrated into the Sand Canyon Locality at a later date and therefore received marginal land, as the optimum arable land was already claimed by the original inhabitants [*i.e.*, the residents of Sand Canyon Pueblo]. Turkey production is argued to have intensified to serve as a dietary supplement. This is reflected in the high percentage of turkey bone in the cliff/talus/bench sites during the late Pueblo III" (Munro 1994:162).

Both authors qualify their conclusions as somewhat speculative, requiring further research. In particular, Driver (1996:371) emphasises the need for additional detailed investigation into the composition and organization of the faunal remains from Sand Canyon Pueblo.

Research Design

It is the intent of this study to determine: (1) whether or not the patterns identified by Driver (1996, as presented above) accurately characterize the variability in faunal remains distributions in the Sand Canyon Locality during the Pueblo III period; (2) to more precisely determine the nature of this variability; and (3) to identify and evaluate the potential "causes" of this variability. Ultimately, it is hoped that this study will assist in developing explanations for the emergence, growth and decline of an aggregated settlement system in the Sand Canyon Locality and in the understanding of the abandonment of the Northern San Juan Region at the end of the Pueblo III period.

Potential Causal Factors

While it is generally accepted that a single factor is unlikely to be solely responsible for the changes in settlement patterns, associated socioeconomic reorganization, and eventual regional abandonment of the Northern San Juan Region during the Pueblo III period, there are several 'prime movers' traditionally forwarded; these include: environmental, economic, social and ideological change (Cordell and Gumerman 1989:11-12; Lipe 1992b:130; Driver 1996). Each of these potential 'prime movers' deserve consideration in examination of the variability displayed by the faunal assemblages from the Sand Canyon Locality.

Regional environmental change during the Pueblo III period has been well documented based on tree ring (Douglas 1929; Van West 1990; Van West and Lipe 1992; Dean *et al.* 1994; Fish *et al.* 1994) and pollen studies (Petersen 1987, 1988, 1989). It is generally accepted that agriculturally favorable climatic conditions that prevailed throughout the late Pueblo II and early Pueblo III periods were interrupted by a cool dry period or "Great Drought" (Dean and Robinson 1977, 1978) near the end of the 13th century. It has been argued that favorable climatic conditions during the 12th century encouraged population growth throughout the region (Dean *et al.* 1994), and prompted a greater dependence on agriculture (Larson *et al.* 1996). As argued by Schlanger (1988) the subsequent "drought" would have resulted in a narrowing of the farmbelt and the Pueblo III inhabitants of the Sand Canyon Locality would then have been exposed to increasing pressure from climatic and geographic circumscription. It is possible that such pressures led to abandonment of the region. Indeed, several researchers have argued that population reorganization, movement, and particularly relocation were the primary means of mitigating the effects of short-term and long-term climatic variations common to the Southwest (Schlanger 1988; Gumerman 1994; Fish *et al.* 1994). As Fish *et al.* (1994:161-162) hypothesize:

> "Moving - abandoning one area for another - to bring additional, in some instances, more marginal land into cultivation may be the inexperienced

> prehistoric farmers' least-cost first solution to production shortfalls and the chronic cause of most abandonments in late prehistory."

It should be noted that the use of the term "inexperienced" (in the above quotation) is probably not appropriate to describe Pueblo farmers, whose ancestors' use of cultigens extends back to at least 500 B.C. (Yarnell 1977; Berry 1982, 1985). However, the recognition of mobility as a primary adaptive mechanism is significant here. While mobility is generally expected of hunter-gatherer societies, the prehistoric record of the southwest indicates that this behaviour also prevailed among village dwelling agriculturalists. Even during the Pueblo periods, populations were commonly shifting and relocating as little as every 25 to 35 years (Euler *et al.* 1979; Cordell 1984:313-317; Schlanger 1988).

There is ongoing debate regarding the severity of the "Great Drought", its impact on agricultural productivity and role in abandonment of the Northern San Juan Region. Investigation of climatic change and agricultural productivity in the Sand Canyon Locality and adjacent areas, for the period A.D. 900 to 1300 (Van West 1990, 1994, 1996; Van West and Lipe 1992) concluded that throughout this time there were always locations within the study area that could produce maize crops adequate to support the entire, or at least, a substantial majority of the resident human population. Specifically, Van West and Lipe (1992:118) state that:

> "...there was always enough productive land to produce sufficient maize to support a very large population (for example, an estimated 31,360 persons at a density of 21 persons/km^2 over the 400-year period), even in the relatively dry times of the middle twelfth and late thirteenth centuries. If mobility and access to productive land were not restricted, or if redistribution systems were in place to support dispersed populations or uneven production, then the prehistoric productive environment could have always sustained many people, even during the so-called Great Drought of A.D. 1276-1299."

They also note that similar droughts commonly occurred throughout the Southwest, without resulting in complete regional abandonments. In fact, a drought even more severe than the 'Great Drought' has been documented in the Northern San Juan Region during the mid 12th century (Van West 1990, 1994; Van West and Lipe 1992) during which population growth and settlement in the area does not appear to have been affected.

However, as acknowledged by Van West (1994:191), her model of agricultural productivity does not incorporate all potentially critical factors. Specifically, soil nutrient depletion, soil erosion, seasonal rainfall fluctuations and length of the growing season were not considered in her study. Petersen (1986, 1987) has argued that the latter variable (length of growing season) may have been the key limiting factor with respect to agricultural productivity during the late 1200's. Based on tree ring and pollen data from the La Plata Mountains and Dolores River Valley he concludes that the 'Great Drought' was not only characterized by decreased rainfall and cooler temperatures, but by a shortened growing season. Petersen (1986:323) states that:

> "During the A.D. 1275-1300 'great drought', the potential dry-farming belt in the Four Corners region may well have been pinched out due to relatively less winter and summer precipitation affecting the bottom of the belt, and shorter growing season affecting the top."

According to Petersen's analysis (1988:328) there was no potential dry-farming belt anywhere within southwestern Colorado during the period A.D. 1275 to 1300.

Van West (1994:191) dismisses Petersen's conclusions on the basis that her detailed tree ring data and intensive GIS analysis provides a much more precise record of environmental change than previously available, and that the data used to infer shortened growing seasons in the Dolores River Valley are not applicable to the Sand Canyon Locality given the topographical differences between the two areas.

Further fuel for this debate has been provided by Varien et al. (1996) who observe that the abandonment of the western portion of the Northern San Juan Drainage appears to have begun prior to the onset of the 'Great Drought'. Given this observation it is difficult to argue that drought was the sole causal factor in abandonment of the region. Furthermore, it seems that while climatic factors may well have contributed substantially to the abandonment of the region, drought does not, by itself, provide an adequate explanation for the preceding settlement pattern changes, nor the permanence of the regional abandonment. Economic and social factors related to population growth may have also been influential.

Demographic studies of the Northern San Juan Region suggest that human populations peaked throughout the region during the early Pueblo III period (Rohn 1989; Dean *et al.* 1994). This increase may have been due to agriculturally favorable climatic conditions during the late-12th and early to mid-13th centuries which encouraged natural population growth, or immigration of groups from the Chacoan sub-region of northwestern New Mexico (Rohn 1989). The increase in population may have stimulated or required adjustments in economic and social organization which are reflected by the evident settlement pattern changes. These changes may have been 'successful' while environmental conditions remained constant and/or the population remained below a certain level, only to prove 'maladaptive' once critical threshold levels were reached. As Larson *et al.* argue (1996:236): "a society is never more vulnerable to climate-related crises than after a period of exponential population growth during a favorable climatic period".

Isotopic and coprolite studies indicate that the Anasazi diet consisted primarily of plant resources, while animals represented a relatively minor secondary source of protein (Decker and Tieszen 1989; Minnis 1989; Stiger 1979). It has also been argued that the nutritional requirements of the Anasazi could have been met by cultigens alone in the Sand Canyon Locality (Van West and Lipe 1992). However, it is presumed here that meat was a valued resource and an important dietary component even if it was not nutritionally essential. Animal meat and fat provide a more complete protein than plant foods (Nickens 1981) and they are documented as highly desired resources in many societies (Jochim 1981; Hayden 1981; Speth 1983; Speth and Spielmann 1983; Abrams 1987; Kent 1989). Population increases may have resulted in stress on, and competition for highly valued resources such as large wild game. Munro (1994:153-154) has argued that regional population increases and restricted mobility on the Colorado Plateau lead to wild game scarcity in the Sand Canyon Locality. She further states that increased utilisation of land for agricultural activity has also been known to drive large animals from an area and may have contributed to the reduction. Such stresses may have prompted the need to restructure economic and social systems to accommodate communal procurement, redistribution, and/or exchange of scarce resources within and between communities.

Additionally, the scarcity of large game may have prompted intensified use of those animal resources which were readily available, particularly domesticates such as turkey.

By the late thirteenth century large pueblo communities were beginning to form elsewhere in the American Southwest, particularly in the Rio Grande, Mogollon Rim, Western Pueblo, Zuni, and Salado areas. These communities display evidence of new forms of community social and religious organization (Rohn 1989; Adams 1989, 1991) which may reflect new ideological concepts with respect to territoriality, ownership and wealth. As well, the settlement patterns in these areas suggest much stronger systems of interlocality and inter-regional exchange than are previously common in the Southwest (Lipe 1992b). As argued by Rautman (1993), intensified social interaction may have reduced the risk of resource stress by facilitating access to resources over a large area. This may have involved development of (formal or informal) local or regional resource re-distribution systems; thus, aggregation may be the product of changes in the organization of corporate labor related to specialized resource procurement and apportionment strategies associated with such systems (Leonard and Reed 1993; Driver 1996). Immigration may have resulted in the introduction of such "new" subsistence technologies (or knowledge), social systems, or religious beliefs to the Sand Canyon Locality. Any or all of these factors could have contributed to significant economic and social changes.

Questions, Hypotheses, and Expectations

The discussion above has briefly presented the predominant thoughts and arguments with respect to settlement patterns and abandonment of the Northern San Juan Region. Clearly this is a complex subject which is likely to be the focus of research and debate for years to come. Until now the data fueling this debate primarily have been in the form of demographic, environmental, architectural and ceramic analyses. This dissertation attempts to use faunal assemblage data to provide an additional perspective by addressing three specific research questions. These are:

1. Is there significant variability among the faunal assemblages from the 15 Pueblo III sites sampled in the Sand Canyon Locality?

2. If so, to what extent is the nature of this variability consistent with environmental, economic, and/or social factors?
3. What are the implications of the faunal data with respect to the emergence, growth and decline of aggregated communities in the Northern San Juan Region?

Key to addressing these questions is determining how the faunal data are likely to be influenced by each potential causal factor. Theoretically each of these should have specific, though not necessarily exclusive, detectable effects on human subsistence practices. Based on consideration of the influence of these hypothesized prime movers on animal procurement, utilization, and apportionment, it is possible to formulate expectations of how they are likely to be reflected in archaeological faunal assemblages. Table 2 presents a model of the patterning among the faunal assemblages expected for each potential causal factor.

<u>Environmental Change</u>. From a zooarchaeological perspective the primary effect of region wide environmental change would be changes in the animal populations available for exploitation. More specifically, if the Sand Canyon Locality was affected by severe drought then there should be apparent changes in the frequencies of environmentally sensitive taxa. Over a timespan as short as the Pueblo III period we would not expect to see the complete disappearance of many species within the area, but the relative abundance and geographic distribution of some animals are likely to change significantly. In particular, the frequencies of desert adapted species such as pronghorn, desert cottontail, jackrabbit, and sage hen should increase relative to animals adapted to moister environments such as mule deer, Nuttall's cottontail and grouse. Many desert adapted species are drought resisters or drought evaders which have evolved ways to circumvent aridity through physiological and behavioral adaptations (Smith 1980). For example, while mule deer and many other medium to large mammals drink intermittently throughout a given day, most pronghorn do so only once each 24 hours and some have been observed to go without water for a week at a time or rely exclusively on moisture from plants such as cacti (Wooding 1982:37). Similarly, unlike other lagomorphs, desert cottontail and

jackrabbits eat cacti and yucca from which they obtain moisture (MacMahon 1994:566). Animals which are less drought tolerant may become scarce within the region or be forced to congregate around available water sources, such as major drainages and springs. Changes in the natural populations of the animals should affect their availability to the human inhabitants of the area and thus be reflected in archaeological assemblages. These changes should be evident as consistent temporal shifts in species composition throughout the locality. Specifically, with the onset of drought in the latter portion of the Pueblo III period there should be an increase in the abundance of desert adapted species at all sites in the locality. Significant reductions in temperate game populations may also result in the need for long range hunting expeditions. These may be apparent by decreased skeletal completeness among such game, as only easily transported butchery units are brought back to the habitation sites. There may also be increases in the diversity of species represented in site assemblages as temperate game become scarce and substitutions sought. It is important to note that such diversity would not necessarily imply a more diverse diet or greater biodiversity in the locality, but rather would reflect the cumulative effect of a significant change in species exploitation through time at a single site. Finally, in times of drought wild animals, particularly those which are not drought tolerant, should be more readily available to residents of sites located near reliable water sources.

Economic Changes. Generally, economic changes due to local population increases are likely to affect which animals are readily available for dietary/utilitarian use, how these animals are procured, and how they are distributed within the community. Driver (1996:369) has presented several hypotheses relating to faunal variability due to economic factors, three of which are relevant here:

> "1. Aggregated human populations should overhunt locally available species (*e.g.*, those available in garden hunting), and one would expect larger species obtained from further away to become more important (Speth and Scott 1989). This should happen regardless of changes in social complexity, provided that aggregated sites are permanently occupied.
>
> 2. Aggregated human populations are required for communal hunting (Driver 1990), and one would expect that it would be easier to organize communal hunts in settlements where larger numbers of people lived.

3. Population aggregation may result in intensification of resource use, especially if local resources are over-hunted. Intensification can take many forms, including increased storage, increased food processing, greater reliance on domestic crops or greater reliance on domestic animals."

Based on these hypotheses we should expect that economic changes may be manifest zooarchaeologically in a number of ways. Faunal assemblages from sites throughout the locality may display reduced frequencies of animals associated with garden hunting through time. This is likely to include reduced quantities of small animals such as lagomorphs (particularly cottontails), rodents, and wild birds. This should be most apparent at large aggregated sites where population stresses would be greatest on the local faunal communities.

Economic intensification may take many forms but could be represented by increased turkey production and/or communal hunting activities. These should be evident in increased occurrence of turkey remains throughout the locality and by concentrations of large game at some sites. Long-range hunting may be indicated by incomplete skeletal representation among these animals (due to the 'schlepp effect' associated with long-range hunting) and possibly occurrence of wild game species from beyond the common catchment area of the site. Evidence of communal hunting should be most evident at large sites such as Sand Canyon Pueblo.

The spatial distribution of the remains within sites may also reflect the increased importance or changing economic roles of particular species. It is likely that patterned variation of the range and types of species found in 'private' *versus* 'public' and 'domestic' *versus* 'ritual' contexts will be notable if substantial economic changes have occurred. In particular, remains of game acquired during communal hunts may be predominantly found in 'public' areas such as courtyards, roofs, plazas or great kivas. Intensified production and use of turkey as a source of meat should be evident in the form of low species diversity among remains recovered from assemblages in 'domestic' contexts such as room floors, and house middens.

Social Changes. As argued by Potter (1997:108) faunal remains are particularly well suited to identifying social differentiation (or "social power") in contexts in which other material remains are usually unavailable or ineffective. The organization and distribution of archaeological faunal assemblages are usually the product of repeated (patterned), and in most cases unintentional or purposeless depositional behaviors. It is argued here that generally they reflect common daily activities to a greater extent than most other material remains and are the product of the true social and economic relations within the community. This is in contrast to intentional depositional behaviors such as mortuary practices which are less common and may reflect the perceived or desired structure of social relations more than true social differentiation (Rathje 1979; Young 1985). It follows that investigation of the distribution of highly valued animal resources may be a particularly effective means of assessing the degree and nature of social differentiation within a community.

Social changes are likely to affect the apportionment of species between communities as well as among individuals within a community. The context (ritual:domestic, public:private) in which particular species are used may also be affected. Three general hypotheses relating to social and ideological factors are presented here (from Driver 1996:369).

> "1. The emergence of social differentiation has been linked to control of valued or exotic resources (Hayden 1990). If animals were valued, we would expect to see differential use of food species based on perceived value as food items, or differential use of different body parts of the same species. These patterns could be observed between sites in a settlement hierarchy or between elite and non-elite residences within large communities.
>
> 2. In the case of domestic animals, breeding populations might be maintained by one social group [that] produced food for others. This economic specialization has been detected zooarchaeologically for state level societies (*e.g.*, Maltby 1979; Zeder 1991).
>
> 3. Aldenderfer (1993) has proposed that emerging social inequality is manifest in control over ritual. One might expect differential use of ritually important species in a society where ritual was being taken over by elites."

If substantial social changes occurred during the Pueblo III period in the Sand Canyon Locality variability in the distribution of 'highly valued' species from early to later sites should be evident. This is likely to be most clearly manifest in the distribution of large wild game, particularly artiodactyls. The hunting and sharing of large-bodied terrestrial mammals has been consistently tied to status enhancement in small-scale, sedentary societies (Kent 1989). This appears to be especially common in contexts where large mammals contribute little to the overall caloric intake of a population, and where the success rate of hunting large mammals is highly variable (Hawkes 1990). Social differentiation should be evident by substantial variations in the abundance of large game and/or large game element frequencies between contemporary sites and between room blocks at Sand Canyon Pueblo.

Economic specialization would be indicated by clustering of individual species, at particular sites or within particular portions of large sites. This may be most apparent among turkey remains, the production of which could be readily controlled through feeding and selective breeding. The demographic composition of such taxa may be characterised by unnatural age or sex ratios, associated with flock management.

Evidence of increased social hierarchy may be reflected in intensified and/or centralized ritual/ceremonial activities. This may result in increased clustering of ritual/ceremonial species within specific communal or public gathering areas. As well, a high degree of variability among species found in ritual/ceremonial contexts may be apparent through time, as ritual activities undergo change and elaboration.

<u>Microenvironmental Variability</u>. It should be noted that a fourth factor, microenvironmental variability, also may have contributed to the patterns evident among the faunal assemblages from the Sand Canyon Locality. As described above a fundamental characteristic of the change in settlement patterns in the Sand Canyon locality is a general movement from the mesa top to the canyon benches and valley bottom. This change in microenvironment may be responsible for some or perhaps all of the variability evident among the faunal assemblages.

Microenvironmental variability should also influence opportunities to hunt different animal species. However, unlike regional environmental change, species frequencies should vary from site to site depending on the local physiographic setting, rather than through time. If microenvironmental variability has had a significant effect on the faunal assemblages it should be possible to identify positive correlations between site settings and species frequencies. These correlations should be consistent with the structure of the faunal populations which inhabit the various site environments.

General Analytical Approach

Evaluating the expected patterns discussed above requires the ability to make comparisons between several variables at a variety of scales (*e.g.*, temporal, intersite, and intrasite). In order to accomplish this, consistent means of assessing assemblage composition and spatial organization within and between sites are required. The complexities of assemblage distributions and organization have been explored through detailed spatial analyses of faunal remains from Sand Canyon Pueblo and more general contextual comparisons within and between the other sites.

In order to ensure consistency between site assemblages a standardized system of identification and quantification has been applied to the faunal assemblages recovered from sites in the locality. While standardization does not necessarily ensure accurate identification or quantification of the remains, it does allow for considerable consistency between researchers and thus enables comparisons to be made between assemblages, with minimal concern for biases due to the experience, abilities, or predilections of individual analysts. The specific methods used in these analyses are presented in the following chapter.

Table 2. A model of expected variation among faunal assemblages in response to potential causal phenomena.

Phenomenon	Taxon Frequencies	Element Frequencies	Intersite Variation	Intrasite Distributions
Drought	⇒ Increased frequency of desert adapted species. ⇒ Increased species diversity.	⇒ Decreased skeletal completeness among large temperate game.	⇒ Greater abundance of wild game at 'late' sites located near permanent creeks or springs.	⇒ Few changes through time. ⇒ Little variability between sites of same age.
Economic Intensification	⇒ Increase in abundance of turkey throughout the locality.	⇒ Low skeletal completeness among large game at large sites.	⇒ Low species diversity at large sites. ⇒ Abundance of large game at large sites.	⇒ Large game clustered in public areas. ⇒ Low species diversity among household refuse.
Economic Specialization	⇒ Decreased species diversity through time.	⇒ Low skeletal completeness among turkey remains at large sites.	⇒ Disproportionate occurrence of turkey among contemporary sites.	⇒ Turkey remains clustered in specialized processing areas.
Social Differentiation	⇒ Little overall frequency change through time.	⇒ Evidence of apportionment of animals according to 'value'.	⇒ Disproportionate occurrence of 'valuable' species at large sites.	⇒ Highly clustered distributions of 'valuable' species.
Intensified Communal Ritual Activity	⇒ Increase in frequency of 'ritual' species.	⇒ Increased/disproportionate frequency of elements associated with 'ritual' paraphernalia.	⇒ Disproportionate occurrence of 'ritual' species at large sites.	⇒ 'Ritual' species clustered in public/ceremonial areas.
Environmental Variability	⇒ Correlations between species frequencies and microenvironmental settings.	⇒ Little variation between sites or change through time.	⇒ Assemblage variation according to micro-environmental settings.	⇒ Uniform species distributions through time.

CHAPTER 2

METHODOLOGY

Introduction

In this chapter the methods used in the analysis of the Sand Canyon Locality faunal assemblages are discussed in detail. The chapter first outlines procedures used in the collection, identification, description and quantification of the faunal remains. This is followed by a description of the methods used for intra-site spatial analyses and inter-site assemblage comparisons. Included are discussions of the theoretical and practical reasons for the selection of the particular methods used.

Faunal Analysis

Excavation and Collection

Excavation of the Sand Canyon Locality sites was conducted using a standardized procedure developed and implemented by Crow Canyon Archaeological Center (Adams 1984; Lightfoot and Bradley 1986). This included manual excavation of all "study units" (architectural unit, arbitrary unit, or trench) using masons trowels and screening of all materials through 6 mm (1/4 inch) mesh. Excavation was conducted stratigraphically, with each cultural or natural deposit being assigned a unique provenience designation (PD) number. Each PD has been described and interpreted with respect to its origin (natural or cultural), context (roof collapse, wall collapse, floor deposit, midden) and integrity (*defacto*, primary refuse, redeposited, disturbed).

It should be noted that while the establishment of standardized excavation procedures was intended to ensure consistent recovery of faunal materials from all sites, the expertise of fieldworkers and supervisors throughout the nine years of investigations was highly variable and this may have introduced some undetectable biases to the recovered samples. As well, the use of 6 mm mesh has certainly had an impact on the composition of the collected faunal assemblage, though it is notable that many specimens smaller than 6 mm were collected. The generally very compact deposit matrix common to all sites and associated slow pace of excavation resulted in many faunal remains, including very small specimens, being recovered *in situ*, in addition many very small specimens were recovered from matrix samples taken for flotation and sediment analyses.

Identification and Recording

The remains were identified through the use of comparative collections at Simon Fraser University, the University of Puget Sound (primarily rodents and small carnivores) and the Burke Museum, University of Washington (birds). Several osteological keys were also employed (including Lawrence 1951; Olsen 1964, 1968; Schmid 1972; Gilbert *et al.* 1981; Cook 1984), to assist in sorting and preliminary identification of some remains. Prior to identification and cataloguing, considerable effort was made to reconstruct elements which had obviously been broken recently (*i.e.*, broken during or after excavation). As it was desired to study the frequency of various culturally significant and natural fracture types, no attempt was made to reconstruct elements which displayed 'old breaks', although fragments which were obviously parts of the same bone were noted as such in the catalogue. Each fragment or reconstructed element was treated as a distinct individual specimen during quantification of the remains. This had the effect of allowing the assemblage to be viewed as it would have been just prior to excavation, with fragmentation caused by cultural and natural taphonomic processes reflected by the condition of the assemblage.

All of the Sand Canyon Locality faunal assemblages discussed in this dissertation were catalogued using a standardized identification and recording system developed by Jon Driver for Crow Canyon Archaeological Center (Driver 1991; see Appendix A). In accordance with this system the following information was recorded for each specimen: taxon, element, part, side, epiphysial fusion, breakage types, modifications, length of fragment, and cortical thickness.

Taxon and Element. In accordance with Driver's (1991, 1992) identification methodology, a specimen was only considered 'identifiable' if the skeletal element which it represented could be positively determined. Very general element categories such as 'long bone' or 'axial' were not employed. All specimens which could not be identified to a specific element were thus classified taxonomically as 'unidentifiable'. It is not uncommon for faunal analysts to assign non-diagnostic bone fragments to general taxonomic categories, such as 'miscellaneous mammal' or 'miscellaneous large bird', with little justification other than fragment size or surface texture. While in some instances it is possible to identify the class which a specimen represents based on such criteria, it is not possible to do so consistently. This inconsistency is further aggravated when several different analysts are involved in a study. Thus the requirement, that a specimen be identified as to skeletal element before being assigned to a particular taxon, is intended to ensure that analyses are not unduly biased by the intuition and guess-work of individual analysts.

All 'identifiable' specimens were identified to the most specific taxonomic category possible, given the limitations of the available reference collections and observable morphological variation. Identifications of specimens to the species level were only made on the basis of direct comparisons with modern skeletons. Osteological keys proved to be a valuable aid in sorting specimens to the family or genus level, but illustrations in general were not detailed or accurate enough to allow confident identification of species. Bones were assigned to a species or genus only when all other possibilities had been examined and ruled out on the basis of morphology and size, consequently many specimens had to be assigned to more general taxonomic categories. In some cases standard order and family designations have been used, but several less conventional categories have also been employed which require explanation. Most mammal remains which could not be identified to at least the family level have been assigned to "small mammal" (smaller than *Lepus americanus*), "medium mammal" (equal to or smaller than *Odocoileus* spp.), and "large mammal" (larger than *Odocoileus* spp.) categories. In some instances more precise categories have been used. "Small carnivore" is used for non-diagnostic specimens which obviously belong to 'smaller' (smaller than *Canis familiaris*) members of the order Carnivora. "Small rodent" is used for nondiagnostic specimens belonging to members of the order Rodentia which are smaller than *Sciurus carolinensis*. The designation "Fox" was used for bones which are obviously small Canidae, but could not be assigned positively to either *Urocyon* or *Vulpes*. Fragments of bird bones including longbone shafts, vertebrae, pelves, sternae and synsacra and non-diagnostic elements such as bird phalanges were also frequently classified according to standardized size categories: "small bird" (smaller than *Turdus migratorius*), "medium bird" (smaller than *Mergus merganser*), and "large bird" (*Mergus merganser*-sized and larger).

Part, Side, and Fusion. For each specimen the 'part' or portion of element represented was also recorded. A standardized recording system for documenting commonly occurring element fragments was used (Driver 1991). Using this system each specimen is described according to the presence and integrity of diagnostic features. For example, each long bone fragment is described with respect to the presence, absence and integrity of proximal and distal ends and the proportion of diaphysis present. Vertebrae fragments are described with respect to the presence, absence and integrity of the centrum, neural arch, and transverse processes. Limb bones and other paired elements were sided (left or right) when sufficient diagnostic features were preserved. The state of epiphysial fusion was recorded when appropriate element portions were represented on a specimen (*e.g.*, long bone ends, vertebral centra, proximal ribs). Three states of fusion were recognized including 'unfused' (epiphysis absent), 'just fused' (epiphysis present but with marked gap between epiphyses and diaphysis), and 'fused' (epiphysis and diaphysis firmly attached). A complete list of the taxonomic categories, element parts and other conventions used during analysis is provided in Appendix A.

Breakage Types. Breakage types were recorded in an effort to quantify different taphonomic processes which may have affected the assemblages. Nine types have been defined reflecting various natural and artificial processes acting on the bones. Those which are likely to be indicative of human activity include "artifactual" and "spiral" fractures. "Artifactual fractures" include those where evidence of deliberate human breakage of the specimen is present. This type of break manifests itself in the form of cut, ground or polished fracture surfaces. "Spiral fractures" consist of breaks that display a smooth spiraling surface. These fractures commonly result from breakage through torsion or percussion while the bone is still fresh or 'green' (Binford 1981). Spiral fractures are commonly considered evidence of human processing of bones; however, natural mechanisms can occasionally result in such fractures (Binford 1981:69-86).

Several breakage types reflect animal modification of specimens. "Carnivore fractures" include heavily macerated fractured surfaces, displaying carnivore tooth marks and punctures, indicating breakage of the bone by predatory or scavenging carnivores. "Rodent fractures" display extensive gnawing marks on the fractured surface. In many cases it was evident that the original fracture was not caused by rodents; however, the activity of these animals had completely obliterated the former breakage pattern.

The remaining break types reflect postdepositional processes that have acted on the bones. "Eroded fractures" display extremely porous and softly rounded fracture surfaces. In most cases erosion was probably not the primary cause of the fracture, but like rodent gnawing, effectively obliterated evidence of the original break type. "Eroded fractures" indicate extensive exposure to water, wind or sun. "Transverse fractures" consist of sharply defined linear fractures running perpendicular to the bone's proximal-distal axis. These breaks commonly occur to bones which have either been exposed to intense heat through cooking or burning, and/or have begun to mineralize (Johnson 1983:60). "Splintered fractures" display longitudinal fissures and cracks and may also display flaking of the bone surface. These breaks typically result from exposure to sun, air and moisture and are indicative of slow burial or repeated reburial episodes (Behrensmeyer 1978). "Excavator fractures" include fractures which obviously occurred during excavation, storage or analysis of the specimens. They are usually indicated by a 'fresh' angular fractured surface which is clean, displaying no staining or discolouration. As previously mentioned, prior to analysis, considerable effort was made to reconstruct fragments that displayed modern breaks. Fractures that did not clearly fall within the above categories were identified as "irregular". This final category included a wide range of breakage patterns of various and uncertain origins.

Modification. The presence of both natural and cultural modifications were also recorded according to Driver (1991). This included documentation of cultural modifications such as cut marks, grinding, polishing, and burning as well as modifications caused by animals, such as rodent and carnivore tooth marks and acid etching. Specimens that displayed surficial evidence of weathering were recorded as either being "weathered" or "heavily weathered". "Weathered" specimens include those which display surficial cracking and flaking of cortical bone, (comparable to weathering stages 1 and 2 as described by Behrensmeyer 1978). "Heavily weathered" specimens include those with rough and fibrous surface texture, extensive flaking and deep cracking (comparable to Behrensmeyer's stages 3 and 4). Weathering states of antler, ossified cartilage, or teeth were not recorded.

Evidence of burning is present on many specimens. Three types of burning were recorded: black, grey, and white, corresponding to the discoloration displayed on the bone due to carbonization and calcinization. It is presumed that black discoloration indicates a relatively short-term or low intensity heat exposure while grey and white represent progressively more extensive and/or intensive (*i.e.*, temperature) exposure (Shipman *et al.* 1984). Localized or patterned burning (such as discrete charring of long-bone ends) was also noted. It was hoped that such burning patterns might provide insight into specific butchery or cooking practices. It should be noted that evidence of heat exposure does not necessarily indicate human use of a given specimen, as house fires or wild fires may have resulted in the modification without any direct human contact or intent. It is also noteworthy that the absence of any such markings does not preclude the possibility of the bone having been cooked. Unfortunately, surface modifications to bones by most types of cooking (*i.e.*, boiling or roasting) appear to be largely indistinguishable from those caused by natural weathering and mineralization processes.

Quantification

Frequency data for the faunal remains from the Sand Canyon Locality sites are provided as number of identified specimens (NISP: Grayson 1979) counts. NISP or the "fragments method" (Chaplin 1971) is the most basic measure of faunal frequency. NISP counts represent the total number of specimens recovered from a site which can be positively identified as belonging to a particular taxon. NISP values are frequently used to determine relative abundance of taxa and are the most commonly used form of faunal data in archaeology. It is well documented that this quantification method has a number of potential problems (for a thorough discussion see Grayson 1979). In particular, NISP data will over-represent taxa with: 1) greater numbers of elements (Klein and Cruz-Uribe 1984; Payne 1972); 2) greater degrees of fragmentation (Grayson 1973, 1979; Watson 1979; Thomas 1969); and 3) higher rates of recovery (Watson 1972; Thomas 1969). Furthermore, NISP counts will produce artificially inflated sample sizes (Watson 1979). Despite these potential problems NISP data has been included here to allow direct comparison to faunal data produced by other researchers, but should not be considered a particularly precise estimate of taxon frequencies.

In an effort to circumvent some of the problems of NISP, many other quantification systems have been devised by various researchers, these include: diagnostic point counts (*e.g.*, Watson 1979; Driver 1985), bone weight, minimum number of elements (MNE) and minimum number of individuals (MNI) estimates (for a comprehensive list of zooarchaeological quantification systems see Lyman 1994). Of these 'alternate' systems the most commonly employed is MNI (White 1953). Many researchers have argued that MNI counts are far superior to those of NISP because they eliminate the problems of differential fragmentation and element frequency as well as problems of establishing specimen interdependence (Klein and Cruz-Uribe 1984; Casteel 1977; Grayson 1973; Chaplin 1971). In addition, it is claimed that, unlike NISP data, 'more relevant' measures of relative dietary significance of individual taxa, such as meat weight estimates, can be calculated directly from MNI values (Chaplin 1971; White 1953). However, MNI is plagued by many serious problems. One of the most basic of these is that few analysts agree on exactly how minimum number estimates should be calculated. The number and types of criteria considered during MNI calculations varies considerably from analyst to analyst, ranging from simply counting only complete bones and recording the highest frequency of a single element (White 1953), to producing higher MNI estimates by considering all complete and fragmented bones and pairing these based on length, sex and/or age distinctions (Chaplin 1971; Bokonyi 1970; Flannery 1967). Consequently, MNI values reported by different analysts are rarely directly comparable.

Other problems with MNI estimates include the tendency for the importance of 'rare' species to be exaggerated at the expense of common species when comparisons of relative frequency are made (Klein and Cruz-Uribe 1984; Casteel 1977). Also, MNI values will vary depending on how an assemblage is subdivided. Grayson (1973, 1979, 1984) has demonstrated that as an assemblage is subdivided minimum number estimates of the total assemblage change. In fact, MNI values can range anywhere between the 'true' MNI (when all specimens are grouped together) to NISP (when each specimen is considered as distinct subassemblage). Consequently, faunal materials from a site cannot be analysed spatially or stratigraphically using MNI, nor can MNI estimates from subassemblages be validly added together and used in tests of significance (Watson 1979).

Finally, and most significantly, Grayson (1984) has demonstrated that there is a consistent and statistically significant log-log linear relationship between MNI and NISP, indicating that MNI is not an independent measure of frequency but rather is simply a function of NISP. As such, MNI does not have any advantages over NISP but, instead, has only the added disadvantages of the aggregation effects mentioned above. For these reasons MNI estimates have not been used in this analysis.

Spatial Analysis

Evaluating the expected patterns of variability, presented and discussed in Chapter 1 (see Table 2), required comparison of the faunal assemblages among sites as well as consideration of the spatial organization of the remains within each site. In order to accomplish this, consistent means of assessing assemblage composition and spatial organization within and between sites were required. Though seemingly straightforward, there are numerous potential problems with conducting such analyses. In particular, assemblage composition is heavily influenced by sample size, making valid statistical comparisons between assemblages of different sizes difficult. There are also numerous practical and theoretical problems with interpreting assemblage composition and organization. This is particularly true of detailed intrasite spatial analyses (Carr 1984. 1985).

Spatial patterning of artifacts and features within sites have been used by archaeologists to make inferences about a variety of cultural phenomena. including: room function (*e.g.*, Hill 1968; Longacre 1970; Schiffer 1976); occupational specialization and intersettlement exchange (*e.g.*, Longacre 1966; Plog 1974; Demargo 1976); management strategies for technological inventories (*e.g.*, Gorman 1978); marital residence patterns (*e.g.*, Hill 1970; Longacre 1970); household organization (*e.g.*, Reid and Whittlesey 1982; Samuels 1989; Kapches 1990; Lowell 1991); gender linkage to activities and activity areas (*e.g.*, Longacre and Ayres 1968); ritual activity (*e.g.*, Muir 1988. 1990); and cultural complexity (*e.g.*, Hayden 1979; Hayden and Spafford 1993). Despite the widespread application of such studies. their success and value has frequently been limited by a general lack of consideration of what intrasite spatial patterning of artifacts and other cultural materials actually represent (Schiffer 1985; Carr 1984. 1985). Intrasite analyses are carried out with necessary underlying assumptions about the nature of. and relationships between. cultural behaviour and archaeological data. Most fundamentally. all intrasite spatial analyses are based on the assumption that human activity is spatially patterned. Presumably spatial patterning of cultural material will result from repetition in the physical location of activities. Factors influencing the consistent and repetitive use of space include practical considerations such as availability of ventilation. shelter. water. surface area (usable space). lighting. and heat. which are necessary for the performance of a specific activity. In addition to such practical constraints on the distribution of activities. cultural attitudes. traditions. and historical contingencies will influence where specific activities occur. These may be related to or independent of practical necessities. The 'need' for privacy. protection. cleanliness (physical and spiritual). or seclusion. for example. commonly influence the location in which specific activities occur.

It seems likely that archaeologists should find evidence of spatial patterning among cultural materials since. at the very least. the practical limitations of space evoke spatial patterning of activities. However. true patterning. from an archaeological perspective.

requires consistency through time. Unfortunately, such consistency does not always occur. As Binford (1980, 1982) has observed, the use of space by the Nunamiut, although to some extent patterned, continually changes on both the inter and intrasite levels through time. Because the archaeologist does not have the luxury of observing a culture at one particular point in time, but must instead deal simultaneously with patterns produced over a segment of time, spatial patterning can be easily obscured.

A second problem relates to taphonomy. Unfortunately, the archaeological record does not represent a complete and systematic inventory of the material culture and associated activities of the former inhabitants of a site. Instead, it is only those objects which have 'fallen out' of the system that are available to the archaeologist (Binford 1982). Schiffer (1972, 1976) and Binford (1977) have both argued that if archaeologists are to interpret past behaviour from archaeological remains they must understand the processes that contribute to the formation of the archaeological record. One of the most fundamental of these processes is the deposition of artifacts. How artifacts come to rest where they are ultimately found by the archaeologist and thus, how their distribution is related to and reflects past behaviour is a matter of great concern to archaeologists, particularly those attempting spatial analyses. Schiffer (1985) has developed a model of artifact deposition involving eight postulated processes which are responsible for the composition of house-floor assemblages. His model suggests that 'primary refuse' (cultural materials which are deposited in their original use location), will frequently be rarest type of deposit encountered by the archaeologist. Thus, most artifacts encountered by the archaeologists are materials which are in 'secondary' context. This model is supported by data accumulated by Murray (1980) who has studied clean-up or "intentional discard behaviour" among 79 cultural groups. As described by Murray it seems that almost all sedentary groups throw most garbage away from the use area. Detailed analyses of the spatial distribution of artifacts at long-term habitation sites, therefore, may tell the archaeologist nothing about where other activities besides discard were performed (Murray 1980:498).

On the other hand Murray (1980) found that migratory peoples generally demonstrate a different pattern. Migratory groups that have outdoor living spaces seem to be the only ones likely to discard elements at their use locations, although they may also discard some elements outside their use locations. We might, therefore, be relatively confident in defining activity areas on the basis of spatial distributions of artifacts at short-term habitation sites occupied by only some migratory populations. The only major exceptions to the patterns observed by Murray were the Bororo and the Nootka. Both of these groups are sedentary, yet, they were found to discard materials within, instead of outside, their dwellings.

It is evident that the archaeologist should expect to be left with very little evidence of activity areas within structures. The discussion above suggests that the only direct evidence of such areas will consist of 'exceptional' refuse deposits consisting of materials that were not intentionally discarded, such as lost or overlooked debris, stored items, and primary or *defacto* refuse which may have been left in place upon abandonment of the structure. It also seems that those areas that were most heavily utilized may be areas in which there is the least amount of cultural material. Thus, the only evidence of intensive use of such areas may, paradoxically, be the unusually low artifact densities that they display.

In addition to coping with the problems of depleted activity assemblages, there is evidence that even artifacts that are found in their original use areas may be misleading to the archaeologist. Binford (1978a) has noted that although the distribution of material culture at a site is the direct result of human activity, not all activity is accurately represented. For example his study of a Nunamiut hunting stand revealed that, although the majority of the activities which occurred at the stand were represented to some degree by material remains, the primary activity (hunting) was not represented at all. The activities that took place within such stands are, however, largely related to reducing the boredom levels of the occupants during their watch for game. David's (1971) study of activity area distributions at the Fulani compound also indicate that the distribution of material culture is not necessarily representative of the activities which occurred. David noted that the slightest changes in compound organization obscured actual patterns of behaviour.

Clearly, the processes involved in the creation of artifactual deposits are complex and may obscure rather than elucidate human behaviour. These problems of interpreting artifact patterning are further complicated by natural and cultural postdepositional transformation processes. This is a massive topic which has been dealt with in some detail by several researchers, particularly Schiffer (1972, 1976, 1983, 1985) and Cordell *et al.* (1987 and references therein). Generally, it is recognized that natural and cultural transformation processes can modify the archaeological assemblage in a variety of ways including physical displacement, removal, destruction and introduction of artifacts (Gifford 1981; Schiffer 1983). The recognition of the occurrence and effects of such processes is key to accurate interpretation of the archaeological record. However, whether such processes can be identified and their effects determined remains questionable (Schiffer 1983). Problems arise in distinguishing the patterns of interest from patterns caused by transformation processes.

It should be noted that attention to stratigraphic context has been paid in the past. This, however, is only the crudest form of assessing the physical context of assemblages. Artifacts that are found within a common strata do not necessarily posses a common cultural context. Burial and preservation of artifactual materials are the result of processes that are generally independent of human behaviour. As Binford (1982:17) points out the burial of cultural debris is not necessarily a cultural process. Since it is the burial processes that strongly condition the character of associations in buried deposits, it should be clear that assemblages defined in terms of depositional criteria are not necessarily discrete occupational episodes.

It is clear that the analysis of intrasite spatial patterning is a complex problem. The 'activity area' if present at all is likely to be represented by very subtle distributional characteristics and patterning. Fortunately, excavations of the Sand Canyon Locality sites have been conducted with concern for the complexities of archaeological deposits. As best as possible, attempts have been made to assess the cultural context of each depositional event encountered at each site. In addition, the Sand Canyon Locality sites have been tested using a standardized stratified random sampling scheme and data collection procedures. This has facilitated direct comparisons between sites, though assemblage size variability still presents some statistical problems.

In an attempt to circumvent the potential pitfalls of spatial analyses considerable effort is made here to gain an understanding of the taphonomic history of the Sand Canyon Locality faunal assemblages. While this requires, to a large extent, reliance on the observations and interpretations made during excavation, characteristics of the remains themselves are also examined in an attempt to gain further understanding of the origin of the specimens. This includes examination of the nature and frequency of modifications indicating natural or cultural disturbance of the deposits as well as consideration of possible natural agents which may have introduced or removed specimens from the assemblages.

In order to understand the complexities of assemblage distributions and associated cultural activities, spatial analyses are conducted at three scales: site wide, major contextual units (*i.e.*, room blocks, kivas, middens, courtyards, great kiva and D-shaped structure), minor contextual units (individual feature, floor, roof, and midden deposits), using three analytical techniques: contingency, diversity and cluster analysis. As presented and discussed in later chapters (4 through 6) the application of multiple methods at various scales allows for identification and evaluation of major spatial/contextual trends as well as more subtle patterns.

Contingency Analysis

The most basic means used to compare the Sand Canyon Locality assemblages and sub-assemblages is contingency analysis. Contingency analysis generally consists of comparing the observed frequency of items within various categories to their theoretically expected frequency based on random occurrence. In comparisons of the Sand Canyon Locality assemblages bi-variate contingency analyses are performed using various contextual variables (*i.e.*, site size, age, location) *versus* taxon frequencies. In this way the interdependency of taxon frequencies and each of the selected contextual variables is assessed. Similarly more detailed intra-site comparisons are made by examining taxon frequencies by major contextual units.

The contingency analyses is performed using the "multiway tables" application in "SYSTAT" (Wilkinson *et al.*, 1992:640-655). In these analyses the frequencies of animal taxa are compared between contexts or sites in a multiway contingency table. In each analysis data from all contexts or sites are pooled to derive 'expected' (*i.e.*, mean) taxonomic frequencies, assuming a perfectly uniform distribution. The observed values for each site or context are then compared to the expected values and standardized residuals calculated using the following formula:

$$\textbf{standardized residual} = \frac{\textbf{(observed - expected)}}{\sqrt{\textbf{expected}}}$$

By dividing the residual value (observed - expected) by the square-root of the expected value, each calculation takes into account, to some extent, differences in sample size and allows direct comparisons between observations. Using this application the Pearson chi-square statistic can be used to evaluate the variability displayed by the tabular array as a whole, while the standardized deviate values allow identification of the major sources of variability (Wilkinson *et al.* 1992:640).

Diversity Analysis

Assemblage and sub-assemblage diversity is measured using Kintigh's "Divers" computer application (Kintigh 1984). The "Divers" program measures diversity in two dimensions: richness, the number of different categories (or types) present; and evenness, the homogeneity of the distribution of counts across the categories. The measure of evenness used is a J-score, calculated as:

$$\frac{\Sigma\, p_i * \log 10(p_i)}{\log 10(k)}$$

where 'p' is the proportion of items in the assemblage belonging to category 'i' and 'k' is the total number of categories used.

The evenness value varies from 0.0, when only one category is present, to 1.0, when all categories are present in equal proportions. More information concerning the use and rationale behind this procedure can be found in Kintigh (1989, 1992).

In most measures of diversity sample size has a great influence on the resulting values. This is particularly true of assemblages that are dominated by a few common 'types' and include only sparse numbers of a wide range of relatively rare 'types'. In such cases assemblages with very large numbers of specimens will generally tend to appear to be more diverse than those with relatively few specimens. Kintigh's "Divers" method differs from most approaches in that it assesses the diversity of each assemblage in relation to the total population represented by all assemblages, and at the same time controls for sample size variations. This is done through pooling the data from all assemblages (or alternately through creating a data model of expected diversity) and randomly generating multiple simulated samples of all possible sizes using a Monte Carlo random draw procedure. That is, multiple simulated assemblages are generated randomly from the pooled data. The mean richness (number of categories represented) and evennness (J-score) observed for each sample size are then used as baselines for comparison of individual real assemblages. Assemblages that fall significantly above or below the calculated mean richness value for their sample size are considered abnormally (or significantly) rich or impoverished in types respectively. Similarly assemblages that have evenness values significantly above or below the calculated mean value for their sample size are considered abnormally homogeneous or heterogeneous respectively.

The Divers program is applied to the faunal assemblages from all sites in the Sand Canyon Locality in order to examine variability in assemblage diversity between sites of different age and size. In addition individual major contexts (*i.e.*, room blocks, kivas, middens, courtyards, great kiva and D-shaped structure) within Sand Canyon Pueblo are analysed in order to assess the degree and nature of variability among them.

Cluster Analysis

In order to examine the organization of the faunal remains within Sand Canyon Pueblo in more detail than is possible using either contingency or diversity analyses, a K-means cluster analysis of the assemblage is performed. K-means is a non-hierarchical divisive method of cluster analysis (Kintigh 1992:19; Kintigh and Ammerman 1982:39). Generally the method attempts to organize observation units (*e.g.*, point locations, artifact attributes or assemblage attributes) into clusters by minimizing variance within clusters while maximizing variance between clusters. The degree of clustering is measured by the "sum of squared distances from each unit to its cluster centroid" (or SSE). The analysis begins with all observation units included in a single cluster. One at a time, the observation unit farthest from its cluster centroid is identified and split-off to form a new cluster. After this, observation units that are closer to the new cluster centroid than to the original centroid are moved to the new cluster and the cluster centroids are recomputed. Each observation unit is then reassessed and reallocated to the cluster with the closest centroid. At each reallocation the cluster centroids are recomputed. This process repeats until an arbitrarily selected maximum number of clusters is formed. In the analyses presented here the maximum number of clusters is defined as 30 (this was the largest number of clusters that the computer program would allow).

Once observation units have been divided into the maximum number of clusters, one at a time, the two nearest clusters are lumped together and the centroids recomputed. Again the observation units are reassigned to the cluster with the closest centroid, and again at each reassignment the centroids are recomputed. New clusters are then split-off as long as a reduction in the SSE can be achieved. The process of lumping and splitting continues until all observation units are lumped back into a single cluster. The result is data on the best achieved configuration for each number of clusters, from 1 to the predetermined maximum number of clusters. The optimal number of clusters can then be assessed by searching for the clustering event which produced the greatest increase in SSE values.

For the Sand Canyon Pueblo spatial analysis each individual well defined contextual unit (*e.g.*, each floor, roof, courtyard, midden) is treated as an observation unit and relative taxon frequencies used as attribute data. The use of relative values rather than absolute NISP values, faunal remains densities or total population estimates is employed for several reasons. The possibility of using absolute NISP values was rejected due to dramatic variations in faunal remains densities from deposit to deposit. It was determined that the use of absolute NISP data in cluster analyses would simply result in observation units being clustered according to sample size rather than individual taxon frequencies. The use of faunal density data (*i.e.*, NISP/m^2) was attempted, but quickly rejected when it proved to also simply group observation areas according to overall bone densities rather than variations in taxonomic composition.

CHAPTER 3

SAND CANYON PUEBLO FAUNA

Introduction

In this chapter the Sand Canyon Pueblo faunal data are presented and discussed with respect to interpretation of the abundance and taphonomic history of the major taxonomic groups represented at the site. The spatial and temporal distribution of the remains will be discussed in Chapter 4, which will be followed by consideration of the significance of the data on local and regional scales (Chapters 5 through 7).

The data presented here include all faunal specimens collected from all excavations conducted at Sand Canyon Pueblo. As mentioned in Chapter 2 the remains have been recovered from a wide variety of contexts (*e.g.*, modern surface, room fill, refuse middens, rodent burrows, floor deposits, *etc.*), using various collection methods (*e.g.*, collected *in situ*, from 6 mm mesh screen, and from flotation samples). As such, it could be argued that all the remains should not be 'weighted' equally when making quantitative comparisons. This adds yet another troublesome dimension to the already problematic domain of quantitative analysis in zooarchaeology (discussed in Chapter 2). The data are presented here in this, perhaps over-simplified, form in order to allow for comparisons to similarly derived and presented data from other sites in the region. A more detailed assessment of the remains which includes consideration of their various contexts, taphonomic histories and biases introduced by excavation procedures is presented later in this chapter and in Chapter 4.

Taxon Frequencies

Tables 3 through 6 present the basic quantitative data for the Sand Canyon Pueblo faunal assemblage, based on NISP calculations of all collected specimens (including those which have been culturally modified and classified as 'artifacts'). A total of 17,628 specimens, including bone, teeth, antler, shell and ossified cartilage, were collected from the site. Of these, 10,852 (61.6%) could be identified to element and thus assigned to a specific taxonomic category (as discussed in Chapter 2). The remaining 6.776 specimens were catalogued as unidentified fragments.

As indicated in Table 3. mammal remains dominate the assemblage. comprising over 63% of the identified specimens. Birds are represented by approximately one third (33.8%) of the identified remains. while trace amounts of amphibians. reptiles and gastropods make up the balance of the assemblage. No fish remains were identified from Sand Canyon Pueblo. The absolute and relative frequencies of individual mammal. and bird remains are presented in Tables 4 and 5 respectively. Table 6 presents the frequency of amphibian. reptile and gastropod taxa.

Table 3. Frequency of identified faunal remains from Sand Canyon Pueblo by Class.

Class	Common Name	NISP	f
Amphibia	Amphibians	122	1.12 %
Aves	Birds	3.672	33.83 %
Mammalia	Mammals	6.929	63.86 %
Reptilia	Reptiles	128	1.18 %
Gastropoda	Snails	1	0.01 %
Totals:		10.852	100.00 %

The identified specimens represent a minimum of 41 mutually discrete taxonomic groups including at least 25 mammal and 12 bird taxa (as well as 1 amphibian. 2 reptile and 1 gastropod). It should be noted that many more taxonomic categories are potentially represented by the remains. as a considerable number of specimens have been assigned to general categories such as "medium carnivore". "Sciuridae" and "large bird". however. it is probable that the vast majority of these remains are of taxa already identified among the assemblage (*e.g.*. Canidae. *Spermophilus*. or *Meleagris* sp. respectively). Some exceptions to this presumption should be noted. specifically the "small bird" and Passeriformes categories likely represent a variety of species not already listed among those identified. Small birds are difficult to identify precisely. due to the extremely large number of potential species, and the very subtle physical differences between them (often undetectable osteologically).

Mammals

As presented in Table 4 the mammal remains include a wide variety of taxa, though many are represented by only a few specimens. The Lagomorphs are most common representing over 42% of the mammalian sub-assemblage. Cottontails (*Sylvilagus* spp.) are extremely abundant while jackrabbits (*Lepus* spp.) are represented in much smaller numbers. No pikas (*Ochotona* sp.) were positively identified among the remains, and it is notable that none of the remains identified simply as lagomorpha appeared to be small enough to represent pika. It is probably safe to conclude that pikas are not represented in the assemblage.

A considerable quantity of rodent remains were recovered from the site, comprising approximately 34% of the mammalian specimens. Small rodents including mice and voles (Muridae), woodrats (*Neotoma* spp.) and gophers (Geomyidae) are extremely numerous, and are probably under-represented given the potential for their very small bones to be lost or overlooked during excavation. The larger rodents primarily include ground squirrels, particularly rock squirrel (*Spermophilus variegatus*) and prairie dog (*Cynomys* spp.). Small numbers of porcupine (*Erethizon dorsatum)* and chipmunk (*Eutamias* spp.) round out the rodent remains.

Artiodactyl remains comprise less than 10% of the mammalian assemblage, but their presence is certainly as significant as any other taxon when one considers the relative size of these animals. At least three species are represented by the Artiodactyl remains: mule deer *(Odocoileus hemionus)*, pronghorn antelope *(Antilocapra americana)* and bighorn sheep *(Ovis canadensis)*. It is possible that additional species are also represented, particularly white-tailed deer *(Odocoileus virginianus)*. Positive differentiation between mule and white-tailed deer is very difficult and was only attempted for relatively complete antler fragments; that no specimens diagnostic of the latter species were identified should be considered of little significance. The majority of the artiodactyl remains were identified simply as "medium-artiodactyl", those which were identified more

Table 4. Frequency of mammalian taxa from Sand Canyon Pueblo.

Order	Taxon	Common Name	NISP	% Mammal	% All Taxa
Artiodactyla	*Antilocapra americana*	Pronghorn antelope	12	0.17	0.11
	Odocoileus hemionus	Mule deer	1	0.01	0.01
	Odocoileus spp.	Deer	213	3.07	1.96
	Ovis canadensis	Bighorn sheep	24	0.35	0.22
	Medium Artiodactyl	Deer-sized artiodactyl	414	5.97	3.82
	Artiodactyla	Even-toed ungulate	4	0.06	0.04
Carnivora	*Canis familiaris*	Domestic dog	4	0.06	0.04
	Canis latrans	Coyote	2	0.03	0.02
	Canis spp.	Dog, wolf, coyote	205	2.96	1.89
	Vulpes vulpes	Red fox	1	0.01	0.01
	Urocyon or *Vulpes*	Fox	8	0.12	0.07
	Canidae	Fox, coyote, dog, wolf	49	0.71	0.45
	Lynx rufus	Bobcat	4	0.06	0.04
	Lynx spp.	Lynx, bobcat	38	0.55	0.35
	Felidae	Lynx, bobcat, mountain lion	1	0.01	0.01
	Bassaricus astutus	Ringtail	4	0.06	0.04
	Procyonidae	Ringtail, raccoon, coati	1	0.01	0.01
	Mustela frenata	Long-tailed weasel	1	0.01	0.01
	Spilogale putorius	Spotted skunk	3	0.04	0.03
	Taxidea taxus	Badger	3	0.04	0.03
	Small Carnivore	Smaller than fox	1	0.01	0.01
	Medium Carnivore	Smaller than wolf	34	0.49	0.31
	Carnivora	Carnivore	2	0.03	0.02
Insectivora	Soricidae	Shrews	1	0.01	0.01
Lagomorpha	*Lepus* spp.	Jackrabbit or hare	135	1.95	1.24
	Sylvilagus spp.	Cottontail	2337	33.73	21.54
	Lagomorpha	Pika, rabbit, hare	464	6.70	4.28
Rodentia	*Cynomys* spp.	Prairie dog	37	0.53	0.34
	Spermophilus spilosoma	Spotted ground squirrel	1	0.01	0.01
	Spermophilus variegatus	Rock squirrel	65	0.94	0.60
	Spermophilus spp.	Ground squirrel	64	0.92	0.59
	Large Sciurid	Ground squirrel or larger	79	1.14	0.73
	Eutamias minimus	Least chipmunk	1	0.01	0.01
	Eutamias spp.	Chipmunk	1	0.01	0.01
	Sciuridae	Squirrel	709	10.23	6.53
	Erethizon dorsatum	Porcupine	4	0.06	0.04
	Thomomys spp.	Small pocket gopher	105	1.52	0.97
	Geomyidae	Pocket gopher	1	0.01	0.01
	Neotoma spp.	Woodrat	458	6.61	4.22
	Peromyscus spp.	Mouse	41	0.59	0.38
	Microtus spp.	Vole	34	0.49	0.31
	Muridae	Mouse, vole	570	8.23	5.25
	Dipodomys ordii	Ord's kangaroo rat	4	0.06	0.04
	Small Rodent	Woodrat or smaller	128	1.85	1.18
	Large Rodent	Larger than woodrat	1	0.01	0.01
	Rodentia	Rodent	67	0.97	0.62
Miscellaneous	Small mammal		316	4.56	2.91
	Medium mammal		277	4.00	2.55
		Totals:	6929	100.00	63.86

precisely are predominantly of deer (*Odocoileus* spp.). It is significant to note that no extremely robust specimens suggestive of large artiodactyls, such as elk or bison were identified among the remains.

The order Carnivora is represented by a wide variety of taxa, though each in small quantities. *Canis* (dog, coyote, wolf) is by far the most common carnivore: both domestic dog (*C. familiaris)* and coyote (*C. latrans*) were positively identified among these remains. *Lynx* are also well represented. These remains may be of bobcat (*L. rufus*) or Canada lynx (*L. canadensis*), though the latter is less probable given its preference for heavily forested environments and northern latitudes (Wooding 1982:130-132). Small quantities of fox, ringtail cat, weasel, skunk, and badger are present among the carnivore remains.

Finally, the order Insectivora is represented by a single shrew mandible.

Birds

Two taxa dominate the bird (*Aves*) remains, *Meleagris gallopavo* and "Large Bird"; together these represent close to 93% of the bird sub-assemblage (Table 5). This undoubtedly reflects the predominance of Turkey remains present at the site. Other large birds such as geese and cranes may also be represented by the "large bird" category, though likely only in very small proportions. In addition to Turkey small quantities of other Galliformes (including quail and grouse) were also identified.

Passerine birds comprise less than 2% of the bird sub-assemblage. Among these specimens Raven (*Corvus spp.*) is conspicuous and easily identified due to its relatively large size. These remains likely represent the Common Raven (*C. corax*) which is native to the area, but the smaller Chihuahuan Raven (*C. cryptoleucus*) could not be excluded due to limited comparative specimens. It is significant to note that several smaller passerine species are also present but could not be identified to species.

Birds of prey, including members of the orders Falconiformes and Strigiformes, are also represented, comprising approximately 1.4% of the bird remains. Among these the American Kestrel (*Falco sparverius*) is particularly prominent, while hawks (*Buteo* sp.), Turkey Vulture (*Cathartes aura*) and Great Horned Owl (*Bubo virginianus*) are represented to lesser degrees.

Table 5. Frequency of bird (*Aves*) taxa from Sand Canyon Pueblo.

Order	Taxon	Common Name	NISP	% Bird	% All Taxa
Anseriformes	Aythyini	Bay Ducks	1	0.03	0.01
	Branta canadensis	Canada Goose	1	0.03	0.01
Caprimulgiformes	*Phalaenoptilus nuttall*	Poor-will	1	0.03	0.01
Columbiformes	*Zenaida macroura*	Mourning Dove	12	0.33	0.11
Falconiformes	*Buteo* sp.	Misc. Hawk	11	0.30	0.10
	Falco sparverius	Kestrel	18	0.49	0.17
	Falco sp.	Misc. Falcon	4	0.11	0.04
	Cathartes aura	Turkey Vulture	9	0.25	0.08
	Falconiformes	Eagle, Hawk, Falcon, Vulture	4	0.11	0.04
Galliformes	*Callipepla squamata*	Scaled Quail	3	0.08	0.03
	Phasianidae	Misc. Quail	1	0.03	0.01
	Dendragapus obscurus	Blue Grouse	1	0.03	0.01
	Tetraonidae	Misc. Grouse	2	0.05	0.02
	Meleagris gallopavo	Turkey	1447	39.41	13.34
	Galliformes	Turkey, Grouse, Quail	18	0.49	0.17
Gruiformes	*Grus canadensis*	Sandhill Crane	4	0.11	0.04
	Fulica americana	American Coot	1	0.03	0.01
Passeriformes	Corvidae	Jays, Crows and Ravens	32	0.87	0.30
	Corvus sp.	Raven	14	0.38	0.13
	Passeriformes	Perching Birds	20	0.54	0.18
Strigiformes	*Bubo virginianus*	Great Horned Owl	2	0.05	0.02
	Strigiformes	Owls	2	0.05	0.02
Miscellaneous	Bird		8	0.22	0.07
	Large Bird		1961	53.42	18.07
	Medium Bird		68	1.85	0.63
	Small Bird		27	0.74	0.25
		Totals:	3672	100.00	33.83

Columbiformes are represented by 12 specimens comprising 0.3% of the bird subassemblage. The Mourning Dove (*Zenaida macroura*) is the single representative of this order. This is not surprising given that it is the only species of dove native to the area. All other bird taxa are represented in very small quantities; frequently by only a single specimen. It is notable that a considerable number of bone specimens representing medium-sized and small birds were identified, but could not be assigned to more specific taxonomic categories.

Amphibians, Reptiles, and Gastropods

The small numbers of amphibian, reptile and gastropod remains recovered from Sand Canyon Pueblo are presented in Table 6. Identification of these specimens is severely hindered by a lack of comprehensive comparative collections. The identifications presented here are made on the basis of reference texts with the aid of the few specimens available in the Simon Fraser University zooarchaeology lab. Among the amphibian remains numerous specimens can be positively identified as representing spadefoot toads (Pelobatidae), this group encompasses all of the toads common to the Four Corners region. Both lizards and snake remains are identified among the reptile sub-assemblage, though it is perhaps more significant to note that no turtle remains (usually fairly distinctive) are positively identified. Little effort was made to further identify the single gastropod specimen as its cultural significance was considered limited.

Quantitative Biases due to Destruction of Remains

As discussed in Chapter 2, bone fragmentation can have extreme effects on the quantification of animal remains. In addition to bone fragmentation as the result of carnivore activity or human processing, exposure to moisture, wind, and sun can result in damage or destruction of animal bones. While the primary variable affecting the degree of bone weathering is the rate of burial, other factors will also have some influence. Bones weather differently depending on natural attributes including density, size, and grease content, as well as cultural factors such as processing, cooking, and disposal practices. Because of these factors some species may be more susceptible to destruction due to weathering than others. This may influence the relative frequency of these species recovered and identified archaeologically. Table 7 lists frequencies of weathered bone (see definitions in Chapter 2) in the Sand Canyon Pueblo faunal assemblage. It is clearly evident that some taxa have been more severely impacted by destructive weathering processes than others. In particular, one quarter of the artiodactyl remains display evidence of destruction due to weathering. Other mammalian taxa including several categories of carnivores and "medium mammal" also display considerable numbers of weathered specimens. Weathering is apparent on a comparatively small percentage of the

Table 6. Frequency of amphibian, reptile, and gastropod taxa from Sand Canyon Pueblo. assemblage.

Class	Taxon	Common Name	NISP	% All Taxa
Amphibia	Pelobatidae	Spadefoot toads	61	0.56
	Amphibia		61	0.56
Reptilia	Iguanidae	Lizards	23	0.21
		Snakes	105	0.97
Gastropoda		Snail	1	0.01
		Totals:	251	2.31

Table 7. Frequency of weathering among faunal remains from Sand Canyon Pueblo.

Taxon (NISP)	Weathered		Heavily Weathered	
	n	%	n	%
Artiodactyla (668)	164	24.6 %	3	0.4 %
Large Bird (1961)	61	3.1 %	2	0.1 %
M. gallopavo (1447)	46	3.2 %		
Medium Mammal (277)	26	9.4 %	1	0.4 %
Sylvilagus spp. (2337)	17	0.7 %		
Canis (211)	11	5.2 %		
Medium Carnivore (34)	3	8.8 %		
Canidae (49)	3	6.1 %		
Sciuridae (955)	3	0.3 %		
Fox (9)	2	22.2 %		
Small Bird (12)	2	16.7%		
Carnivora (2)	1	50.0 %		
Medium Bird (68)	1	1.5 %		
Geomyidae (106)	1	0.9 %		
Lepus spp. (135)	1	0.7 %		
Muridae (645)	1	0.2 %		

"large bird" and *M. gallopavo* remains. Two "small bird" specimens display evidence of weathering representing a relatively large percentage of this taxon, but a very small percentage of bird remains in general. Very little weathering is apparent among the small mammal bones.

The variability in degree of weathering may be due to cultural or natural processes (as mentioned above); however, whatever the cause, the result is that some taxa, particularly the artiodactyls, have been selectively depleted and consequently are likely under-represented in the assemblage as a whole.

Cultural *vs.* Natural Bone Accumulations

It should not be assumed that all animal remains recovered from Sand Canyon Pueblo or any archaeological site are the result of human activity. Non-human factors may have contributed to the presence of particular specimens or species. For this reason, careful consideration of the possible origins of animal remains should be made prior to drawing cultural inferences from the data. In general, the introduction of animal remains to archaeological sites will occur as the result of one of four processes: 1) death of 'domesticated' animals raised on the site by humans; 2) trapped or hunted animals transported to the site by humans; 3) natural death of wild animals which lived and died on the site; or 4) dead animals transported to the site by non-human predators or scavengers. While the first two processes relate directly to the human occupation of the site, the latter two may be independent of human occupation and thus unrelated to cultural activities at the site (occurring before, during or after occupation of the site).

Considerable attention has been paid to identification of natural death assemblages for medium and large mammals, particularly ungulates (*e.g.*, Brain 1980, 1981; Binford 1981; Haynes 1982; D'Andrea and Gotthardt 1984; Blumenschine 1986), and there is an ever growing body of literature pertaining to determining the taphonomic origin of smaller animals (e.g., Dodson and Wexlar 1979; Kusmer 1986; Andrews 1990; Shaffer 1992), such as rodents, birds, snakes and lizards. These studies have been primarily concerned with the identification of damage to bone and the resultant element frequencies caused by carnivore and raptor predation. While identification of cultural modification of medium and large mammal remains can usually be confidently assessed on the basis of fairly discrete criteria such as cut marks and breakage patterns, the origins of smaller animals are more difficult to assess. These animals are usually included or excluded from consideration in archaeological analyses based solely on ethnographically observed practices. There is a potential danger in such use of ethnographic literature in that it promotes the formulation of circular arguments and leads to stagnant and possibly erroneous interpretations of archaeological data. Despite the relatively limited amount of literature devoted to cultural modification of small animals it should be possible to deduce some characteristics which are indicative of either natural or artificial taphonomic processes. Definite indications of human procurement may not always be evident for all taxa, and it is certainly impossible to determine the taphonomic history of each individual specimen. However, consideration of artificially and naturally produced modifications should provide a basis for assessment of the most probable taphonomic origin for each taxa.

Culturally Modified Bone

Human procurement may produce modifications to remains which are wholly distinct such as grinding, polishing, or cut marks. Remains that display such characteristics are obviously indicative of human use of the taxa that they represent, although such markings are not likely to occur on all, or even a majority of culturally introduced specimens. Evidence of burning, such as carbonization or calcinization, may be a more common characteristic of culturally utilized taxa, though naturally deposited bones may become charred as the result of wild fires, or accidental house fires (Grayson 1988; Lyman 1988). Human procurement can also produce characteristic breakage patterns including sawed or cut edges. Spiral (or green bone) fractures are frequently considered indicative of human activity, however, these can be produced by several natural agents including carnivores (Binford 1981), natural traumatic injury (Lyman 1984), or trampling (Haynes 1983). Extreme damage to bone may also result from human procurement. For example, ethnographic sources describe Puebloan practices of grinding small animals such as rabbits to a fine pulp during food preparation (Tyler 1964). Archaeologists may be helpless in recognizing these latter practices since under such circumstances the bones would be ground into small fragments which would likely be unidentifiable, if recovered at all.

Considering the evidence of cultural modification displayed by the Sand Canyon Pueblo faunal assemblage (Table 8) a 'cultural origin' for some remains can be inferred with considerable confidence. Six taxonomic groups (*Lynx* spp., *M. gallopavo*, Artiodactyla, *Canis* spp., *Lepus* spp., and *Sylvilagus* spp.) are represented by multiple specimens displaying direct cultural modification in the form of grinding, polishing and cut marks. In some cases such modification is extremely common. This is particularly true of the *Lynx* remains, of which 19% have been made into tools or other artifacts. All these taxa also include numerous specimens that display burning and spiral fractures. Two additional taxa: *Strigiformes* and *Grus canadensis*, also include single specimens that display direct evidence of cultural modification (grinding/polishing and cut marks respectively). Each of these taxa is represented by very few specimens, so it is not surprising that multiple examples of cultural modification are absent.

The remaining taxa display no definite evidence of cultural modification, leaving their origin uncertain. Four of these: "small bird", Corvidae, Sciuridae and *Neotoma* sp., each include multiple specimens displaying burning and spiral fractures, though in the case of the latter two taxa these occurrences are extremely rare (between 0.5 and 1.1% of specimens). Burning is also apparent on single specimens of *Zenaida macroura*, Geomyidae, and Iguanidae. Spiral fractures are evident on small numbers of Tetraonidae and Muridae. It is notable that no evidence of cultural modification was present on any of the Falconiformes (NISP = 46), snake (NISP = 105), or amphibian (NISP = 122) remains despite their considerable representation at the site. Numerous very rare taxa (*i.e.*, NISP < 10), such as Anseriformes, fox, mustelids and Soricidae also do not display evidence of cultural modification, though this should be considered of little significance given their very small numbers.

Table 8. Evidence of Cultural Modification.

Taxon (NISP)	Spiral Fractures		Burning		Cut Marks		Ground/ Polished	
	n	%	n	%	n	%	n	%
Lynx spp. (42)	1	2.4	5	11.9	1	2.4	8	19.0
M. gallopavo (1447)	49	3.4	89	6.2	19	1.3	132	9.1
Artiodactyla (668)	63	9.4	49	7.3	25	3.7	59	8.8
Canis spp. (211)	3	1.4	9	4.3	5	2.4	16	7.6
Lepus spp. (135)	13	9.6	2	1.5	1	0.7	5	3.7
Sylvilagus spp. (2337)	125	5.3	69	3.0	2	0.1	4	0.2
Strigiformes (4)			1	25.0			1	25.0
Grus canadensis (4)					1	25.0		
Small Bird (27)	3	11.1	3	11.1				
Corvidae (46)	1	2.2	3	6.5				
Sciuridae (955)	9	0.9	5	0.5				
Neotoma spp. (458)	5	1.1	4	0.9				
Zenaida macroura (12)			1	8.3				
Geomyidae (105)			1	1.0				
Iguanidae (23)			1	4.3				
Muridae (645)	2	0.3						
Tetraonidae (3)	1	33.3						

Naturally Modified Bone

Bones that are the result of killing and/or consumption of animals by predators and scavengers may display several distinctive modifications. Most obvious are tooth marks which may be present as the result of mammalian carnivore activity (Binford 1981), although the bones of very small animals may be totally consumed by predators, such as owls, without extensive modification (Dodson and Wexlar 1979; Kusmer 1986; Andrews 1990). Bones may also display spiral fractures (Binford 1981) or be extensive macerated (Korth 1979), as the result of carnivore predation. Long bone ends are frequently gnawed by carnivores and diaphyses split to obtain marrow. Licking of long bone ends by carnivores and other animals may result in smooth polished surfaces, which closely resemble culturally modified bones (Haynes 1980: Binford 1981). In such cases crushed bone and tooth marks may be evident elsewhere on the specimen. Acid etching of cortical bone may be evident on bone fragments which have passed through a carnivore's digestive tract (Andrews 1990:30).

Despite these fairly distinctive characteristics, the identification of taxa introduced to the Sand Canyon Pueblo site by carnivores is complicated by the fact that the Anasazi are known to have kept domestic dogs. Dogs are quite likely to have had access to discarded animal remains and could easily produce modifications indistinguishable from those made by wild carnivores.

Table 9 presents the frequency of carnivore modification to faunal remains from Sand Canyon Pueblo. Carnivore modification is evident among eight taxonomic groups. It is significant to note that carnivore modification is relatively common to two taxa (Artodactyla and *Meleagris*) which are almost certainly of cultural origin. Unfortunately, the data do little to clarify the origin of the other taxa.

Unmodified, predominantly complete bones should result from the natural deaths of animals living on a site (Driver 1985:18). Burrowing animals that are not killed by predators commonly die in their burrows and should display little bone damage due to

Table 9. Evidence of Carnivore Modification.

Taxon (NISP)	**Carnivore Modification**	
	n	**%**
Artiodactyla (668)	37	5.5 %
Sylvilagus spp. (2337)	34	1.5 %
M. gallopavo (1447)	22	1.5 %
Sciuridae (955)	5	0.5 %
Canis spp. (211)	3	1.4 %
Neotoma spp. (458)	2	0.4 %
Lepus spp. (135)	1	0.7 %
Zenaida macroura (12)	1	8.3 %

weathering or trampling. Animals that are killed and then processed by humans for food or raw materials are more likely to be represented by fractured specimens, particularly long bones which are commonly broken to extract marrow. Table 10 presents a comparison of complete and fragmented long bones of animals which may have naturally inhabited and died in burrows or dens at Sand Canyon Pueblo. Only major long bones are considered here in order to mitigate biases due to element size, recovery rates and identifiability. The humerus, femur and tibia have been selected for consideration due to their relatively large size and diagnostic characteristics. Taxa for which fewer than 10 long bone specimens are represented are not included in the analysis (*i.e.*, fox, *Lynx* spp. and amphibians). It should be noted that variation in the size of the taxa may still introduce some biases into the comparisons presented. In particular, the extremely small size of Muridae (mice and vole) long bones may influence the rate of recovery of fragmented specimens (*i.e.*, complete Muridae long bones may be far more likely to be recovered than fragmented ones).

Table 10. Frequency of complete and fragmented major long bones* among selected taxa.

Taxon	**Complete**		**Fragmented**	
	n	**f**	**n**	**f**
Lepus spp.	2	10.0%	18	90.0%
Sylvilagus spp.	130	25.0%	391	75.0%
Sciuridae	142	67.6%	68	32.4%
Neotoma spp.	83	67.5%	40	32.5%
Geomyidae	12	80.0%	3	20.0%
Muridae	156	84.3%	29	15.7%

* major long bones include humerus, femur and tibia only.

The data presented in Table 10 indicate two distinct patterns. These are more clearly illustrated by Figure 5. The *Lepus* and *Sylvilagus* long bone remains are predominantly represented by fragmented specimens, the other taxa (all rodents) are dominated by complete elements. While the frequencies may, in part, reflect size differences between the taxa, particularly among the smaller rodents (as mentioned above), the differences between the similarly proportioned Sciuridae and *Sylvilagus* remains are unlikely due to factors associated with recovery rates or identifiability.

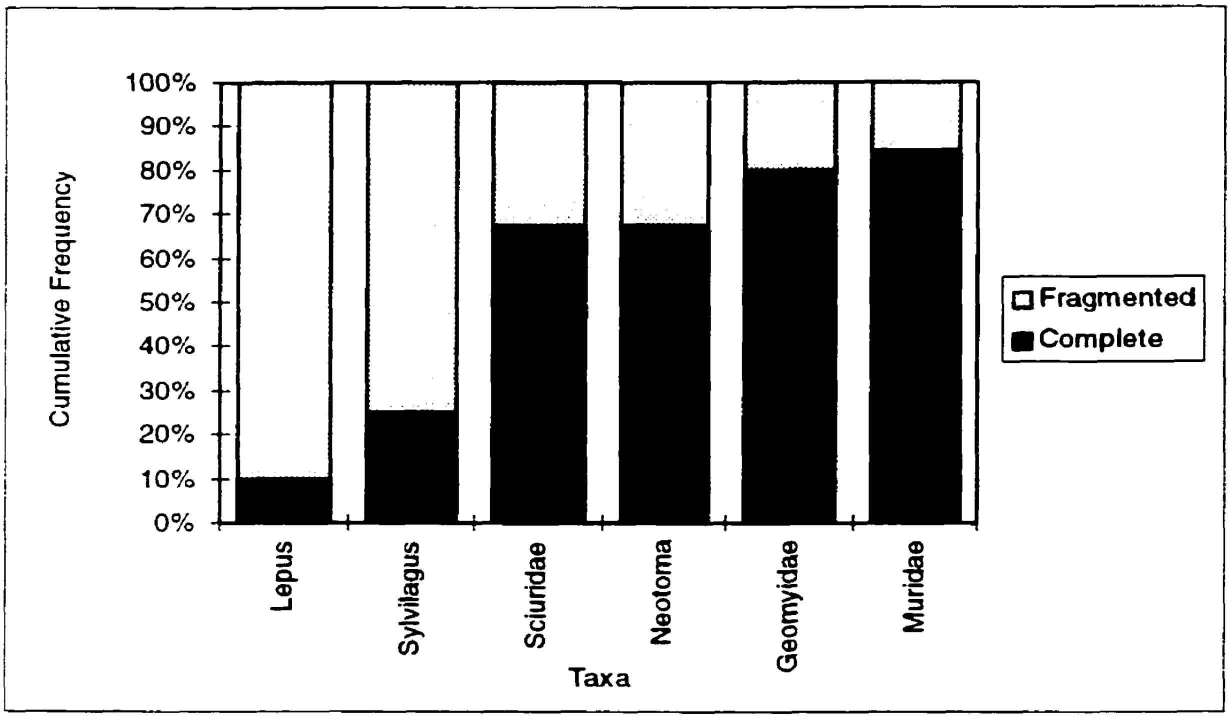

Figure 5. Relative frequency of complete and fragmented major long bones for selected taxa from Sand Canyon Pueblo.

The fragmentation data support the argument that the taphonomic history of the lagomorphs and rodents vary considerably. Specifically, the relatively rare fragmentation of rodent long bones is consistent with the remains primarily representing animals which died naturally in their burrows. Conversely, the high frequency of fragmentation among the lagomorph long bones lends further support to the conclusion that these specimens are primarily a product of cultural activity (as suggested by the evidence of cultural modification presented above).

Taphonomic Origins of the Faunal Remains

Based on the above analysis and discussion some conclusions regarding the taphonomic origin of the faunal remains can be drawn. Several taxa can be confidently assessed as being, at least in part, the result of human activities. These include all those taxa that display definite indications of cultural modification (*i.e.*, cut marks, polishing, or grinding). Specifically these include: ***Lynx***, ***Meleagris***, Artiodactyla, ***Canis***, ***Lepus***, *Sylvilagus*, Strigiformes and *Grus canadensis*. It is also possible that significant numbers of specimens representing these taxa are introduced to the assemblage naturally. This may be particularly true of those taxa that display very rare indications of cultural modification (such as *Sylvilagus*). However, it is currently not feasible to determine the taphonomic history of individual specimens.

A second group of taxa displays characteristics that suggest they are primarily of natural origin. This group consists of all the major rodent taxa represented at the site. It should be noted that numerous rodent species are mentioned ethnographically as having been trapped and eaten by Puebloan peoples (Gnabasik 1981). However, no evidence of butchering or processing are evident among the many rodent remains recovered from Sand Canyon Pueblo. Instead, the rodent remains include primarily complete, unmodified specimens, consistent with the interpretation that they are predominantly the result of these animals having died naturally in their burrows.

The origin of the remaining taxa is uncertain. Most of these are represented by relatively few specimens, which provide little evidence of their collective taphonomic history. Those taxa that are represented by considerable numbers of specimens include the *Falconiformes*, snakes and amphibians. These remains display no definite evidence of cultural modification, nor is evidence of carnivore predation apparent. The most telling evidence of the origin of these specimens may be the context in which they were discovered. This will be discussed further in Chapter 4.

Skeletal Part Frequencies

While it is generally expected that most animals will be represented archaeologically by more or less complete skeletons, in some instances cultural and/or natural processes may influence the relative frequencies of particular skeletal regions, elements, or element parts. For example, large game may be represented by only those elements which are brought to a habitation site by hunters, or alternately represented at a kill site only by those elements which are left behind (White 1953; Perkins and Daly 1968). Smaller animals are less likely to be affected by such differential transportation, but may become disarticulated and distributed throughout a site as a result of butchering and processing. Consistent and repeated cultural practices may cause specific portions of some taxa to be selectively preserved, destroyed or removed from the archaeological assemblage. Natural agents can have similar effects on skeletal part frequencies. Carnivores may selectively remove or destroy specific elements of some species creating assemblages that contain incongruent element compositions (Binford 1981:214-216; Marean *et al.* 1992). Rodents may collect elements within a particular size range or of a particular density, resulting in their removal from a site or preservation within a burrow (Hoffman and Hays 1987). Natural mechanical dispersal mechanisms such as colluvial and fluvial forces may result in selective modification to skeletal part frequencies. For example, vigorous fluvial action will result in separation of elements which float easily from those which do not (Voorhies 1969). Analysis of skeletal part frequencies allows for an assessment of the degree to which individual taxa have been affected by such factors. While it is seldom possible to determine the precise cause of incongruent element frequencies an examination of skeletal part frequencies may allow the most probable or predominant factors to be identified.

Following is a description and discussion of the skeletal composition of remains for each major taxonomic group represented at Sand Canyon Pueblo. To facilitate discussion a breakdown of remains for each taxa by skeletal region is provided (Table 11). Seven general regions are presented: cranial, axial, pectoral girdle, fore limbs, pelvic girdle, hind limbs, and phalanges. It should be noted that some specimens could not be assigned to a specific region, these primarily include remains identified simply as "metapodial" or "sesamoid". Upon examination of the data presented in Table 11 several patterns are immediately apparent. Not surprisingly, regions with fewer skeletal components (*e.g.*, the shoulder and pelvis) consistently have lower specimen frequencies. Aside from this variability, most taxa with substantial numbers of identified specimens (*i.e.*, > 100) are well represented in all skeletal regions. The small rodents present an exception to this pattern, as no phalanges were identified as representing any of these taxa. The lack of phalanges among the small rodent remains is unquestionably due to identification and recovery biases. These small elements are unlikely to be consistently recovered during excavation and little effort was made to precisely identify phalanges of small mammals during analysis, because of morphological similarities across different families.

Pocket gopher (Geomyidae) is the only well represented taxon that displays a clearly skewed element distribution. Elements of the cranial region far out-number those of all other skeletal regions for this taxon. The phenomenon of abundant gopher crania has been observed by other researchers at other sites in the southwest who have argued that it represents evidence of human procurement of these animals (Shaffer 1992). While possible, it seems more probable that the frequencies reflect recovery and identification biases. The only elements in the skeleton of a pocket gopher which are likely to be consistently collected are the cranium and perhaps complete specimens of the larger long bones (humerus, tibia, and femur) and pelvic girdle, though even these can fall through 6 mm mesh. Axial elements and phalanges, if recovered, are unlikely to be identified precisely and consequently will most often be classified as small mammal or small rodent. This phenomenon is also evident to a lesser extent among the slightly larger woodrat (*Neotoma*) remains, where cranial and hind limb elements are predominant. One would expect the predominance of cranial elements to be equally apparent among the mice and vole remains, however they display a fairly uniform element distribution. This is likely due to the tendency for these very small specimens to be recovered *in situ* as whole articulated skeletons. Any mice and vole remains that are not identified *in situ* are unlikely to survive the rigors of excavation and screening.

Taxa with fewer identified specimens display more irregular distributions. *Lynx* spp. has representation from all regions with exception of the shoulder. Given the small number of *Lynx* specimens identified the uniformity of this distribution is quite remarkable. Less uniform distributions are apparent among the Mourning Dove (*Zenaida macroura*) and Passeriformes. Cranial elements are absent from both of these taxa, while wing elements are particularly prevalent among the Passeriformes. Given such small sample sizes it is difficult to draw any meaningful conclusions from these latter 'patterns'.

Table 11. NISP counts by skeletal region for major taxa.

Taxon	Skeletal Region						
	Cranial	Axial	Pectoral Girdle	Fore Limb	Pelvic Girdle	Hind Limb	Phalanges
Artiodactyla	63	152	27	137	37	178	51
Canis spp.	68	47	8	36	4	43	32
Lynx spp.	2	7		7	2	7	9
Lepus spp.	21	15	9	38	9	37	1
Sylvilagus spp.	490	233	137	434	219	730	89
Sciuridae	197	254	54	159	74	178	38
Neotoma spp.	206	30	18	39	46	119	
Geomyidae	80		1	7	5	13	
Muridae	168	151	19	79	79	153	
M. gallopavo	146	128	152	220	28	253	382
Falconiformes	3	5	10	9	4	8	7
Z. macroura		5		4		3	
Passeriformes		2	11	35	1	15	1
Amphibian	16	33	8	10	8	33	5
Snake		105					
Iguanidae	18	3			2		

Artiodactyla

As mentioned above, the NISP values for artiodactyla presented in Table 11 indicate that all skeletal regions of these animals are represented at the site. A more detailed breakdown of skeletal part frequencies for the artiodactyla remains is presented below (Figure 6), using the NISP values divided by the 'natural element frequency' (NEF) for each individual element or element portion, as a basis for comparison. NEF values represent the number of times that an element naturally occurs in the skeleton of a given species (in this instance *Odocoileus hemionus* was used). For example, the NEF value for the femur (or any other paired bone) is 2.

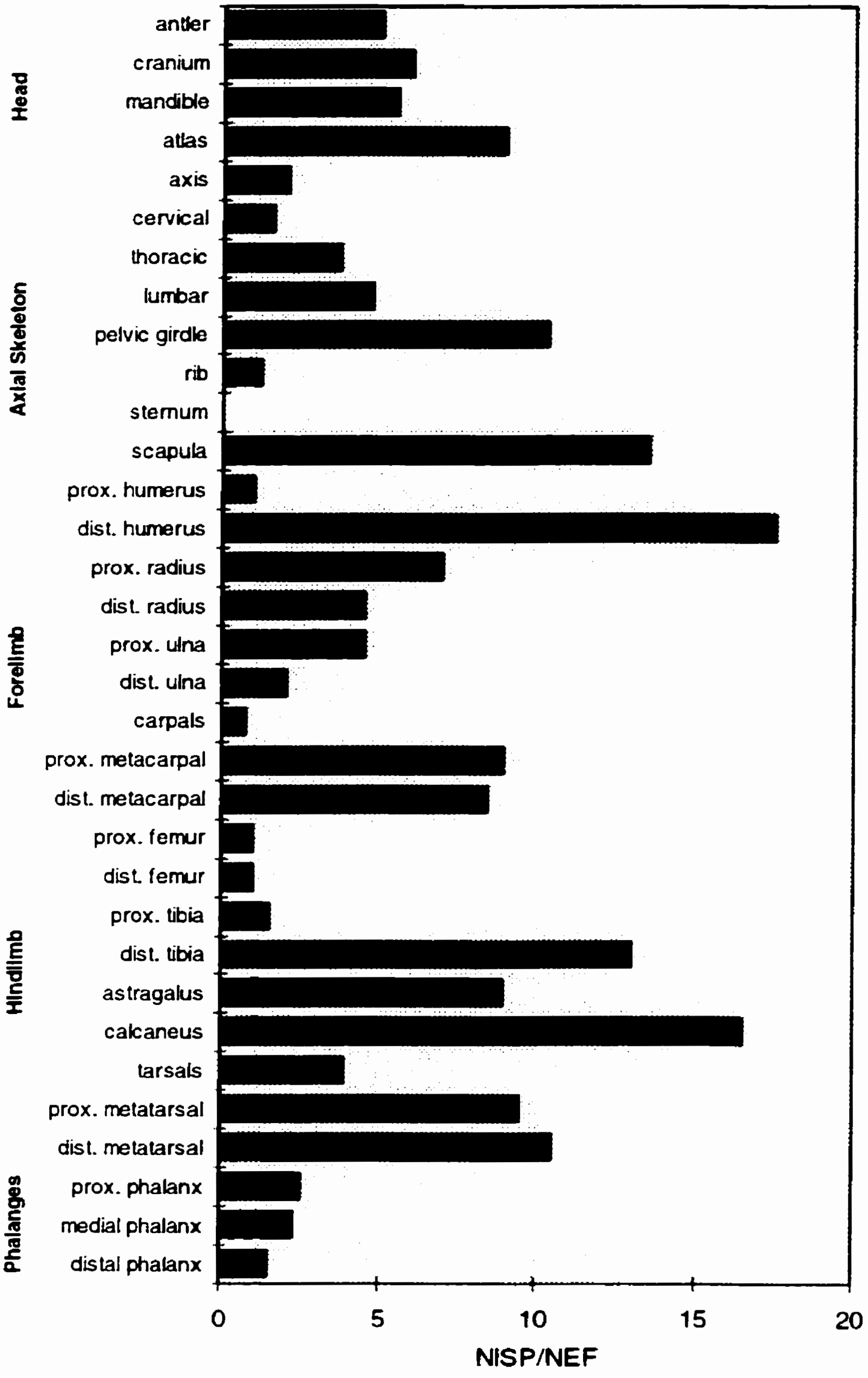

Figure 6. Bar graph indicating the frequency (NISP/NEF) of each skeletal element or element portion for all artiodactyl remains from Sand Canyon Pueblo.

As indicated in Figure 6, the axial skeleton is very poorly represented, particularly the rib cage, when compared to other skeletal regions. The cranial region is represented by moderate numbers of specimens, though the limbs are by far most common. While most portions of both the fore and hind limbs are well represented, some parts particularly the femur, distal tibia, and proximal humerus are quite scarce. It is difficult to explain these frequencies in terms of butchery patterns since bones that would co-occur in common butchery units or meat joints do not appear to be consistently represented. For example, the high frequency of scapulae relative to the very rare frequency of proximal humeri is inconsistent with body part selection during butchery.

To investigate this possible relationship between element frequencies and butchery practices further the element frequencies have been compared to the quantity of meat, fat and marrow with which they would be associated using Binford's (1978b) modified general utility index (MGUI) for caribou. Figure 7 plots modified general utility index values for each element or element portion against the element frequency from the

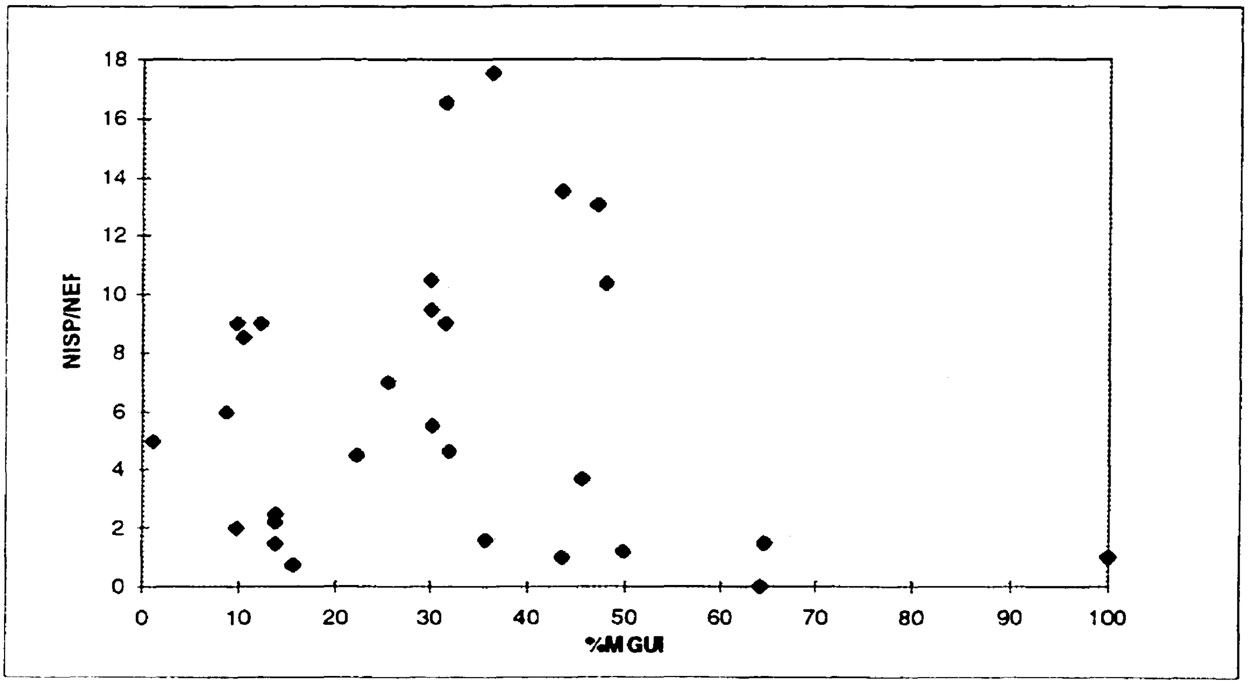

Figure 7. Scattergram plot of modified general utility index (%MGUI) values (based on values calculated for caribou, after Binford 1978b), *versus* element frequencies (expressed as NISP/NEF). Pearson r = -0.19, d.f. = 27.

archaeological assemblage. No clear relationship is evident between the two variables (r = -0.19) and the scattergram does not display any of the utilization patterns postulated by Binford (1978b). As mentioned above the artiodactyl remains display a relatively high degree of damage due to weathering, and it is likely that the sub-assemblage has been heavily depleted due to destruction of specimens. In addition to erosion due to weathering a number of other factors are likely to have contributed to attrition of the artiodactyl remains. These include destruction and removal of specimens by rodents and carnivores. The amount of carnivore modification evident on artiodactyl remains (Table 9 above) suggests that they were particularly prone to scavenging.

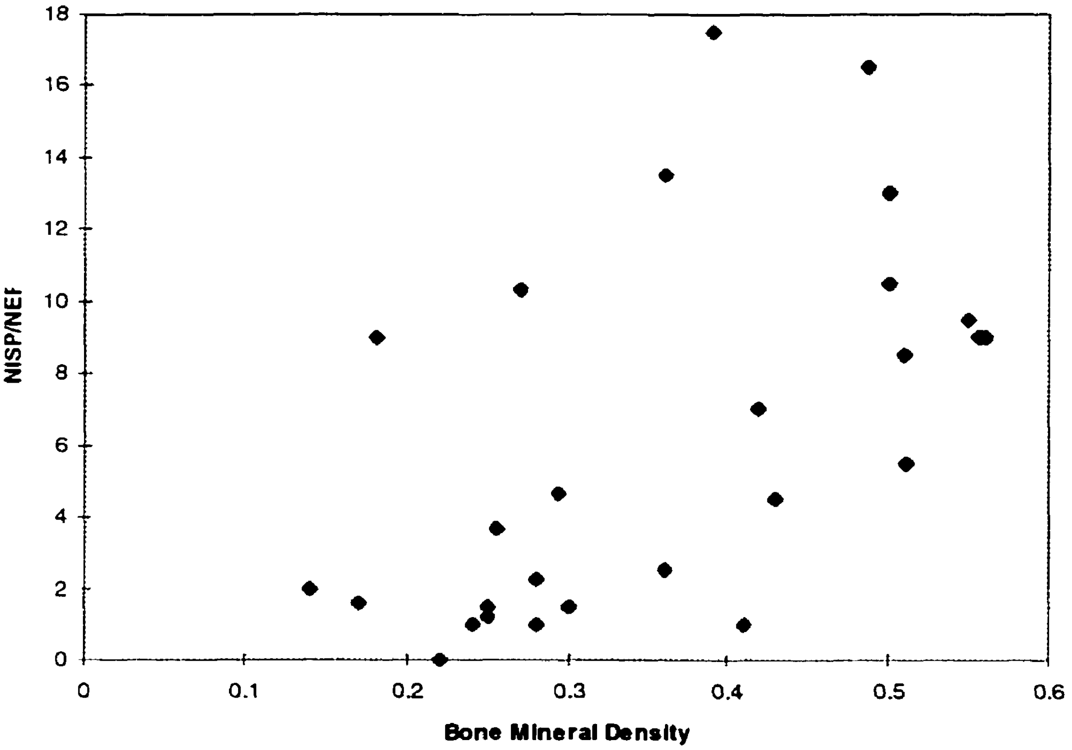

Figure 8. Scattergram plot of bone mineral density (g/cm^3: after Lyman 1994:246-247) *versus* element frequency (expressed as NISP/NEF). Pearson r = 0.56, d.f. = 25.

Indeed when element frequencies are compared to bone mineral density (Figure 8) a positive statistically significant (P < 0.01) correlation is evident, with relatively dense elements being more common than less dense ones. This suggests that the variability in element frequencies are, in large part, the product of natural diagenesis rather than cultural selection. While far from conclusive the element frequency data suggest that the artiodactyl specimens identified at Sand Canyon Pueblo represent the remains of animals which were brought to the site whole.

CHAPTER 4:
SPATIAL DISTRIBUTION OF FAUNAL REMAINS FROM SAND CANYON PUEBLO

Introduction

This chapter presents the spatial distribution of faunal remains from Sand Canyon Pueblo. As discussed in Chapter 2, the spatial analyses have been conducted using two analytical methods: contingency and cluster analyses. The intent of these analyses is to identify significant and consistent patterns in the distributions of faunal remains which may reflect the function of structures and the apportionment of animal resources within the Sand Canyon Pueblo community. Numerous uncontrolled factors such as taphonomic processes, stratigraphic interpretations and sample size variations make identification of patterns difficult. However, whenever possible, attempts have been made to eliminate such potentially confounding variables and phenomena. This has been done by performing multiple analyses at varying levels of detail and by excluding disturbed and poorly understood deposits or imprecisely identified specimens from some analyses. The specific procedures and precautions undertaken are described as each analysis is presented below.

Architectural Features of Sand Canyon Pueblo

As described by Bradley (1992:79), Sand Canyon Pueblo includes an estimated 420 rooms, 90 kivas, 14 towers, an enclosed plaza, a D-shaped biwalled structure, and a great kiva (see Figure 9). Most structures are enclosed within a semicircular masonry wall which is prominent along the west, north and east sides of the site. The pueblo is situated at the head of a small canyon which divides the site into roughly equal eastern and western portions. While both sides of the site contain a variety of structure types, large "public" architectural features (Bradley and Lipe 1990), including the great kiva, D-shaped structure and plaza area, are limited to the western side.

For analytical and logistical reasons the various site structures have been grouped into 15 architectural blocks (numbered 100 through 1500). Each block consists of a cluster of contiguous architectural structures and features. Boundaries between blocks are defined on the basis of breaks in structural continuity due to terrain features such as gullies and cliff edges, or nonstructural architectural features such as plaza areas (Bradley 1992). Excavations were stratified by architectural block in an attempt to sample a representative assortment of structures and features.

It was observed during initial investigations of Sand Canyon Pueblo that the number of kivas relative to the number of rooms evident at the site was unusually high (Adams 1984, 1986). Pueblo III sites in the Mesa Verde area, such as the large cliff dwellings at Mesa Verde National Park, typically display room to kiva ratios of approximately 10 or 12 to 1 (Bradley 1992:80). The average room to kiva ratio apparent at Sand Canyon Pueblo is much lower, at approximately 5:1. However it was also observed that a wide range of variability in this ratio occurs throughout the site, ranging from as low as 2:1 (*i.e.*, block 100) to as high as 30:1 (*i.e.*, block 300). In order to investigate this variability, as well as to ensure representative sampling, the architectural blocks were assigned to one of three groups on the basis of the ratio of rooms to kivas (Bradley 1992). Blocks with fewer than five rooms per kiva were considered "kiva-dominated" blocks; those with 5-16 rooms per kiva were considered "standard blocks"; and block 300, which displays evidence of 30 rooms per kiva, was defined as a room dominated block. From each of these classes of architectural blocks, kiva suites (*i.e.*, associated clusters of structures and features typically consisting of a kiva, courtyard, and adjacent rooms) were judgementally selected for excavation. Selection of suites was based on surficial evidence of architectural remains which indicated the presence of relatively undisturbed deposits and architectural structures that more or less conformed to the expected "Prudden Unit" pattern (Adams 1985, 1986; Bradley 1986, 1987, 1988, 1989, 1992). In total, kiva suites within six blocks (100, 200, 300, 500, 1000, and 1200) were selected for detailed investigation. In addition, the two major "public" structures: the great kiva (block 800) and the D-shaped structure (block 1500) were also investigated (Bradley and Churchill 1994). The location, characteristics, and extent of excavations of each architectural block is briefly described below.

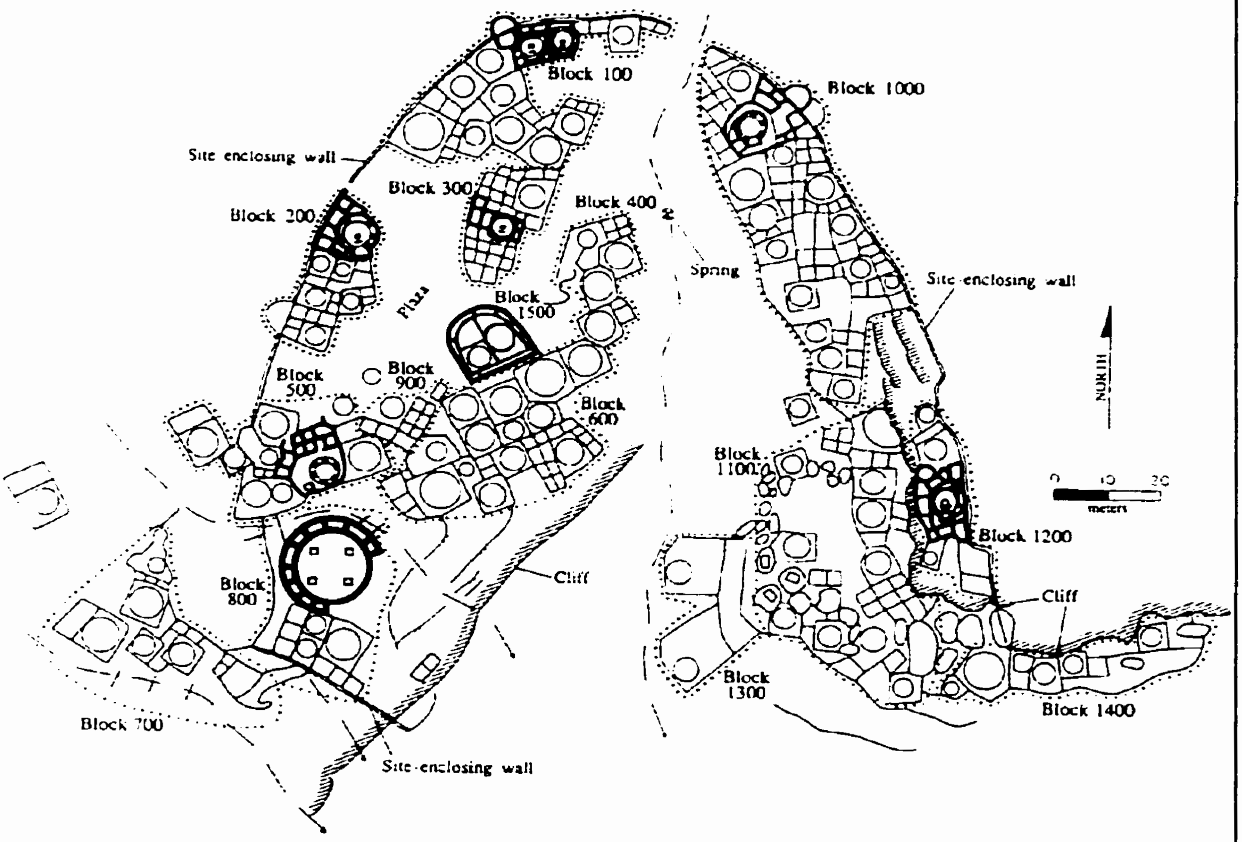

Figure 9. Plan map of Sand Canyon Pueblo indicating architectural blocks and excavated structures (after Bradley 1992:80).

Excavated Architectural Blocks

Block 100. Architectural block 100 is located in the northernmost portion of the site (Figure 9). It is bordered by the site-enclosing wall to the north, the spring drainage to the east, and the main plaza area to the south. The block consists of at least twelve kivas, a D-shaped tower and associated rooms. With a room to kiva ratio of approximately 2:1 it is one of the most heavily kiva-dominated architectural blocks at the site. Investigations of block 100 (see Figure 10a) included excavation of two circular above-ground kivas, a subrectangular kiva, a D-shaped tower, two rooms, and an internal open area immediately adjacent to the block.

Block 200. Architectural block 200 is a discrete cluster of structures located along the northwestern edge of the site. The block's western extent is defined by the site-enclosing wall, while the plaza area delimits the block's southern, eastern and northern boundaries. The block consists of at least six kivas, a D-shaped tower and associated rooms. Bradley (1992) estimates the room to kiva ratio for the block at 3:1. Excavations of architectural block 200 were conducted within the northernmost kiva suite. One kiva, seven rooms and two adjacent open areas were excavated (see Figure 10b).

Block 300. Architectural block 300 is a tightly clustered room dominated block located in the central northwest portion of the site. The block sits immediately south of block 100 and adjacent to the northeastern side of the plaza. A single kiva and approximately thirty rooms were originally identified based on surface observations, however upon excavation an additional small kiva was discovered. The small kiva is believed to have been a relatively late addition to the block, built in a space originally occupied by two rooms (Bradley 1992:90). The very high room to kiva ratio of 30:1 reflects the inferred original block configuration prior to addition of the small kiva.

Five rooms and the small kiva were excavated in the central portion of the block (Figure 10f). Unlike the other block excavations, a complete kiva suite was not investigated, since some rooms associated with the small kiva were not excavated, while others not clearly associated with the kiva were. Bradley (1992) believes that the kiva-suite model may not be appropriate for architectural block 300 because of the lack of close spatial relationships between most rooms and the identified kivas.

Block 500. Block 500, defined by Bradley (1988) as a kiva dominated block with a room to kiva ratio of 2:1, is situated at the west end of an east-west running line of architectural blocks (including blocks 400, 600 and 900) in the west central portion of the site. It is adjacent to the southwest end of the plaza and just northwest of the great kiva (block 800). Investigation of block 500 included excavation of a single kiva, nine associated rooms and portions of an intervening courtyard area (Figure 10c).

Block 1000. Architectural block 1000 is a large complex of kivas (at least 14) and rooms located in the northern portion of Sand Canyon Pueblo, just east of the site's central north-south axis. The block is defined along its north and eastern margins by the site enclosing wall; the south and western margins of the block are formed by steeply sloping terrain. Block 1000 is classified as a "standard" architectural unit with a room to kiva ratio of approximately 7:1 (Bradley 1992). Investigations included excavation of a kiva suite consisting of one kiva, ten rooms and an associated courtyard (Figure 10e). In addition a D-shaped three story tower located outside the site enclosing wall, immediately north of the kiva suite was also excavated. Excavations revealed that this latter structure was connected to the kiva suite *via* an interior doorway, built into the site enclosing wall.

Block 1200. Architectural block 1200 is located on the eastern side of Sand Canyon Pueblo, on a prominent bluff overlooking much of the site. The block is clearly defined on its eastern side by the site retaining wall, while steep slopes and cliffs define its northern, western and southern limits. It consists of approximately five kivas, associated rooms, a small circular tower and several small courtyard areas. The block is classified as a "standard" architectural unit with a room to kiva ratio of approximately 11:1 (Bradley 1992). Detailed investigations included excavation of two kivas and nine rooms as well as sampling of deposits located outside of the block along the cliff edge which defines its western limit (Figure 10d).

Block 800 - The Great Kiva. Architectural block 800 consists of a 'great kiva', partially encircled (on the northeast, northwest and southwest quarters) by a single row of rooms (Figure 11). The block also includes a small cluster of kiva suites immediately south of the great kiva, as well as a single small kiva located in the northwest portion of the block. The size and identified internal features (bench, pillars, masonry platforms, and subfloor vault) of the structure conform to other great kivas found throughout the region in the eleventh and twelfth centuries A.D. (Bradley 1991). Great kivas are generally

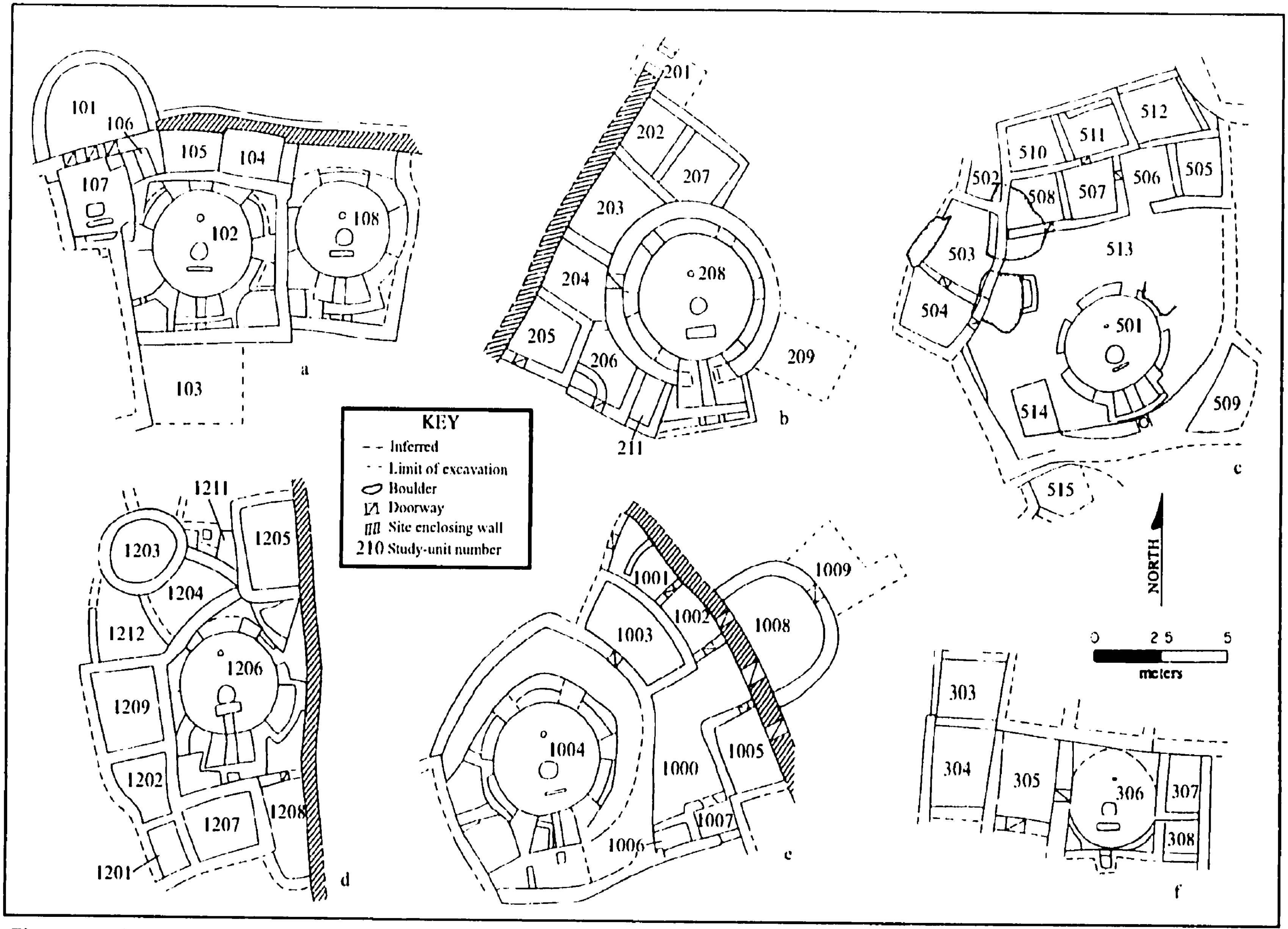

Figure10. Plan maps of excavated structures in architectural blocks at Sand Canyon Pueblo: a, Block 100; b, Block 200; c, Block 500; d, Block 1200; e, Block 1000; and f, Block 300 (adapted from Bradley 1992, with permission of the publisher).

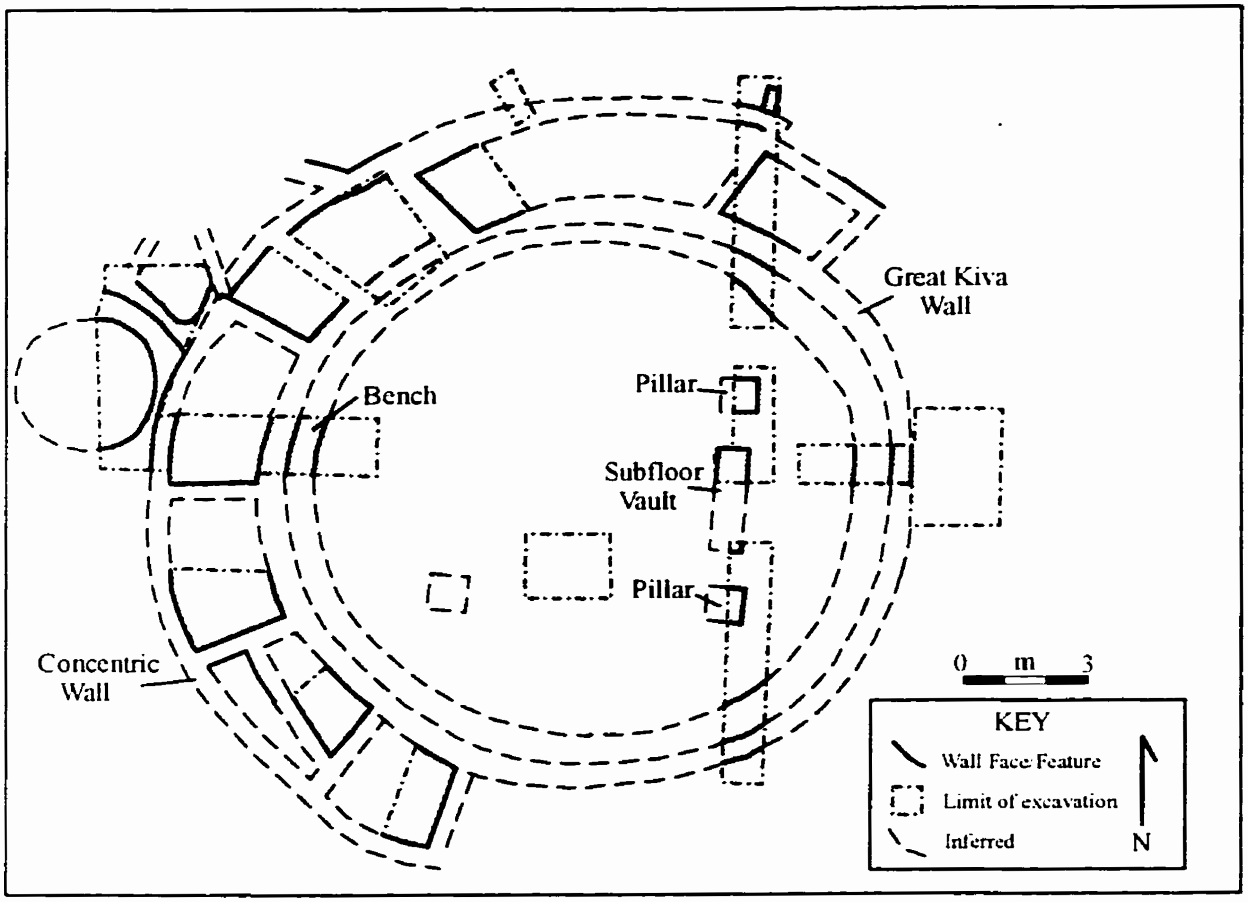

Figure 11. Plan map of Architectural Block 800 indicating excavated areas (after Bradley and Churchill 1994).

regarded by southwestern archaeologists as facilities for 'public' or communal events, particularly large scale economic (intercommunity redistribution and exchange) and ritual activities (*cf.* Plog 1974; Altschul 1978:139; Upham 1982; Wilshusen 1989:103; Vivian 1990:486). Investigations of Architectural block 800 included limited trenching of the great kiva, excavation of portions of approximately eight rooms, testing of several exterior (nonstructural) areas adjacent to the block and excavation of the eastern third of the small kiva in the northwest portion of the block.

Block 1500 - The D-Shaped Structure. Architectural block 1500 consists of a multi-storied, biwalled, D-shaped structure enclosing two kivas. The structure is a free-standing architectural unit relative to other architectural blocks identified at the site. Based on its unique shape and large size this structure has been interpreted as being communally planned and built to function as a "civic" facility (Bradley and Churchill 1994). As argued by Bradley (1991:3) the structure not only resembles D-shaped buildings identified elsewhere (such as the "sun temple" of Mesa Verde) . but is also similar to circular multi-walled structures at Chaco Canyon and in the northern San Juan (Holmes 1878; Vivian 1959; Lekson 1983). Such structures have been commonly interpreted as specialized ritual facilities (*e.g.*, Vivian 1959; Rohn 1977; Plog 1974).

Investigations of block 1500 included excavation of portions of twelve rooms. approximately half of the westernmost kiva and limited testing of the other kiva (Figure 12). In addition excavations were conducted in three exterior areas immediately adjacent to the architectural unit.

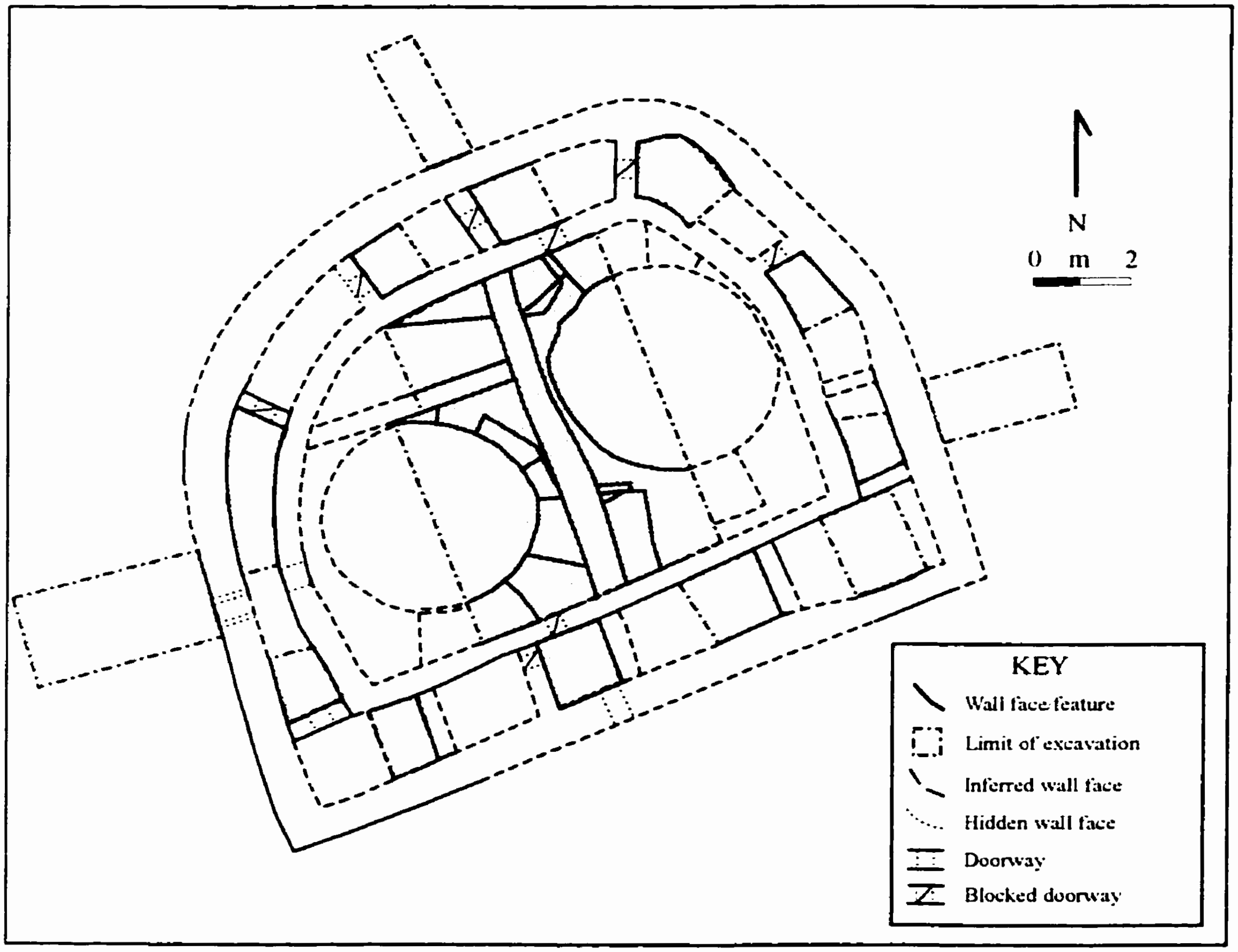

Figure 12. Plan map of Architectural Block 1500 indicating excavated areas (after Bradley and Churchill 1994).

Other Excavated Areas

In addition to the major block excavations described above, numerous smaller scale excavations also were conducted at the site. These included test excavations of several kivas as well as a stratified random sample of nonstructural contexts. The kiva test excavations consisted of single excavation units placed within a judgementally selected sample of kivas throughout the site. Eleven kivas were investigated in this manner (from architectural blocks 400, 500, 600, 700, 800, 1000, and 1400). The stratified random sample of nonstructural contexts included excavation of thirty 2x2 meter excavation units. For sampling purposes three nonstructural contextual strata were defined ("outside above", "inside", and "outside below") and ten excavation units randomly placed within each. The "outside above" strata included six to ten meter wide area immediately outside of the site retaining wall. The inside strata included nonstructural contexts within the pueblo boundaries (*i.e.*, including the central plaza and other open areas). The "outside below" strata included a six to sixteen meter wide area immediately below the pueblo, primarily including flatter portions of the ravine and canyon slopes which form the site's southern boundary.

Finally, limited excavations were undertaken of an additional structural block located outside and approximately 30 meters north-northwest of the 'site proper'. This structure was designated Block 1600 and was determined to be associated with a Pueblo II occupation of the site. Materials recovered from these excavations have been excluded from the spatial analyses presented here, and from site comparisons presented later in Chapter 6.

Contingency Analysis

Two separate contingency analyses are presented here. The first examines the distribution of faunal remains by architectural block, while the second examines the distribution by structure type (room, kiva, courtyard, *etc.*). The taxon frequency values for each context (Tables 12 and 14) include all specimens recovered during excavation of these areas. Rodent remains have been excluded from all of these analyses based on the conclusion that the majority of these specimens as 'intrusive', presented in Chapter 3. However, no attempt has been made to exclude other remains recovered from potentially disturbed or intrusive deposits. These factors are ignored for the time being, but will be addressed in subsequent analyses (see "Cluster Analysis" below).

The contingency analyses presented below compare the observed frequency of faunal remains to the frequencies expected if all taxa were distributed uniformly throughout the site. This is done through the calculation of standardized residual values for each major taxon within each contextual unit (*i.e.*, architectural block or structure type). The standardized residual values (Tables 13 and 15) are based on comparison of the observed absolute frequencies of each taxon to their 'expected' frequencies (calculated from the relative frequencies when remains from all blocks are pooled). Exceptionally high or low residual values indicate 'unexpectedly' high or low taxon frequencies, respectively. The 'total' residual values are the absolute sum of standardized residuals and thus reflect the overall degree of frequency variability exhibited by a given taxon or architectural block. Chi-square values are also provided and in each case indicate that the variability displayed is 'highly significant' (i.e., $P < 0.01$), though it is notable that the many small cell values (NISP < 5) limit confidence in this test of significance.

Table 13 presents standardized residual values for each major taxonomic group by architectural block. Among the taxa, Galliformes and artiodactyls display the greatest overall variability in frequencies, represented by exceptionally high or low standardized residual values within most architectural blocks and very high total residual values. Specifically, Galliformes remains are much more abundant than expected within some blocks (blocks 500, 800 and 1200), while particularly scarce within block 1500 (the D-shaped structure). Artiodactyl values display an even more pronounced pattern, being exceptionally high for blocks 100, 200 and 1000, but substantially lower than expected for most other blocks.

Other taxa displaying high degrees of frequency variability include reptiles, amphibians and canids. This is not surprising since it was noted during cataloguing that these three taxa are all commonly represented by highly concentrated bone deposits, likely representing burial of virtually complete skeletons. In each case the taxa are exceptionally

Table 12. Frequency (NISP) of major taxonomic groups by architectural block.

Taxon	**Architectural Block**								**Total**
	100	**200**	**300**	**500**	**800**	**1000**	**1200**	**1500**	
Artiodactyls	141	93	5	6	2	220	35	101	603
Lagomorphs	438	249	7	176	82	691	221	847	2711
Canids	8	14	0	2	19	30	8	149	230
Lynx	2	1	0	2	1	26	1	1	34
Oth. Carnivores	0	1	0	0	0	0	0	9	10
Galliformes	147	149	12	97	95	235	181	250	1166
Birds of Prey	1	1	0	1	4	19	1	22	49
Other Birds	11	9	0	1	2	7	6	70	106
Reptiles	31	0	0	0	0	2	0	94	127
Amphibians	1	18	0	0	0	73	0	11	103
Total	780	535	24	285	205	1303	453	1554	5139

Table 13. Standardized residuals* for major taxonomic groups by architectural block.

Taxon	**Architectural Block**								**Total^{+}**
	100	**200**	**300**	**500**	**800**	**1000**	**1200**	**1500**	
Artiodactyls	**5.17**	**3.81**	1.30	**-4.75**	**-4.50**	**5.43**	-2.49	**-6.02**	33.47
Lagomorphs	1.31	-1.98	-1.59	2.09	-2.51	0.14	-1.16	0.95	11.73
Canids	**-4.55**	-2.03	-1.04	-3.01	3.24	**-3.71**	-2.73	**9.53**	29.84
Lynx	-1.39	-1.35	-0.40	0.08	-0.31	**5.92**	-1.15	-2.89	13.50
Oth. Carnivores	-1.23	-0.04	-0.22	-0.74	-0.63	-1.59	-0.94	**3.44**	8.83
Galliformes	-2.25	2.51	2.81	**4.02**	**7.11**	-3.53	**7.72**	**-5.46**	35.40
Birds of Prey	-2.36	-1.82	-0.48	-1.04	1.46	1.87	-1.60	1.87	12.49
Other Birds	-1.27	-0.61	-0.70	-2.01	-1.08	**-3.83**	-1.09	**6.70**	17.31
Reptiles	2.67	-3.64	-0.77	-2.65	-2.25	**-5.32**	-3.35	**8.97**	29.62
Amphibians	-3.70	2.22	-0.69	-2.39	-2.03	**9.17**	-3.01	-3.61	26.83
Total^{+}	25.91	20.01	10.00	22.80	25.13	40.51	25.24	49.45	219.03

Pearson Chi-square = 969.19, d.f. = 63, P = 0.00.

Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

* Calculated as: (Observed-Expected)/√Expected. Values which fall beyond (higher or lower than) one standard deviation of the mean standardized residual value (*i.e.*, -0.20 ± 3.50) are in bold.

\+ Totals represent sums of absolute values.

abundant within only one block, while being scarce in most others. It is likely that both the amphibian and reptile remains represent animals that died naturally on the site, while the concentrations of canid remains appear to represent disposal and/or burial of domestic dogs (Note: Given that the amphibian and reptile remains are likely 'intrusive' their inclusion in these analyses may be unnecessary and perhaps misleading. However, it should be noted that the contingency analyses presented here were also conducted excluding amphibian and reptile remains from consideration, see Appendix B. Overall, the major patterns displayed by those 'tests' differ little from results presented here). *Lynx* and "other carnivores" display distribution patterns similar to the three aforementioned taxa (*Lynx* is exceptionally abundant in block 1000 while "other carnivores" are common to the D-shaped structure), though it is notable that neither is represented by complete or even partially complete skeletons in any part of the site. Taxa that display little variation in frequencies between architectural blocks include the lagomorphs and birds of prey, suggesting that these taxa are relatively uniformly distributed throughout the site.

Architectural block 1500 (the D-Shaped Structure) displays the highest overall deviation from expected values among the investigated blocks, with an absolute total residual value of 49.45. Indeed, more than half of the taxa within this block display standardized residual values beyond one standard deviation of the overall residual mean (*i.e.*, -0.20 ± 3.50). Taxa which are more abundant than expected within block 1500 include canids, "other carnivores", "other birds" and reptiles. As mentioned above two taxa: artiodactyls, and Galliformes, display significantly lower than expected frequencies within this block.

Architectural block 1000 also displays considerable deviation from expected values. Artiodactyl, *Lynx* and amphibian remains are all much more common than expected within this block, while reptiles, Galliformes, "other birds" and canids all display lower than expected frequencies.

The remaining blocks display considerably less overall variability than blocks 1000 and 1500, though some significant frequency deviations are apparent. Blocks 500, 800 and 1200 display an abundance of Galliformes, and have diminutive quantities of most other taxa particularly artiodactyls. Blocks 100 and 200 exhibit high values for artiodactyl remains, but display little consistency with respect to other taxon frequencies. No significantly high or low standardized residual values are apparent for block 300. Not surprisingly, the exceptionally small sample recovered from this block precludes the identification of any significant patterns.

A second contingency analysis of the remains organized by structure type is presented below (Tables 14 and 15). It should be noted that some specimens have been excluded from this analysis due to ambiguous structural affiliation, while other specimens from nonstructural areas (*i.e.*, the central plaza) which were not considered in the above analysis are included.

The contingency analysis by structure type displays some patterns similar to those observed in the analysis by architectural block. Much like the preceding analysis artiodactyls, canids, Galliformes and amphibians all exhibit relatively pronounced frequency variability, while lagomorphs, and "other carnivores" demonstrate relatively little variability between contexts. As well, the D-shaped structure (block 1500) continues to display an abundance of canids, "other birds", and Reptilia as well as diminutive quantities of Galliformes and artiodactyls, though these tendencies are somewhat less pronounced than when analyzed by architectural block. Notable differences between the two analyses are also apparent. In particular, *Lynx* and birds of prey frequencies vary considerably when organized by structure type which was not evident in the block by block comparison. Also, the great kiva appears substantially different from block 800 (of which it is a part), lacking the Galliformes remains that dominate the 800 block as a whole, and instead being characterized by a relatively high frequency of canid remains.

Many of the structure types display pronounced variability from expected taxon frequencies, particularly the room, tower, and courtyard categories. In each of these cases the extreme variability is largely due to a pronounced abundance of one taxon. For instance, much of the variability evident in the room deposits is the result of a relatively high abundance of amphibian remains recovered from these areas. Rooms are the only structures that display an abundance of amphibian remains, due largely to complete toad skeletons recovered from two locations (*i.e.*, rooms 202 and 1002). Aside from this

Table 14. Frequency (NISP) of major taxonomic groups by structure type.

Taxon	Structure Type							Total
	Room	**Kiva**	**Tower**	**Plaza**	**Courtyard**	**Great Kiva**	**D-Shaped**	
Artiodactyls	124	170	173	13	14	1	113	608
Lagomorphs	504	665	309	261	173	52	674	2638
Canids	9	31	2	69	13	18	89	231
Lynx	2	6	1	0	25	1	1	36
Oth. Carnivores	1	0	0	3	0	0	9	13
Galliformes	284	171	13	235	121	15	168	1007
Birds of Prey	1	1	0	9	19	2	14	46
Other Birds	14	8	2	19	2	2	52	99
Reptiles	0	31	2	3	0	0	91	127
Amphibians	109	2	0	0	0	0	11	122
Total	1048	1085	502	612	367	91	1222	4927

Table 15. Standardized residuals* for major taxonomic groups by structure type.

Taxon	Structure Type							Total^{+}
	Room	**Kiva**	**Tower**	**Plaza**	**Courtyard**	**Great Kiva**	**D-Shaped**	
Artiodactyls	-0.47	3.12	**14.11**	**-7.19**	-4.56	-3.05	-3.08	35.67
Lagomorphs	-2.41	3.49	2.45	-3.69	-1.68	0.47	0.77	14.95
Canids	**-5.73**	-2.79	-4.44	**7.52**	-1.01	**6.65**	4.19	32.33
Lynx	-2.04	-0.68	-1.39	-2.11	**13.63**	0.41	-2.65	22.93
Oth. Carnivores	-1.06	-1.69	-1.15	1.09	-0.98	-0.49	3.22	9.69
Galliformes	4.77	-3.41	**-8.85**	**9.83**	**5.31**	-0.83	**-5.17**	38.17
Birds of Prey	-2.81	-2.87	-2.16	1.37	**8.41**	1.25	0.77	19.65
Other Birds	-1.54	-2.96	-2.55	1.91	-1.98	0.13	**5.54**	16.60
Reptiles	**-5.20**	0.57	-3.04	-3.22	-3.08	-1.53	**10.60**	27.24
Amphibians	**16.30**	-4.80	-3.53	-3.98	-3.04	-1.50	-3.50	36.54
Total^{+}	42.33	26.37	43.67	41.83	43.75	16.31	39.49	253.75

Pearson Chi-square = 1671.60, d.f. = 54, P = 0.00.

Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

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* Calculated as: (Observed-Expected)/√Expected. Values which fall beyond (high or lower than) one standard deviation of the mean standardized residual value (*i.e.*, 0.03 ± 4.92) are in bold.

+ Totals represent sums of absolute values.

phenomenon room deposits are characterized by an abundance of Galliformes and low frequencies of canid and reptile remains.

The towers exhibit a clear abundance of artiodactyls, and an almost equally apparent paucity of Galliformes remains. It is notable that no other structure type displays a pattern even remotely similar to this: artiodactyls are less abundant than expected in most other contexts and only the D-shaped structure has a comparable lack of Galliformes. An abundance of artiodactyls was also apparent within blocks 100, 200, and 1000 during the previous contingency analysis. Not surprisingly, given the results of the previous analysis, these three architectural blocks all include D-shaped tower structures, though the tower within block 200 was not excavated.

The courtyard context contains an extremely high frequency of *Lynx*, birds of prey, and to a lesser extent Galliformes. The frequency of artiodactyls from courtyard contexts is relatively low. The majority of courtyard remains are from block 1000. Block 500 also has a courtyard area which is included in this group, but very few remains were recovered from this area (NISP=14). The lack of artiodactyl remains among the courtyard deposits is particularly interesting and somewhat unexpected given that block 1000 displays the highest concentration of artiodactyl specimens of all the investigated blocks.

Deposits from the plaza, which largely include midden refuse located immediately adjacent to blocks 200, 300, 500 and 1500 are characterized by an abundance of Galliformes and a paucity of artiodactyl remains. In these respects the pattern is similar to that noted for the courtyard assemblages. However, unlike the courtyard deposits canid remains are abundant among the plaza middens while the relative quantities of birds of prey and *Lynx* are not remarkable.

The great kiva displays the least overall variability from expected values, though canid remains are notably abundant within this context. The frequencies of taxa recovered from standard kivas also display little overall deviation. The only notable exception is the relatively low frequency of amphibian remains, though this is a characteristic of all structure types other than rooms.

K-Means Cluster Analysis

As described in Chapter 2, a K-means cluster analysis is employed here in an attempt to obtain a more detailed understanding of the distribution and organization of faunal remains within Sand Canyon Pueblo. This analysis involves consideration of all well defined contexts within the site (*e.g.*, individual kiva/room interiors, roof deposits, and middens). Remains recovered from disturbed deposits (such as rodent burrows, or modern ground surface), or poorly understood contexts are excluded from this analysis. In total 124 discrete sub-assemblages from well defined contexts are identified. Unfortunately many of these include very small numbers of identifiable specimens. Those locations with fewer than twenty identifiable specimens are excluded from the analysis, requiring exclusion of 67 sub-assemblages. The cluster analysis is conducted using the remaining 57 sub-assemblages as individual 'observation units'. Unfortunately only very small numbers of identifiable specimens were recovered from the Great Kiva, precluding this structure's inclusion in the cluster analysis. The specific procedures and methodology employed are explained in detail in Chapter 2. The results of the analysis are presented here, including a discussion of the characteristics and distributions of each of the resulting cluster types.

Results

The sum of squared distances from cluster centroid values (SSE, Table 16) indicate that the 57 observation units are best grouped into nine clusters. This is better illustrated in Figure 13. During analysis relatively smooth clustering of observation units occurred between thirty and nine clusters, as indicated by only slight relative increases in SSE values (d%SSE). At eight clusters a relatively large increase (5.5%) in %SSE values occurs, resulting from grouping of significantly dissimilar observation units. Subsequent clustering also displays large increases in SSE values, indicating incongruent grouping of observation units. Based on the nine cluster solution, mean taxon frequencies for each cluster (A through I) have been calculated. These are presented in Table 17 and illustrated graphically in Figures 14 through 18.

The majority of the observation units fall within two clusters, A and C. Collectively these two clusters include 41 observation units (n= 24 and 17 respectively). Four of the remaining clusters consist of small groups of observation units (i.e., n = 2 to 5), while the other three (G, H and I) consist of single observation units. These latter clusters are clearly "outliers" which share little similarity with any other observation units.

Table 16. Sum of squared distances from cluster centroids (SSE) values, resulting from k-means cluster analysis of 57 observation units.

No. of Clusters	SSE	%SSE	d%SSE
1	513.00	100.00	13.96
2	441.38	86.04	19.48
3	341.46	66.56	11.14
4	284.33	55.42	10.77
5	229.03	44.65	8.49
6	185.49	36.16	8.54
7	141.70	27.62	4.91
8	116.50	22.71	5.50
9	88.30	17.21	2.73
10	74.31	14.48	1.87
11	64.68	12.61	1.51
12	56.92	11.10	1.27
13	50.43	9.83	1.41
14	43.20	8.42	1.07
15	37.71	7.35	0.86
16	33.31	6.49	0.63
17	30.08	5.86	0.54
18	27.27	5.32	0.53
19	24.59	4.79	0.54
20	21.78	4.25	0.32
21	20.18	3.93	0.45
22	17.84	3.48	0.38
23	15.90	3.10	0.31
24	14.31	2.79	0.25
25	13.03	2.54	0.23
26	11.85	2.31	0.21
27	10.76	2.10	0.19
28	9.78	1.91	0.20
29	8.78	1.71	0.16
30	7.98	1.55	N/A

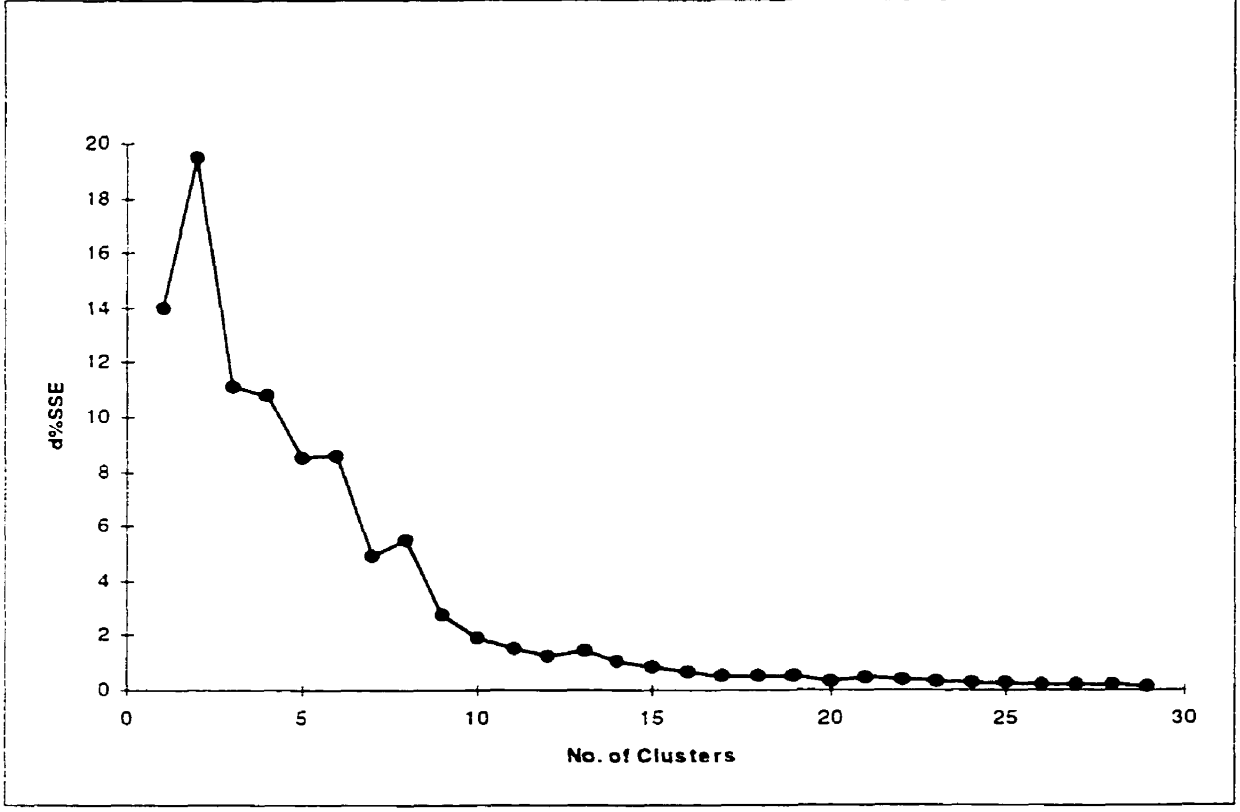

Figure 13. Plot of number of clusters *versus* change in SSE values (d%SSE) for K-means cluster analysis.

Cluster A is the most common cluster type, containing 24 of the 57 observation units. The cluster includes assemblages dominated by Galliforme and large bird remains, with these taxa typically comprising approximately 48% to 78% of identified remains. Lagomorph remains are also fairly common (comprising approximately 14% to 37% of identified remains), while most other taxa are represented in small quantities. Reptiles and amphibians are completely absent from the assemblages within this cluster.

Cluster B is comprised of only four observation units. It is very similar to Cluster A in most aspects. The Galliformes and large bird category is dominant (37% to 72%), followed by lagomorphs (9% to 30%), while most other taxa are represented in small quantities. The most notable difference between clusters A and B is the consistently higher abundance of 'secondary taxa' within cluster B, particularly "other carnivores" which comprises as much as 10% of a typical cluster B assemblage. Like cluster A, reptiles and amphibians are completely absent from this cluster.

Cluster C is the second most common cluster type, containing 17 observation units. The cluster includes assemblages dominated by lagomorph remains (62% to 86%). Artiodactyls and 'Galliformes and large bird' each commonly represent approximately 10% of the identified remains. Most other taxa are represented in smaller quantities (typically comprising less than 10% of identified specimens), though reptiles are completely absent from the cluster C assemblages.

Table 17. Taxon frequency mean and standard deviation values for all clusters.

Taxon	Cluster								
	A n=24	**B** n=4	**C** n=17	**D** n=5	**E** n=2	**F** n=2	**G** n=1	**H** n=1	**I** n=1
Galliformes and Large Bird	63.2	54.8	11.6	15.0	42.5	16.5	1.0	0.0	38.0
	± 15.2	± 17.4	± 7.8	± 16.0	± 21.5	± 9.5	± 0.0	± 0.0	± 0.0
Other Bird	2.5	3.5	1.1	1.6	43.0	15.5	0.0	7.0	4.0
	± 3.1	± 3.5	± 1.9	± 3.2	± 7.0	± 14.5	± 0.0	± 0.0	± 0.0
Artiodactyls	2.0	6.5	9.1	35.6	7.0	0.5	0.0	11.0	4.0
	± 4.2	± 8.2	± 7.1	± 7.8	± 7.0	± 0.5	± 0.0	± 0.0	± 0.0
Canids	4.9	2.5	1.2	0.6	0.0	37.0	17.0	0.0	2.0
	± 6.3	± 2.5	± 2.3	± 1.2	± 0.0	± 4.0	± 0.0	± 0.0	± 0.0
Other Carnivores	0.4	8.0	0.2	0.0	0.0	3.0	0.0	0.0	0.0
	± 0.8	± 3.0	± 0.5	± 0.0	± 0.0	± 3.0	± 0.0	± 0.0	± 0.0
Lagomorphs	25.3	19.5	74.1	43.4	7.0	13.0	0.0	25.0	23.0
	± 11.2	± 10.9	± 11.8	± 7.8	± 7.0	± 2.0	± 0.0	± 0.0	± 0.0
Medium-Sized Mammal	1.7	5.3	2.1	3.8	0.0	14.5	82.0	0.0	0.0
	± 2.6	± 3.3	± 4.3	± 3.6	± 0.0	± 3.5	± 0.0	± 0.0	± 0.0
Reptiles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
	± 0.2	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0
Amphibians	0.0	0.0	0.8	0.0	0.0	0.0	0.0	57.0	0.0
	± 0.0	± 0.0	± 3.1	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0	± 0.0

Cluster D is also dominated by lagomorph remains (typically comprising 36% to 51% of identified remains), however, artiodactyls are almost equally prevalent (28% to 43%). The frequency of Galliformes and large birds is highly variable within cluster D assemblages, while 'other bird', canids, and 'medium-sized mammal' are rare. Other carnivores, reptiles and amphibians are absent from cluster D observation units. Cluster D is a fairly rare cluster type including only five observation units.

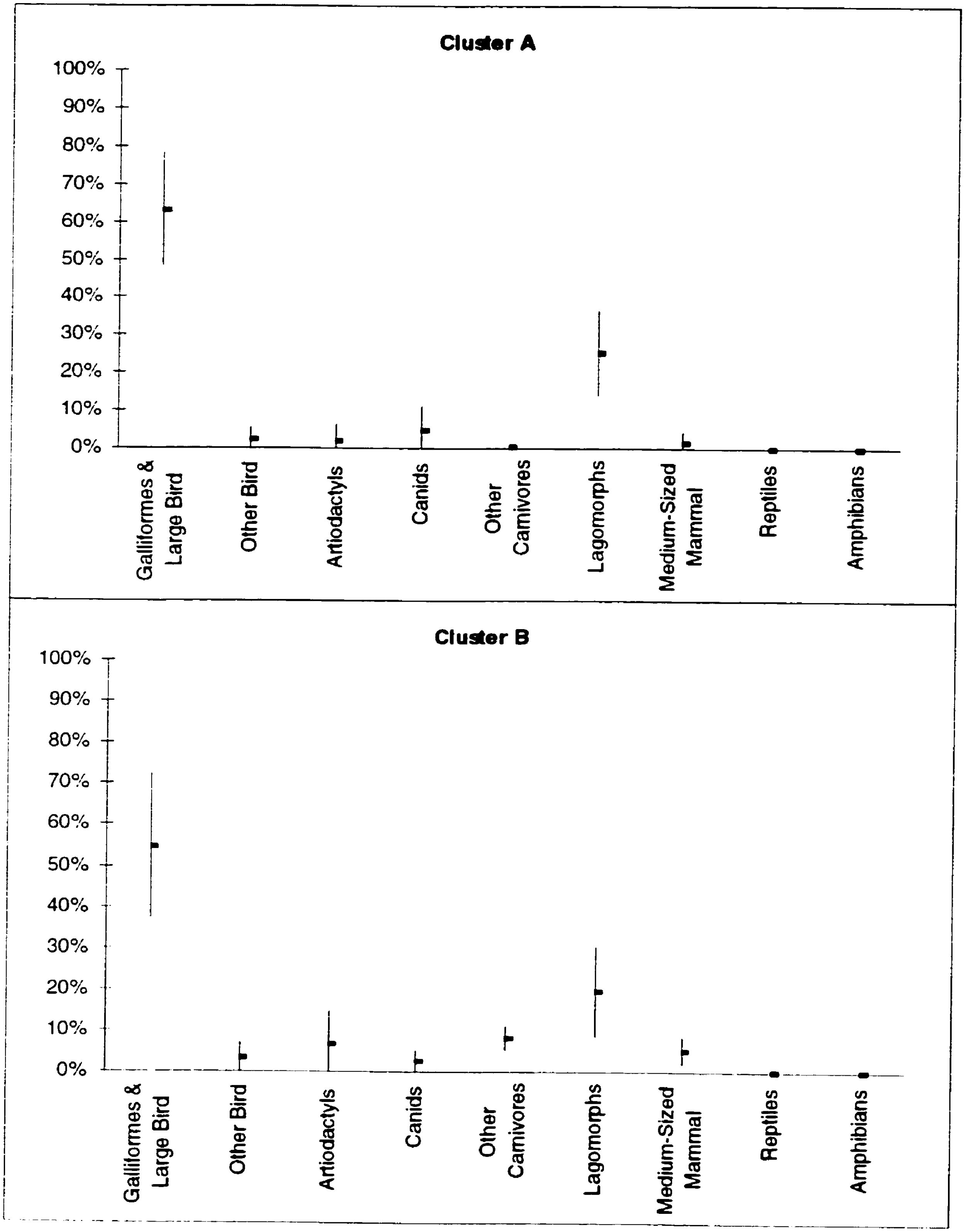

Figure 14. Taxon mean and standard deviation values for clusters A and B.

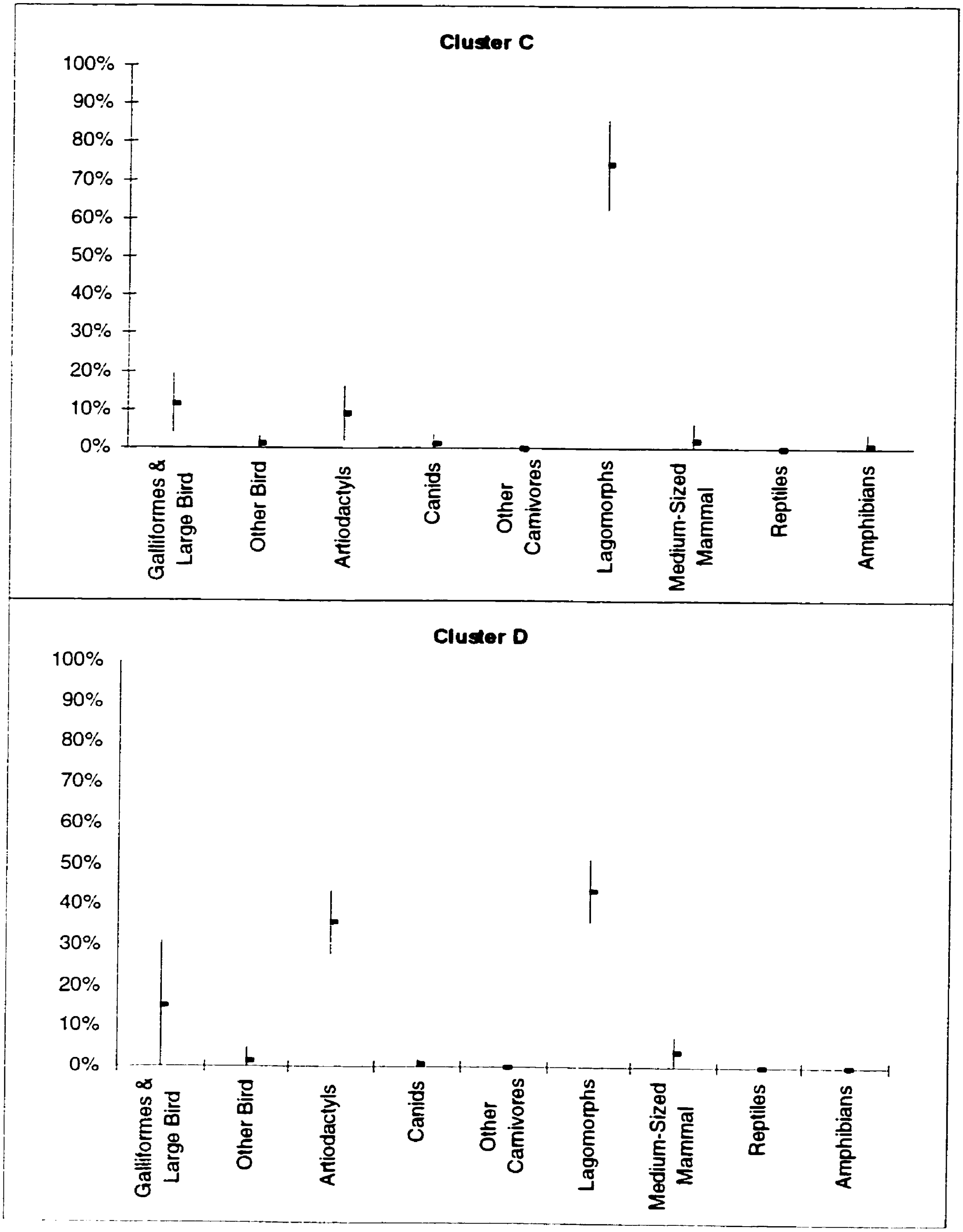

Figure 15. Taxon mean and standard deviation values for clusters C and D.

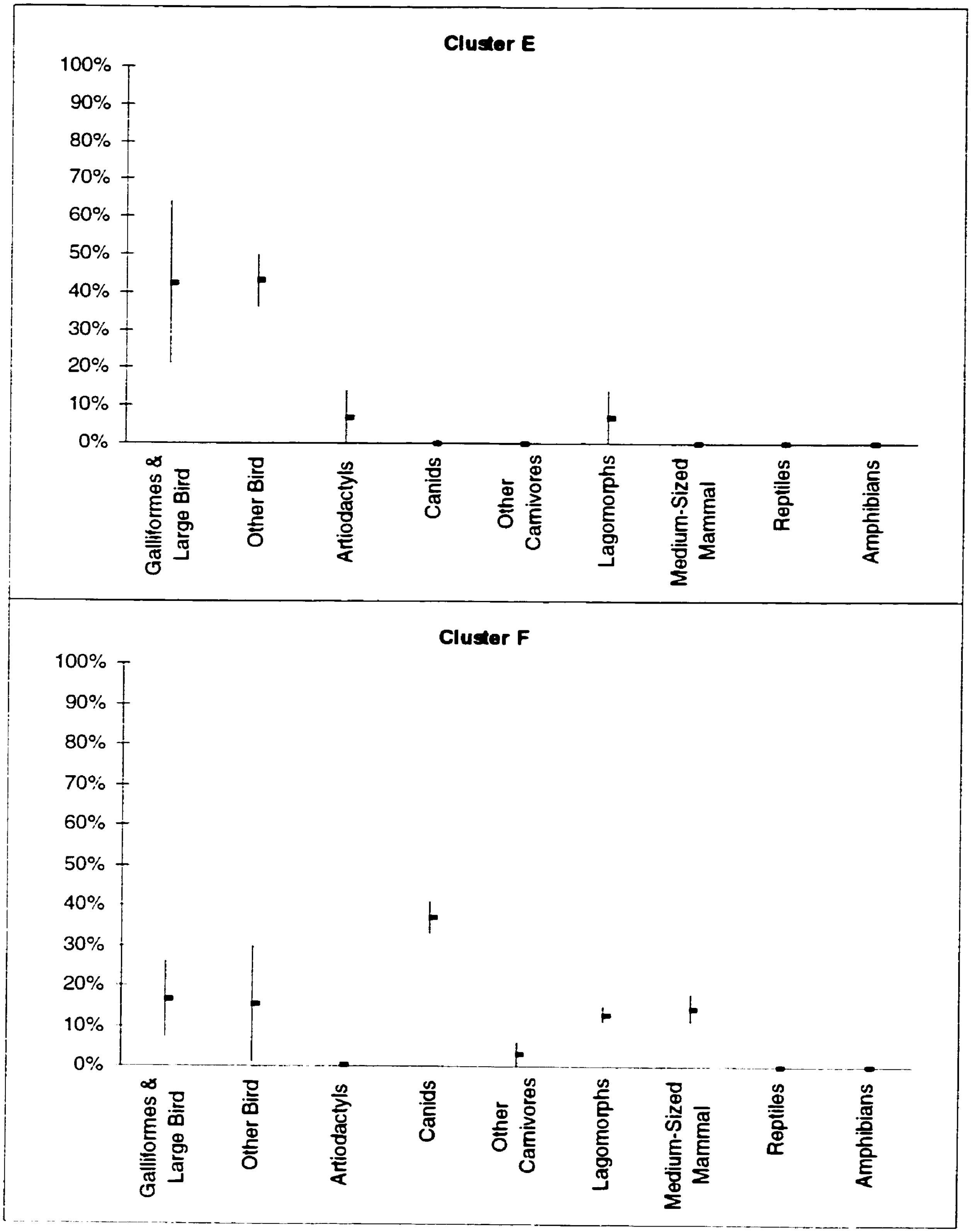

Figure 16. Taxon mean and standard deviation values for clusters E and F.

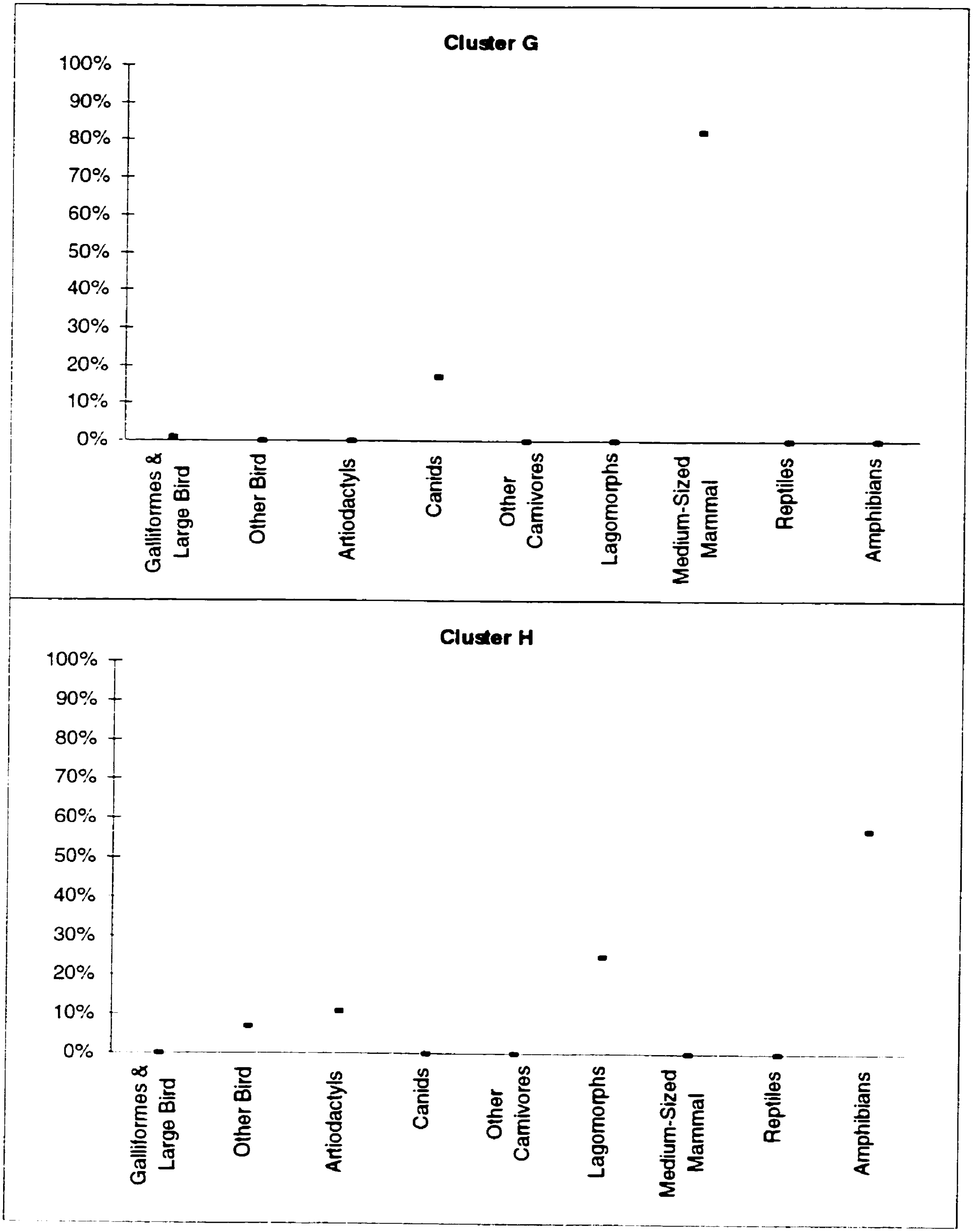

Figure 17. Taxon mean and standard deviation values for clusters G and H.

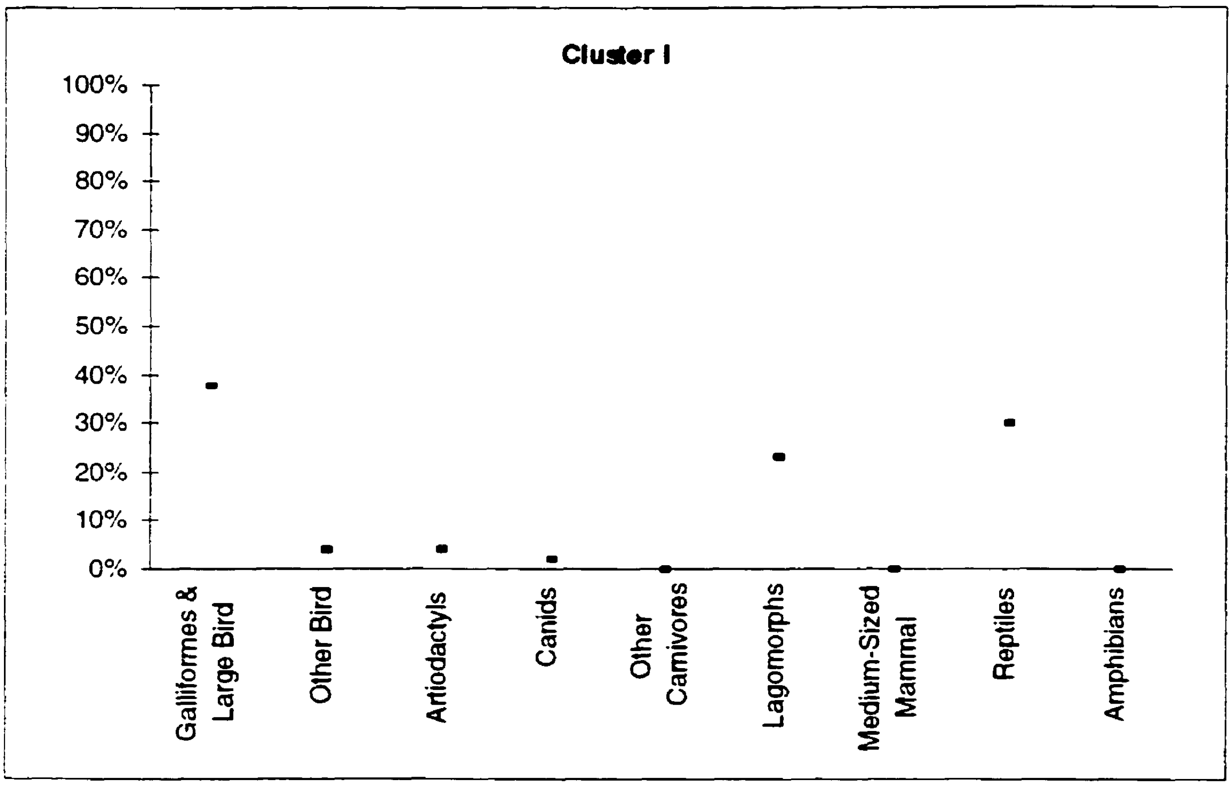

Figure 18. Taxon mean and standard deviation values for cluster I.

Cluster E includes only two observation units which share an abundance of 'other bird' remains (36% to 50%). Additional taxa among these assemblages include 'Galliformes and large bird', artiodactyls and lagomorphs. The 'Galliformes and large bird' category is highly variable in frequency within this cluster, while the other two taxa are represented in fairly small numbers. No other taxa are identified among the cluster E observation units.

Cluster F also includes only two observation units. These assemblages are characterized by an abundance of canid remains (approximately 37%). Both bird categories are represented in highly variable quantities, while lagomorph and 'medium-sized mammal' remains consistently comprise approximately 15% and 16% of the assemblages respectively. Low frequencies of 'other carnivores' and trace quantities of artiodactyls are also represented.

Clusters G, H, and I all represent single observation units which share little or no similarity with other assemblages and consequently were assigned to their own unique cluster types. Cluster G is comprised primarily of 'medium-sized mammal' and canid remains. A review of the catalogue records for this assemblage indicates that it primarily represents a single virtually complete immature *Canis* sp. skeleton, probably domestic dog. Similarly cluster H is unique due to the presence of several, more or less complete spadefoot toad skeletons. If the amphibian remains were ignored the cluster H observation unit would likely fall within Cluster C. Cluster I is characterized by an abundance of reptile remains, again likely due to the presence of one or two more or less complete skeletons. If the anomalous concentration of reptile remains is ignored for this assemblage the remaining taxon composition strongly resembles that of Cluster A.

The distribution of the cluster types by context are presented in Table 18. Here some clear trends in the spatial distribution of the clusters are apparent. Most prevalent is the tendency for exterior midden deposits to consistently fall within cluster A. Only one exterior midden deposit deviates from this trend, falling within cluster B. As noted above clusters A and B are very similar in composition: both being dominated by Galliformes and large bird remains followed by lagomorphs. Courtyard midden deposits are also characterized exclusively by the Galliformes and large bird dominated cluster types.

Table 18. Frequency of cluster types by context.

Context	Cluster								
	A	B	C	D	E	F	G	H	I
Exterior Midden	15	1							
Courtyard Midden	2	1							
Room Interior			3						
Room Roof			5		2		1	1	
Kiva Interior	1		1	3					
Kiva Roof	3	1	3						1
Tower Interior			2						
Tower Roof				2					
D-shaped Structure Roof	2	1	4			1			
D-shaped Structure Interior	1					1			
Totals:	24	4	17	5	2	2	1	1	1

Deposits associated with room interiors are few in number, but all fall within cluster C (lagomorph dominated). Room roof areas display a more varied composition, including deposits that fall within clusters E ("other bird" dominated), G (canid dominated), and H (toad dominated), though a majority of deposits fall within cluster C.

The few kiva interior deposits that were included in the analysis also display a somewhat varied cluster type composition. While the two common cluster types (A and C) are represented here, most (n=3) of the kiva interiors are associated with cluster D (artiodactyl/lagomorph dominated). Though it is important to note that all three of these observation units are from room blocks associated with towers (blocks 100 and 1000).

Kiva roof deposits include representation from clusters A, B, C, and I. However, the diversity among these deposits is perhaps exaggerated by the number of cluster types. This is apparent when the strong similarities between clusters A, B, and I are taken into consideration. As mentioned above cluster I consists of a single observation unit containing an anomalous quantity of reptile remains, but otherwise resembling cluster A in character, while (as mentioned above) clusters A and B are very similar to one another.

The two D-shaped towers produced identical results. Deposits from the interiors of both structures fall within cluster C while their roof deposits fall within cluster D.

Deposits from the D-shaped structure fall within a wide variety of clusters. The roof deposits are quite diverse representing clusters A, B, C and F (canid dominated). The two interior deposits from the D-shaped structure are quite dissimilar from each other representing clusters A and F.

Discussion

Many of the patterns observed as a result of the K-means cluster analysis are not unexpected given those which were apparent during the contingency analysis presented earlier in this chapter. However, in many respects the cluster analysis provides a more detailed view of the distribution of faunal remains within the site. Some general patterns can be seen which were not immediately apparent as a result of the contingency analysis. In particular these include: the consistency in taxon composition among midden deposits, the discontiguous distribution of Galliforme and large bird remains within the site, the highly concentrated distribution of artiodactyl dominated assemblages on tower roofs and within associated kivas, and the diversity (inconsistency) of deposits associated with the D-shaped structure. These predominant patterns clearly warrant further discussion.

Midden Deposits

The midden deposits examined in this analysis presumably represent refuse accumulations from multiple activity areas throughout the site. They include middens located within the central plaza, adjacent to room blocks, outside the site-enclosing wall and along the lower slopes of the central drainage which separates the eastern and western portions of the site. Despite these disparate origins the compositions of the deposits are all remarkably similar, dominated by Galliformes and large bird remains followed by significant quantities of lagomorphs, and only minor contributions from other taxa. This composition is not unlike that identified for the site as a whole (though the average frequency of Galliformes and large bird remains among the midden areas is more than double that of the site average). Given this, it is tempting to conclude that these assemblages may cluster together due to similarities in sample size rather than due to significant similarities in composition. That is, the midden samples may simply reflect the overall composition of remains at the site due to relatively large sample sizes. On average midden deposits produced greater quantities of identifiable faunal remains compared to the other site contexts, producing an average of approximately 131 specimens per observation area, compared to an average of 46 specimens for floor and roof deposits. However, the midden deposits vary widely in sample size with NISP values for several observation units as low as 20 to a maximum value of 456, yet all but one of the observation units fell within cluster A. This suggests that consistency among the midden deposits is due to similarities in depositional activities rather than simply a product of sample size or statistical manipulation.

Galliformes and Large Bird Distributions

Remains identified as Galliformes and large bird are evident among all the various contexts examined above, though they are clearly more strongly associated with some more than others. Specifically the predominance of these remains among midden deposits is clear (as discussed above). High concentrations of Galliformes and large bird remains are also common in roof deposits, which likely represent outdoor activity or refuse areas. The fact that these remains are common to refuse areas suggest that these birds were utilized widely and commonly throughout the site by virtually all inhabitants. Conversely very low concentrations of Galliforme and large bird remains are found in association with either the D-shaped towers or D-shaped structure. This pattern was consistently evident during both the cluster analysis and contingency analyses. While Galliformes and large bird remains occur in varying quantities throughout the site these structures are the only ones that displayed significantly lower than average quantities during the contingency analyses and are the only structures that do not contain one or more Galliformes and large bird dominated deposits.

Artiodactyla Distributions

The high frequency of artiodactyl remains associated with the D-shaped towers was apparent in the previous contingency analysis; however, the cluster analysis further clarifies the nature of this distinct pattern. Relatively high concentrations of artiodactyl remains (Cluster type D) are clearly associated with the roofs of both D-shaped towers which were investigated, while the interiors of these structures display relatively few such remains. It is notable that *Odocoileus*, *Antilocapra*, and *Ovis* are evident among the remains from both structures. Cluster D assemblages are also found within the kivas associated with the 'tower blocks' (blocks 100 and 1000). Collectively this information indicates that the pattern is not simply due to the chance deposition of a single animal on the surface of the site after abandonment. Clearly the concentration of remains is the result of consistent and repeated human activity.

The D-shaped Structure

Differences between the D-shaped structure and other contexts at the site are not readily apparent through the cluster analysis. Deposits from the D-shaped structure vary widely in faunal composition and display no clear patterning. The preponderance of reptiles, and "other bird" remains evident among the D-Shaped structure during the contingency analyses are not apparent in the cluster analysis. This may be largely due to the relatively small samples recovered from most of the rooms associated with the D-shaped structure. The effectiveness of the cluster analysis was severely hindered by small sample sizes and as mentioned above a majority of deposits had to be excluded from the analysis because of inadequate numbers of identified specimens. Exclusion of remains recovered from disturbed or poorly defined contexts also has an adverse impact on the number of specimens available for inclusion in analysis of the D-shaped structure.

The concentration of canid remains identified as associated with the D-Shaped structure in the contingency analysis is somewhat clarified by the cluster analysis. Specifically it is apparent the majority of the canid remains recovered from the structure are derived from two specific locations (structures 1510 and 1513). As mentioned previously these concentrations represent the remains of single virtually complete canid skeletons.

Concluding Remarks

Overall, on the basis of the contingency analysis it is clear that the distribution of faunal remains throughout the site is not uniform. Significant variation in the distribution of remains is apparent when the assemblage is sub-divided by architectural block or structure type. The distribution and organization of the remains has been further clarified by cluster analysis, which indicates that some taxa are distributed broadly throughout the site while others appear to be concentrated in specific locations. Together these analyses have identified several significant and provocative spatial patterns among the animal remains from Sand Canyon Pueblo.

Faunal remains associated with the D-shaped structure and architectural blocks associated with D-shaped towers stand out as particularly distinct. An abundance of wild birds ("other birds") clearly distinguish the D-shaped structure from all other portions of the site. This structure is also characterized by remarkably low numbers of Galliforme remains and considerable quantities of reptile remains, though the latter specimens are likely 'intrusive'.

All three architectural blocks containing D-shaped towers (blocks 100, 200, and 1000) exibit concentrations of artiodactyl remains. Within blocks 100 and 1000 artiodactyl remains appear to be abundant within kivas and are found in particularly high concentrations on the roofs of the towers themselves. In addition the 1000 block displays localized concentrations of *Lynx*, and bird of prey remains in the courtyard between the tower and kiva. Galliformes and large birds remains are relatively uncommon among the tower blocks and are significantly scarce within the towers themselves.

The distribution of lagomorphs is remarkably consistent throughout the pueblo. Lagomorphs stand as the only taxon that does not display marked concentrations or absences within the site. Galliformes and large birds are also distributed broadly throughout the site (with exception of the D-shaped structure and towers mentioned above), but are particularly abundant among midden deposits. These primarily include deposits located within the central plaza, and courtyards as well as those located outside the pueblo proper ("outside above", and "outside below").

The following chapter examines the ethnographic record with respect to animal utilisation among historic Pueblos in an attempt to understand the cultural significance of these apparent patterns.

CHAPTER 5
INTERPRETATION OF THE SAND CANYON PUEBLO FAUNAL DATA

Introduction

The analyses in the previous chapters identified major patterns in the organization and distribution of faunal remains from Sand Canyon Pueblo. In this chapter these patterns are examined in more detail and their cultural significance explored. Ethnographic data from historic Pueblo communities are used here as a basis for inference. It is important to note that while a great deal of very detailed information is available from the ethnographic record, interpretation of assemblage composition and spatial distributions based on these data should be done with considerable caution.

The potential 'dangers' of relying heavily on ethnographic analogy for interpretation of the archaeological record have been debated for many decades (*e.g.*, Clark 1951; Ascher 1961; Wylie 1985). Opinions on the subject range from those of Gould and Watson (1982), who have argued that interpretation based on ethnographic analogy is likely to lead to circular reasoning and stagnant discourse, to the belief of Wylie (1985:107), that archaeologists must rely on ethnographic analogy in order to "bring unfamiliar and otherwise inaccessible aspects of the past into view." It is this latter opinion which best reflects the intent of this chapter. However, analogy should not be used recklessly and some precautionary remarks are warranted.

It should be kept in mind that Sand Canyon Pueblo was abandoned approximately 600 years prior to most formal ethnographic documentation. While many of the patterns observed at Sand Canyon Pueblo may appear to be consistent with the ethnographic record, it is possible, and perhaps likely, that the cultural activities documented during historic times actually varied considerably from those that occurred prehistorically. The considerable expanse of time, relocation of communities and contact with Spanish and Euro-american cultures are all likely to have had considerable impacts on Puebloan cultures. As well, it is important to recognize that many of the Southwestern ethnographers primarily focused their attention on ritual and ceremonial activities. Consequently, specific descriptions of many common domestic activities are rare. As will be discussed below this has introduced some readily apparent inconsistencies between the ethnographic and archaeological records, and likely has introduced additional discrepancies which are less obvious or even undetectable.

Ethnographically Documented Faunal Utilization

The traditional subsistence practices of Puebloan peoples as they are represented in the ethnographic literature include utilization of a large number of animals for a wide variety of purposes. In her extensive, though not exhaustive, review of Puebloan ethnographic literature Gnabasik (1981) has found specific references to at least 28 mammal, 35 bird and four reptile species. The literature indicates that while animals certainly represented an important source of food they were also used widely for other purposes. Generally, animal utilization by Pueblo peoples can be grouped into five categories: 1) consumed as food; 2) consumed during ritual; 3) consumed as medicine; 4) used as raw materials for domestic clothing and tools; and 5) used as raw materials for ritual costumes and other paraphernalia. Ethnographic references are made to the utilization of most of the animal taxa identified at Sand Canyon Pueblo. Tables 19 and 20 summarize the use of these animals as documented by Gnabasik (1981).

In addition to physical uses many of the animals are documented as having specific spiritual significance in historic Puebloan societies (Tyler 1974, 1979). These range from spiritual/symbolic associations with natural phenomena such as seasons, water, wind, sun, earth, birth and death, to cultural activities such as warfare, hunting, diplomacy and racing as well as abstract and 'supernatural' concepts such as transformation, spiritual power, healing, and witchcraft. Such associations are noted for each taxa identified at Sand Canyon Pueblo in Tables 19 and 20, based on research compiled by Tyler (1974, 1979). These associations are drawn upon below, to aid in interpretation of the major patterns identified at Sand Canyon Pueblo.

Animals as Food

Of the 45 mutually discrete animal taxa identified at Sand Canyon Pueblo (see Tables 19 and 20) only 19 are specifically documented as being commonly consumed as food. These primarily include mammalian species: antelope, deer, bighorn sheep, domestic dog, jackrabbits, cottontails and most of the medium-sized and larger rodents. Birds that were commonly eaten include ducks, doves, turkey, grouse and quail. References to the consumption of unspecified species of snakes and lizards are also documented.

Gnabasik (1981:107) notes that rabbits (including both cottontails and jackrabbits) were "probably the most abundant and the most common source of meat to be used by the Pueblos." At any given pueblo rabbits could usually be obtained locally and their habitat and food supply were likely enhanced by the horticultural activities of the Puebloans. Rabbit hunting was sometimes carried out by individuals armed with throwing sticks or simply by using their bare hands, though more commonly communal hunts or 'rabbit drives' were conducted during which the animals were surrounded by many hunters armed with nets, clubs, throwing sticks, bows and arrows (Anell 1969:59-60). As discussed below, these communal hunts were sometimes organized by a specific society for the purpose of obtaining meat for ritual purposes.

Deer, antelope and other large game were also an important source of meat and considerable ethnographic literature is devoted to their significance in the Puebloan subsistence economy (Gnabasik 1981:42-77). Like rabbit hunting, deer hunts were frequently conducted by individuals or small groups to obtain food, though as will be discussed below, communal hunting of deer was frequently a formal ritualized activity that transcended the gathering of 'daily' domestic food.

It is notable that while turkeys were eaten by many historic Puebloans (Gnabasik 1981:202-206), the use of these birds as food appears to have been restricted among some communities. Though wild turkeys were common to the Hopi area, they were not hunted nor were domestic turkeys kept at the Hopi pueblos (Lange 1950:207; Reed 1951:200). Lange (1950:207) reports that the Hopi had a taboo against eating turkey, which was considered a ritually important bird. Similarly turkeys appear to have been kept at the

Tewa pueblos solely as a source of feathers, which were used only for specific ritual purposes (Henderson and Harrington 1914:35).

The other animals listed above were evidently of secondary importance and are discussed in less detail by the ethnographers. Many of the larger rodents were apparently commonly obtained during rabbit drives (Parsons 1920:59; Lange 1959:139), and some such as the wood rat were specifically pursued. White (1974b:107) notes that historically wood rats were a highly prized food at Zia.

Quail were also commonly taken during rabbit drives (White 1932:56; Lange 1959:129) and grouse are noted as having been hunted specifically as important sources of food (Henderson and Harrington 1914:34). Doves and ducks were also hunted, though their feathers appear to have been of primary interest rather than their meat (Gnabasik 1981:139-140, 185).

Lizard and snake are identified as possibly having been eaten during times of famine. However the ethnographic record is somewhat dubious, in that the use of these animals as food appears to be largely based in speculation on the part of the ethnographers (Henderson and Harrington 1914:47), who simply comment that the Tewa may have eaten snakes and lizards during times of famine in former days.

It is likely that food preparation was an activity that commonly occurred in areas such as courtyards and on roofs, though small rooms within room blocks may also have been used. Cooking also likely occurred in these places, particularly on well ventilated roof tops and in courtyards. Refuse associated with these activities was commonly gathered up and deposited in middens or trash pits either in areas adjacent to the room block, in abandoned rooms elsewhere within the site or outside of the pueblo (Gnabasik 1981). In addition to animal foods which were in the process of being cooked, it also possible that unused stored foods may be represented archaeologically (*i.e.*, bones associated with 'cuts' of jerked meat). Storage areas were usually located within room blocks (Gnabasik 1981), though courtyards and roof tops also may have been used.

Overall, it seems likely that the remains of animals that were consumed as food would be found in a wide variety of locations throughout the pueblo, though they should primarily be concentrated in refuse middens adjacent to food preparation areas.

Table 19. Ethnographically documented uses and ritual/spiritual associations for mammals recovered from Sand Canyon Pueblo (after Gnabasik 1981; Tyler 1975).

Order	Common Name	Consumption			Raw Materials		Ritual/Spiritual Associations
		Food	Ritual	Medicinal	Clothing & Tools	Ritual Items	
Artiodactyla	Pronghorn antelope	✓	✓		✓	✓	Leadership/authority, spiritual power, war, peace maker, prey, south.
	Mule deer	✓	✓	✓	✓	✓	Spiritual power, transformation, sacrifice, prey, north.
	Bighorn sheep	✓			✓	✓	Germination, racing, war (defense), prey.
Carnivora	Domestic dog	✓			✓		
	Coyote					✓	Transformation, trickster, war (scout/guard), messenger, death.
	Fox					✓	Racing, hunting.
	Bobcat					✓	War, hunting, south.
	Ringtail	No specific uses or associations documented					
	Weasel			✓			Hunting, child birth.
	Skunk					✓	
	Badger					✓	Curing (herbal remedies), fire, corn, south.
Insectivora	Shrews						Curing, nadir (below).
Lagomorpha	Jackrabbit or Hare	✓	✓		✓		Zenith (above), prey.
	Cottontail	✓	✓		✓	✓	Fertility, prey, nadir (below).
Rodentia	Prairie dog	✓					
	Ground squirrel	✓					
	Chipmunk	✓					
	Squirrel	✓				✓	
	Porcupine						Curing
	Pocket gopher	No specific uses or associations documented					
	Wood rat	✓					
	Mouse	No specific uses or associations documented					
	Vole	No specific uses or associations documented					
	Ord's kangaroo rat	✓					

Table 20. Ethnographically documented uses and ritual/spiritual associations for birds, amphibians and reptiles recovered from Sand Canyon Pueblo (after Gnabasik 1981; Tyler 1975, 1979).

Class/Order	Common Name	Consumption			Raw Materials		Ritual/Spiritual Associations
		Food	Ritual	Medicinal	Clothing & Tools	Ritual Items	
Anseriformes	Duck	✓				✓	Water, rain, germination, traveling spirits.
	Goose					✓	Water.
Caprimulgiformes	Poor-will						Night, sleep, nadir (below).
Columbiformes	Mourning Dove	✓				✓	Water (springs & rain), grain (winnowing).
Falconiformes	Hawk					✓	Sky, war, hunting, zenith (above).
	Kestrel					✓	Hunting, initiation, apprenticeship, war (scout).
	Falcon					✓	Hunting (rabbit)
	Turkey Vulture					✓	War (recovery of the dead), purification.
Galliformes	Quail	✓					Earth.
	Grouse	✓					Earth.
	Turkey	✓			✓	✓	Earth, death (mountain turkey).
Gruiformes	Sandhill Crane						Water, guardianship (corn), rain.
	American Coot						Water, taboos/restrictions.
Passeriformes	Jays					✓	Lightning, war.
	Raven/Crow					✓	Witchcraft, transformation, bad luck, war, death, rain.
	Small Passerines					✓	Summer, sun.
Strigiformes	Owls					✓	Witchcraft, transformation, drought, rain omen, neutrality, hunting, fertility, night, death.
	Great Horned					✓	Fertility, hot weather, harvest.
Amphibia	Spadefoot Toads	No specific uses or associations documented					
Reptilia	Lizards	✓					
	Snakes	✓				✓	

Ritual Procurement and Consumption of Animals

A small number of taxa are specifically documented as having been procured and consumed in ritual contexts. These include references to four taxa identified at Sand Canyon Pueblo: antelope, deer, cottontails, and jackrabbits. Ceremonies during which these animals were consumed included community wide activities, such as the all-night summer solstice ceremony at Laguna (Parsons 1920:59), as well as more exclusive rituals held by one or two select members of specific societies, such as the tending of the warrior society scalps at San Felipe (White 1932:13, 1974a:37). As was noted above, all these animals also were commonly consumed as food on a 'daily' basis; their use in ritual activities was apparently largely related to the context in which the animals were procured. This is well documented by numerous accounts of communal rabbit, deer and antelope hunts. Communal rabbit hunts were commonly held to provide a supply of meat for ritual specialists for ceremonial purposes (*e.g.*, Parsons 1918:173, 1921:162, 1977:70; White 1932:52, 1974a:31-40; Anell 1969:61). For example, Whitman (1947:137-138) observes that at San Ildefonso the war captain and his assistants would formally organize and conduct a rabbit hunt in order to obtain a supply of meat for dancers during the spring *Tede Share* ceremony. Similarly at Zia, deer hunts in which only the men could participate, were held at the request of the war captain to supply meat to the *cacique* (ritual specialist) for ceremonial purposes (White 1974b:301-302), and at Jemez the mountain lion society was principally responsible for providing the *cacique* with deer and rabbit meat (Parsons 1977:70).

As indicated above, communal hunting was a task organized by specific societies, or leaders, within a Pueblo. The animals obtained during such hunts were often distributed within the community according a formalized hierarchy related to the level of an individual's involvement in the hunt or status within the presiding society. While hunters were entitled to portions of the spoils, the primary ritual specialists had preferential access, commonly receiving sizable and/or desirable portions of the game killed in the hunt. White's (1974b:303) account of such a hunt at Zia illustrates this well:

> "... as they enter the pueblo upon their return. They go directly to the *hotcanitsa* [the *cacique's* office] where the *Masewi* [war captain] and

> *Oyoyewi pro tem* [other war captain], assisted by the *tcraikatsi* [*cacique's* assistants] if there are lots of deer, carry the meat inside. A deer is divided into two parts, one for the *cacique*, the other for the hunter who killed it. The hunter gets the head, the skin and part of the backbone and the chest from the neck down to and including the fourth rib, and a part of the belly. The rest goes to the *cacique*" (White 1974b:303).

A similar account of formalized game apportionment after deer drives at Taos is provided by Parsons (1970:19):

> "The slayer got a hind leg, the hide and antlers; the man who was next to come up on the slain animal got a shoulder; all the other hunters had a share. The two first deer to be killed went to [the] Hunt chief who had 'made the talk', *i.e.*, prayed before the hunt began, asking the deer not to be afraid to give themselves to the hunters... Deer hunters will take one of their deer to a kiva to which all the kiva chiefs are bidden, to a feast of venison, the deer meat having been boiled in the kiva..."

In some cases the bones of large game were treated with considerable reverence and ritual. For example, at Zia the postcranial bones of deer obtained during communal hunts were discarded outside of the pueblo and protected from ravaging by dogs, while the head and horns were ceremonially 'dressed' and displayed on the roofs of the houses of the hunters (White 1974b:302-304). As noted by Gnabasik (1981:47) such treatment would result in removal of most remains from the site as well as separation of cranial and post-cranial skeletal elements.

> "...deer bones and eventually even the skull are deposited or buried outside the pueblo proper. With the separate treatment of the skull, deer skulls should not be found with any other deer bones, especially since the post-cranial skeleton seems to have at least been tossed on the midden or possibly in a special place of it or near it, while the skulls (and antlers?) are buried further away from the pueblo, probably at or near a shrine. The presence of the skulls with their antlers on the house tops is to be noted, as is the claim that they are only taken out and buried when they are very old and probably deteriorating."

Similar 'ritualized' treatment of cottontail and jackrabbit bones is not documented ethnographically. Most accounts suggest that the majority or all of the meat obtained during communal rabbit hunts was taken to the office of the *cacique* or a particular society, where it was stored for ceremonial use (Gnabasik 1981:108-124). Gnabasik (1981:109, 123) notes that bones from rabbits obtained during communal hunts were commonly tossed out with other domestic trash. In at least three communities (Cochiti, Laguna, and Zuni) rabbit meat was not eaten at all by the leaders of the hunters society as it was considered poisonous to them (Lange 1959:130, 271-272).

Animals as Medicine

Two taxa identified at Sand Canyon Pueblo are documented as having been used for medicinal purposes. Parsons (1970:60) observed that deer blood was used as a remedy for "chest sickness", while Beaglehole and Beaglehole (1964:30) report the use of weasel meat to alleviate the pain of child birth. Other animals were more commonly used for medicinal purposes, particularly large predators: bear, wolf, cougar and eagle as well as badger and porcupine (Gnabasik 1981; Tyler 1975). Of these taxa only the latter two have been identified at Sand Canyon Pueblo, though neither are documented as having been actually consumed for healing purposes.

Unfortunately little information is provided regarding the procurement, preparation, or treatment of the animals themselves in these cases or how these activities are likely to be represented archaeologically. However, Potter (1997:114) notes that a distinction is made between the meat and skeleton of these animals. In reviewing the treatment of carnivores obtained for ceremonial or medicinal use he notes that "...the meat has no special significance, and the killer may divide it as he chooses: the bones, however, must not be scattered about, and are either thrown into the river, or placed in shrines to be buried later".

Animals as Raw Materials for Clothing and Tools

In addition to being a source of meat, some animals were valued as sources of raw materials for the manufacturing of tools and clothing. Tables 19 and 20 indicate that at least seven taxa identified at Sand Canyon Pueblo were commonly used historically as sources of raw materials for such items. These include all the artiodactyls which were valued for their skins (for clothing), as well as antler, horn, and bones for tools, though specific reference to use of these latter materials are rare (Gnabasik 1981:51-55, 97-98, 104, 266). The skins of several small fur bearing animals also were commonly used in the manufacture of clothing and blankets. Those specifically mentioned and identified at Sand Canyon Pueblo include jackrabbit and cottontail (Lange 1959:128). Finally the hair of domestic dogs and turkey feathers were used in weaving blankets (Reed 1951:199-200; Lange 1959:164).

It is notable that the archaeological record suggests that the above list is incomplete. In particular, tools made from turkey bones as well as the bones of other animals are quite common to archaeological pueblo assemblages, but are not specifically noted in the ethnographic literature. Gnabasik (1981:266) suggests that this may be due to the fact that such items were so common that ethnographers found them of little interest or that the use of bone tools had dramatically declined by the time ethnographers arrived in the various pueblo communities. It is likely that the use of animals in daily domestic activities is generally understated throughout the ethnographic literature, and it can probably be safely assumed that the range of animals used in the manufacturing of items such as clothing and tools is much broader than listed here.

Animals as Raw Materials for Ritual Paraphernalia

The ethnographic record is rich with references to ceremonial activities which involved the use of costumes, masks, ornaments, musical instruments and other paraphernalia made primarily from skins, furs, feathers and bones of various animals (Gnabasik 1981). Over half of the taxa identified at Sand Canyon Pueblo are specifically documented as having been used for such items.

The hides, horns/antlers, bones and hoofs of artiodactyls are all noted as having been used as dance 'equipment' at various Pueblos. Costumes were made from hides, masks were frequently adorned with antlers or horns, and musical instruments were commonly made from 'deer leg bones' (presumably metapodials), scapulae, and hoofs. The use of such items was particularly prevalent at various game and hunting dances

(Gnabasik 1981:104), though 'deer skin' clothing is noted in most descriptions of dance costumes regardless of the ceremony.

The pelts of many carnivores were also used as ceremonial costumes, robes and masks. Five of the carnivores identified at Sand Canyon Pueblo are specifically mentioned as having been used in this way, including coyote, fox, bobcat, skunk and badger (Bradfield 1973; Gnabasik 1981; Neusius 1985). In some cases cranial bones, phalanges and caudal vertebrae may have remained attached to the skins (Gnabasik 1981:41-42).

The feathers of a wide variety of birds are repeatedly noted as having been essential components of costumes, masks, prayer-bundles, prayer-sticks and other ritual items (Gnabasik 1981). In some cases selected species were used for particular occasions, though specific ritual associations appear to vary significantly among communities. Almost all bird taxa identified at Sand Canyon Pueblo are mentioned in the ethnographic literature. It should be noted that the few taxa which are not mentioned (Poor-will, quail, grouse, Sandhill Crane and American Coot) were possibly also used, as it is unlikely that the ethnographers were able to document the species of every feather they observed.

While it is improbable that the use of feathers will be directly represented archaeologically, the skeletal remains of birds procured for the purpose of obtaining feathers may be represented. In some cases entire bird wings were used in ceremonies (Gnabasik 1981:179). Presumably this would include articulated skeletal elements as well as bird skins and feathers. Finally, it has been observed that birds such as kestrels, macaws, and parrots, were sometimes kept as pets or as a supply of feathers (Tyler 1979:198; Gnabasik 1981:263).

Live rattlesnakes and their remains also were used for specific ritual purposes. According to Stevenson (1894:77) rattles from two snakes were included as part of altar paraphernalia for ceremonies by the Zia snake society. More commonly live rattlesnakes were incorporated into dances or other 'snake handling' ceremonies (Gnabasik 1981:231). Reference to other animals being used similarly is limited to the Santiago's Day ceremony at Cochiti where live squirrels were captured, brought to the center of the village and then released (Lange 1959:360). These latter activities are unlikely to be represented archaeologically.

Patterns and Inferences

The previous chapter identified several significant spatial patterns among the distribution of animal remains from Sand Canyon Pueblo which warrant interpretation. In this section these patterns will be examined and discussed in terms of their consistency with the ethnographic record. In approximate order of intensity the predominant patterns identified include:

1. concentrations of artiodactyl remains within architectural blocks containing towers (blocks 100, 200, and 1000) and particularly high concentrations of artiodactyl remains on the roofs of the towers themselves;

2. a consistent and even distribution of lagomorph remains throughout the site;

3. concentrations of Galliformes and 'large bird' (presumably primarily consisting of turkey) remains within midden deposits throughout the site;

4. an abundance 'other bird' remains associated with the D-shaped structure (block 1500); and

5. a localized concentration of *Lynx* and birds of prey remains within the block 1000 courtyard.

Based on consideration of the ethnographic data discussed above, it is argued here that these five major patterns can be generally characterized as either representing standard 'domestic refuse' or 'ritual refuse' assemblages. As used here 'domestic refuse' includes assemblages of animal remains primarily resulting from the use of animals as food, and raw materials for clothing and tools; while 'ritual refuse' includes assemblages that appear to represent accumulations of bone primarily resulting from processing or consumption of animals during observances of rites or ceremonies and use of animals as raw materials for costumes, instruments or 'props' during such activities.

It should be noted that additional patterns were also identified in the previous chapter. In particular localized concentrations of amphibian and snake remains were identified among several room deposits. Given the absence of any direct evidence for the use or processing of these specimens (*e.g.*, cut marks, burning, and breakage; see Chapter 3) and the minor role that these animals appear to have played among historic pueblo communities, these 'patterns' are presumed to be the product of the natural death of several individual animals after abandonment of the site and consequently are considered of no cultural significance and will not be discussed in detail here. Also, dense concentrations of canid remains were identified in a number of locations (*i.e.*, associated with the D-shaped structure and block 800). As mentioned in the previous chapter these remains clearly represent individual animals which have been deposited as virtually complete skeletons. While these remains may represent food refuse or even ritually consumed animals this seems unlikely. No cut marks were observed on any of the remains, and excavation records reveal that the individuals were partly or fully articulated when found (in fact one was delivered to the zooarchaeological laboratory still encased in site matrix and had to be 'excavated' by the author). It seems most likely that the remains represent disposal of domestic dogs which died naturally at the site.

Expected Assemblage Characteristics

Presumably the composition of refuse accumulations associated with standard domestic food preparation and consumption should be dominated by those taxa which are known to have been eaten as food: *i.e.*, lagomorphs, Galliformes and artiodactyls; and to a lesser extent those which were used as raw materials for clothing and tools. Domestic refuse should occur relatively broadly throughout the site, particularly within courtyards, roof tops and abandoned structures, with the highest concentrations occurring within refuse midden deposits located near or immediately adjacent to the source of the debris. Presumably domestic refuse will be the most common type of deposit at the site and consequently the species composition of the remains is likely to closely correspond to the overall relative frequencies of the taxa recovered at the site as a whole, though rare taxa are likely to be underrepresented among domestic refuse. In particular wild carnivores, and wild birds other than Galliformes are unlikely to be found in great quantities.

Ritual refuse deposits should primarily consist of the remains of taxa that were processed and consumed in ritual contexts as well as those used as raw materials for ritual paraphernalia. Presumably this would include artiodactyls and lagomorphs procured during communal hunts, as well as a wide variety of wild carnivores and birds used for masks, costumes and other items.

Animal remains related to costumes worn during ritual dances and feasts may occur among ritual refuse. Although it is unlikely that these items would be intentionally discarded among the debris from a given feast, it is possible that small or fragmented items could be lost during festivities. In addition it is possible that these costumes would be stored in locations near usual ritual activity areas, for example, in a back storage room of a society house. Skeletal materials associated with ceremonial masks and costumes may include phalanges, claws and caudal vertebrae of wild carnivores and wild birds. Wild birds may also be represented by articulated wing elements. Non-perishable remains associated with ceremonial items other than costumes may include scapulae, long bones and distal phalanges of artiodactyla.

In some cases the disposal of animals used in ritual contexts also may be 'ritualized', resulting in unnatural element distributions, unusual associations of taxa, or formalized interment. As mentioned previously heads of game animals were sometimes displayed on roof tops after communal hunts, while the remainder of the carcass was disposed of outside the pueblo. This practice would potentially introduce unusually high proportions of cranial elements into ritual refuse and may obscure the presence of the game animals themselves. In other cases the bones of the animals may completely be removed from the site, intentionally buried or 'enshrined' as described for the treatment of medicinal carnivore remains, also mentioned above.

Domestic Refuse Assemblages

Of the patterns listed above two appear to be consistent with the expected composition and distribution of domestic refuse. Specifically, these include the noted uniform distribution of lagomorph remains throughout the site and the consistent concentration of Galliformes and 'large bird' remains identified in midden deposits. The midden deposits, in particular, are remarkably consistent with the expected pattern of domestic refuse. The deposits are clearly and consistently dominated by Galliformes, but also contain significant quantities of lagomorphs. Other taxa display relatively low concentrations, particularly those that were probably not commonly consumed as food (*i.e.*, 'other birds', birds of prey and wild carnivores). This pattern was most evident as a result of the cluster analysis, where midden deposits were found to all fall within clusters A or B (dominated by Galliformes and 'large bird'). These assemblages were also noted to be generally lacking in other taxa. Indeed comparison of midden assemblages to the Sand Canyon Pueblo assemblage as a whole indicates a distinct paucity of taxonomic diversity. Figure 19 illustrates the comparatively low species richness of midden assemblages compared to all other contexts at Sand Canyon Pueblo. The richness value for the midden deposits (pooled) falls below expected values (90% confidence interval) for Sand Canyon Pueblo as a whole relative to sample size. This indicates that relative to the assemblage size, fewer species are represented among the midden deposits than would be expected. Similarly the midden deposits display a lower than expected evenness value (Figure 20) given the size of the number of identified specimens; indicating that the deposits are dominated by a small number of taxa, while all other taxa are poorly represented. No doubt this is a reflection of the dominance of turkey and lagomorph remains among the midden deposits.

That the midden remains are likely representative of domestic refuse is not in itself a particularly significant discovery. One would expect that domestic refuse would accumulate as midden deposits and be prevalent throughout the site. However, the fact that the deposits are very consistent with expectations based on the ethnographic record lends support to the validity of the use of ethnographic analogy in this study.

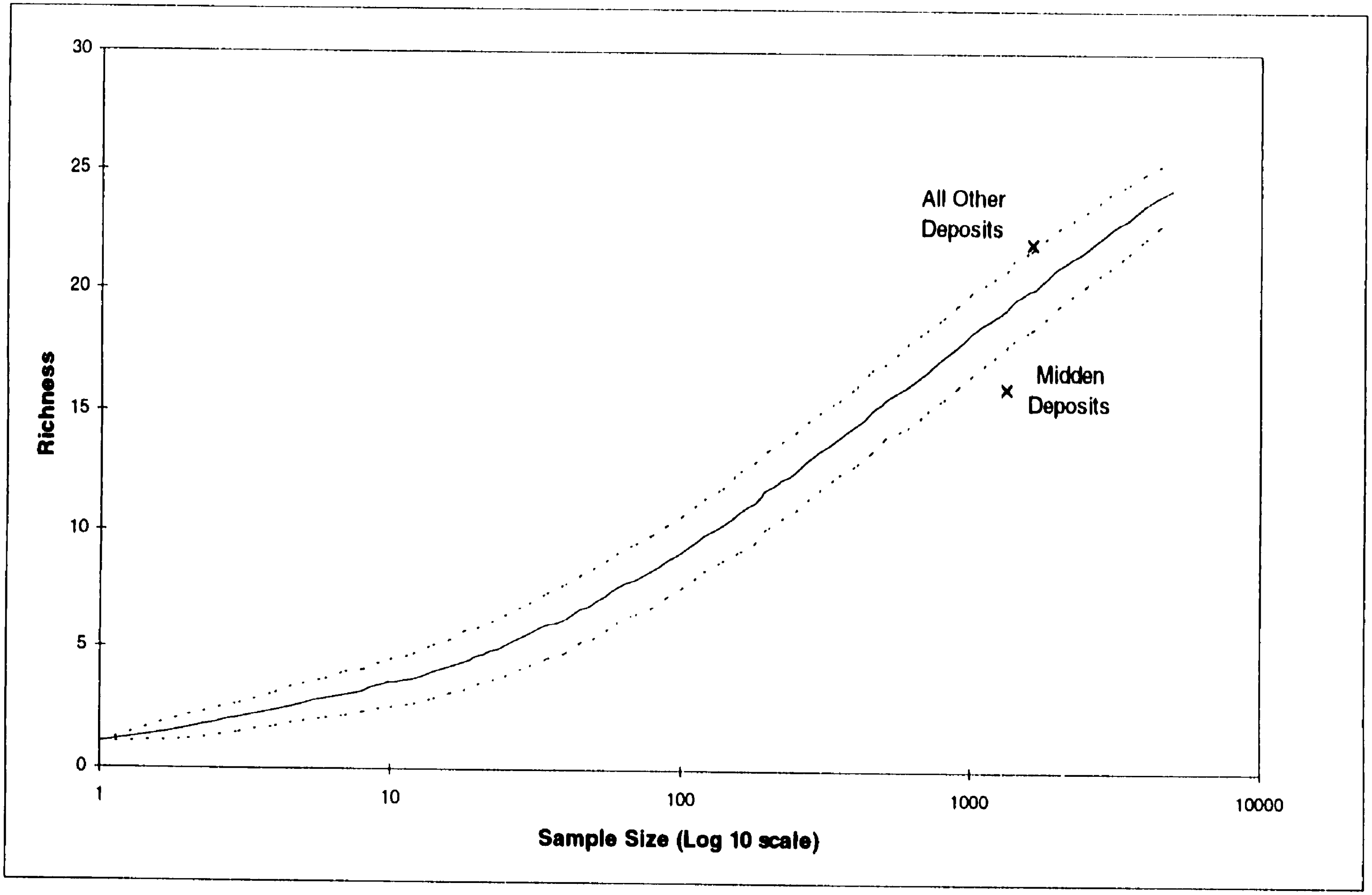

Figure 19. Plot of sample size *versus* richness for taxa recovered from midden and all other deposits at Sand Canyon Pueblo. The solid line indicates predicted mean values for all deposits pooled. Dotted lines inidcate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000).

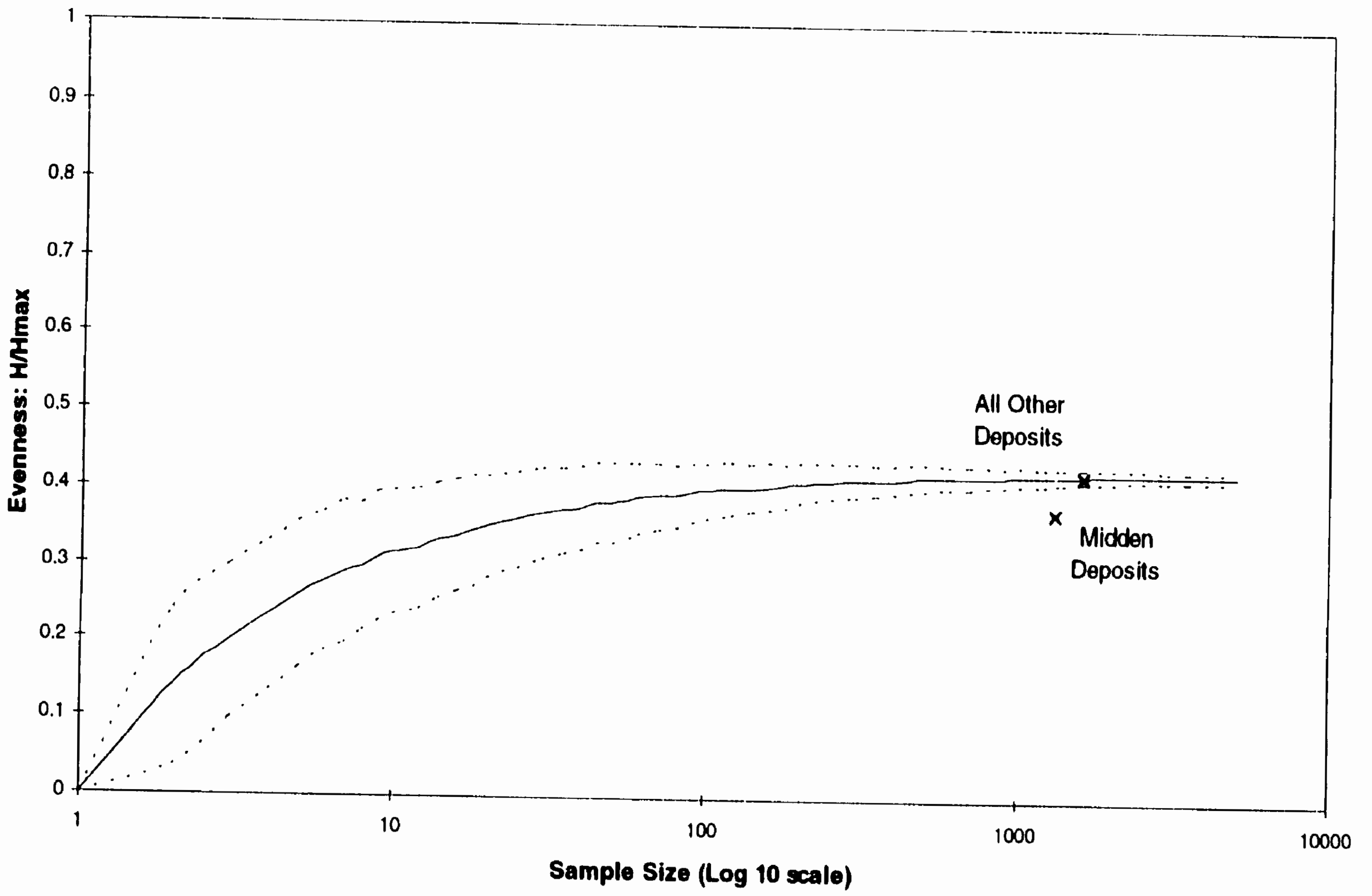

Figure 20. Plot of sample size *versus* evenness for taxa recovered from midden and all other deposits at Sand Canyon Pueblo. The solid line indicates predicted mean values for all deposits pooled. Dotted lines inidcate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000).

Ritual Refuse Assemblages

The three remaining patterns listed above appear to be consistent with expected ritual refuse assemblages. These include the concentration of artiodactyl remains within the tower blocks, the concentration of "other bird" remains found in association with the D-shaped structure, and the concentration of *Lynx* and birds of prey remains within the courtyard of Block 1000. What primarily distinguishes these deposits from others at Sand Canyon Pueblo is the marked prevalence of taxa other than Galliformes and lagomorphs. While this characteristic is not *by itself* necessarily suggestive of ritual behavior, the predominant taxa among these assemblages are in all cases consistent with ethnographic accounts of animals procured for and used in various dances, ceremonies, and society activities.

Concentrations of artiodactyls. The significant concentrations of artiodactyla remains among architectural blocks 100, 200, and 1000 are by far the most prominent and intriguing of these patterns. The distribution of artiodactyl remains is strongly suggestive that the 'tower blocks' were associated with communal hunting and feasting activities, perhaps acting as hunting or war society houses (or offices). As indicated in the ethnographic accounts discussed above, apportionment of game obtained during communal hunts was usually controlled by specific individuals or societies. Ritual specialists, and society heads received specific portions or a prescribed number of animals. Also, society 'offices' were used for storage of meat obtained during these hunts. It seems likely that a disproportionate quantity of game, such as that identified in association the 'tower blocks', would be found in or near the 'offices' of such societies or individuals.

The concentration of artiodactyla remains on the roofs of the towers within blocks 100 and 1000 are reminiscent of the ethnographic references to the display of animal heads on roof tops after a communal hunt. However, examination of the skeletal elements represented among the tower roof deposits (see Figure 21, below) does not support this interpretation. Figure 21 illustrates the relative proportion of elements represented among the tower roof deposits and indicates that all skeletal regions are represented. Clearly the remains are not simply the result of crania being displayed on the tower roof tops. In fact, very few cranial elements are actually present. Instead it appears that whole animals are represented by the remains. It may be that the towers themselves acted as society offices or storage areas.

In addition to differences in quantity, apportionment of animals as described ethnographically, may also produce distinctive skeletal element distributions. While ritual specialists and society heads received specific allotments, hunters were also frequently entitled to a share of the animals they killed and presumably other members of the community would have had limited access to some (perhaps less desirable) portions of the game. This should produce unnatural and disproportionate distributions of skeletal elements throughout the site. Specifically, if the 'tower blocks' acted as focal points for redistribution of artiodactyls within Sand Canyon Pueblo, notable differences in element frequencies between these blocks and the remainder of the Pueblo may be expected. However, as indicated by Figure 22 (below), element frequencies actually differ very little between the 'tower blocks' and the rest of Sand Canyon Pueblo. The only notable contrast is the abundance of thoracic vertebrae and ribs among the 'tower blocks' and increased occurrence of lower leg bones, particularly tarsals and metatarsals among the remainder of the site. The somewhat disproportionate occurrence of lower limb bones (particularly metapodials) among the 'other blocks' is interesting given that these elements are valuable as raw materials for bones tools such as awls. However, in terms of meat value, the patterns indicate only minor differences in apportionment of artiodactyls. This is better illustrated by Figures 23 and 24, where elements have been grouped by common butchery units and ordered according to associated meat values.

Figure 23 indicates that all butchery units are represented among all four sub-assemblages (blocks 100, 200, 1000 and 'all other areas'). Given the relatively small numbers of specimens within each sub-assemblage the thorough skeletal representation is remarkable. Variability among sub-assemblages is minimal though several minor differences are apparent. Blocks 100 and 1000 display strikingly similar assemblage structures, while the butchery unit frequencies among block 200 more closely resemble the 'other areas'. Differences between these groups are primarily limited to an abundance of

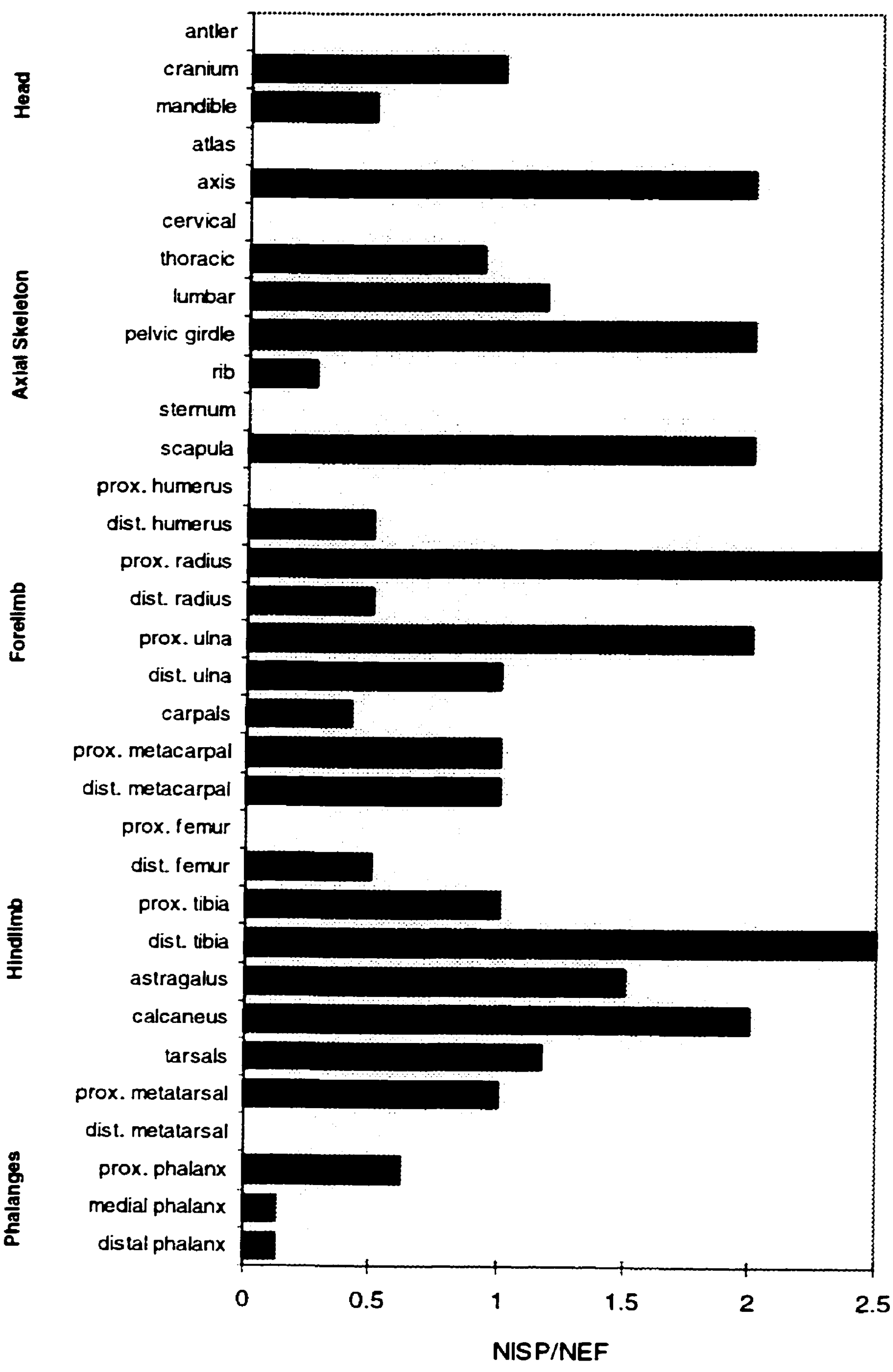

Figure 21. Bar graph indicating the frequency (NISP/NEF) of each skeletal element or element portion for artiodactyl remains from tower roofs at Sand Canyon Pueblo.

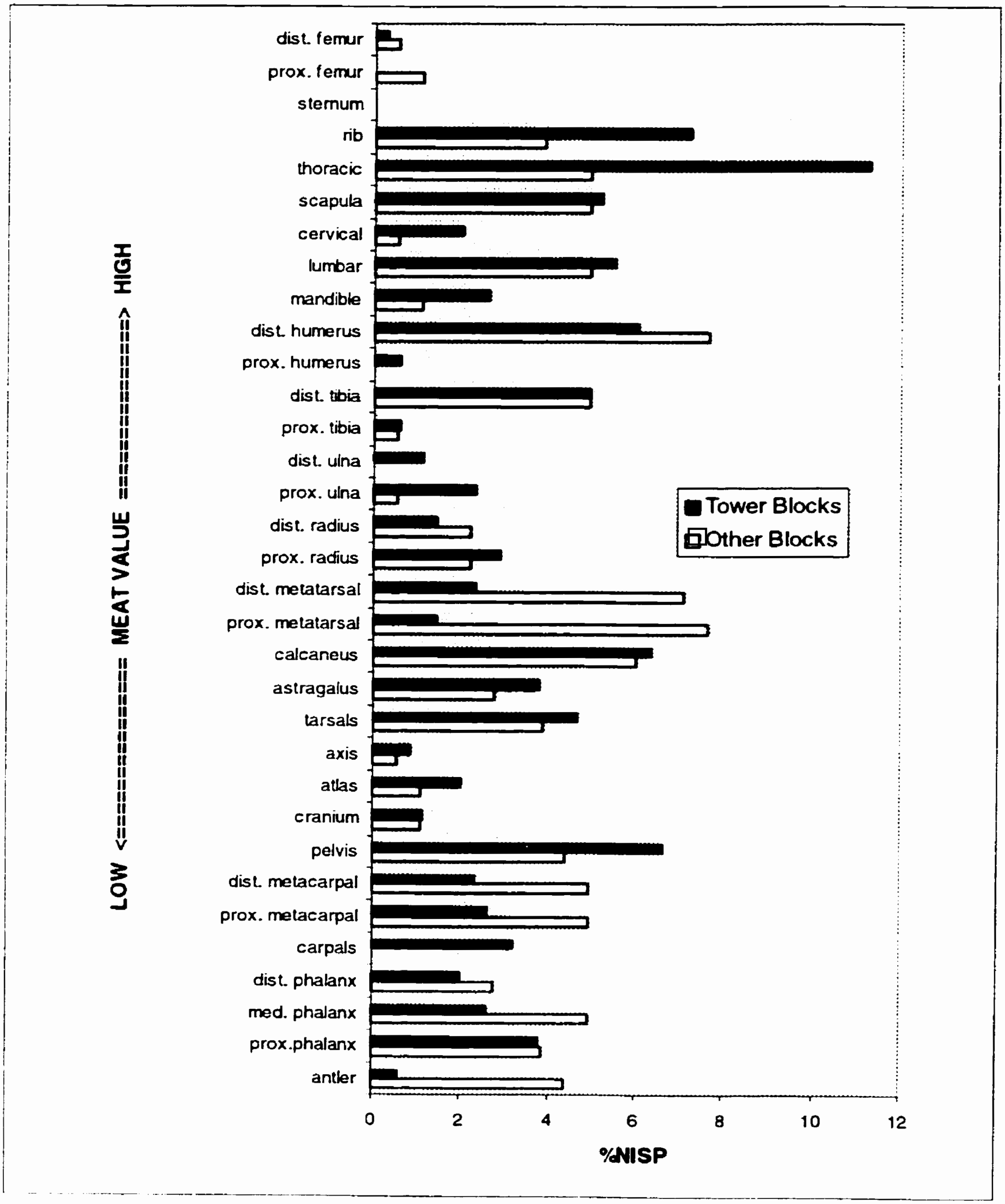

Figure 22. Bar graph indicating the relative frequency (%NISP) of each skeletal element or element portion for artiodactyl remains from the 'tower blocks' (Blocks 100, 200, and 1000) compared to all other blocks at Sand Canyon Pueblo. Elements are listed according to meat value rankings for caribou (after Binford 1981).

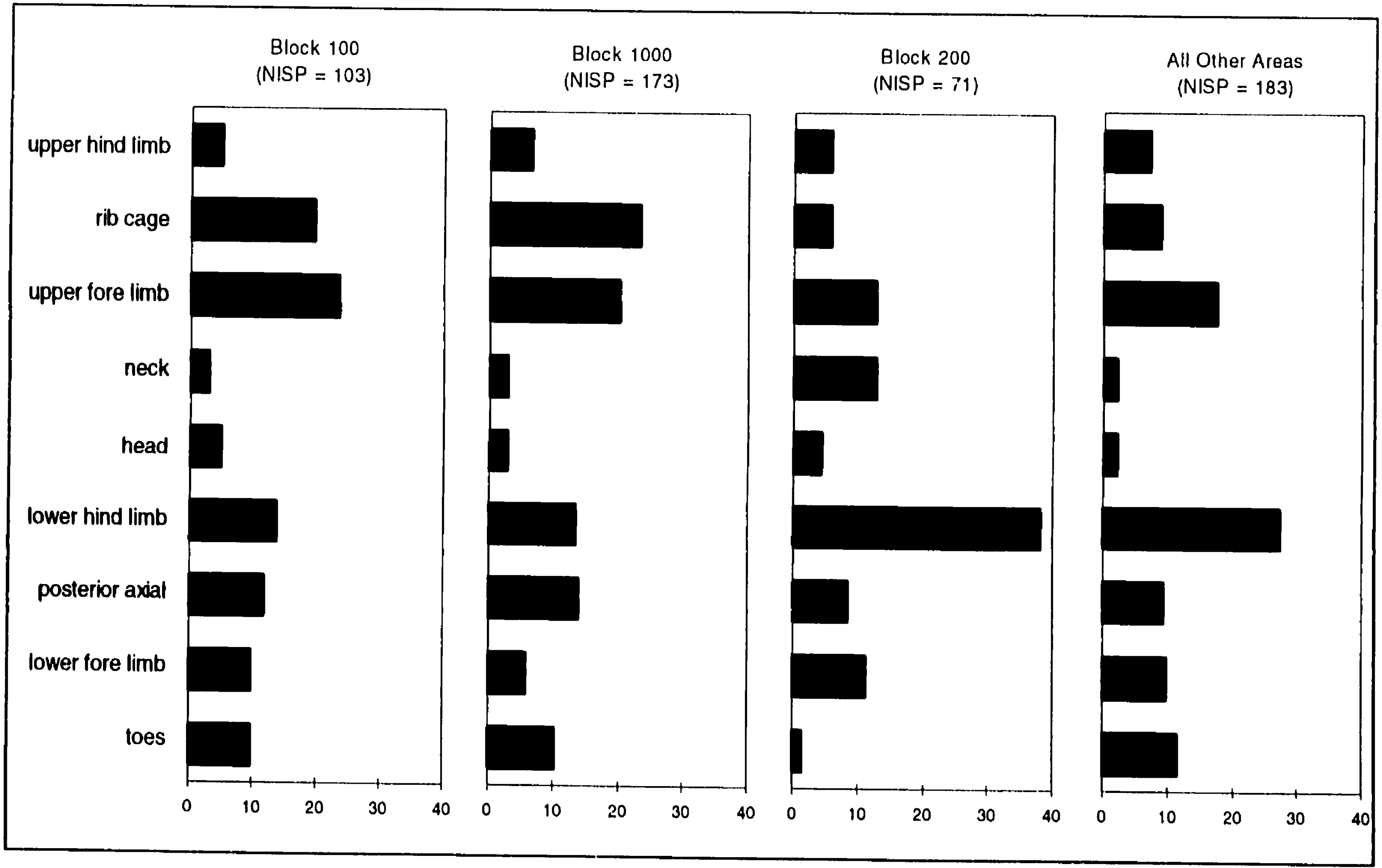

Figure 23. Bar graphs comparing the relative frequency (%NISP) of each common butchery unit for artiodactyl remains from the 'tower blocks' (Blocks 100, 200, and 1000) to all other excavated areas at Sand Canyon Pueblo. Butchery units are listed according to meat value rankings for caribou (after Binford 1981).

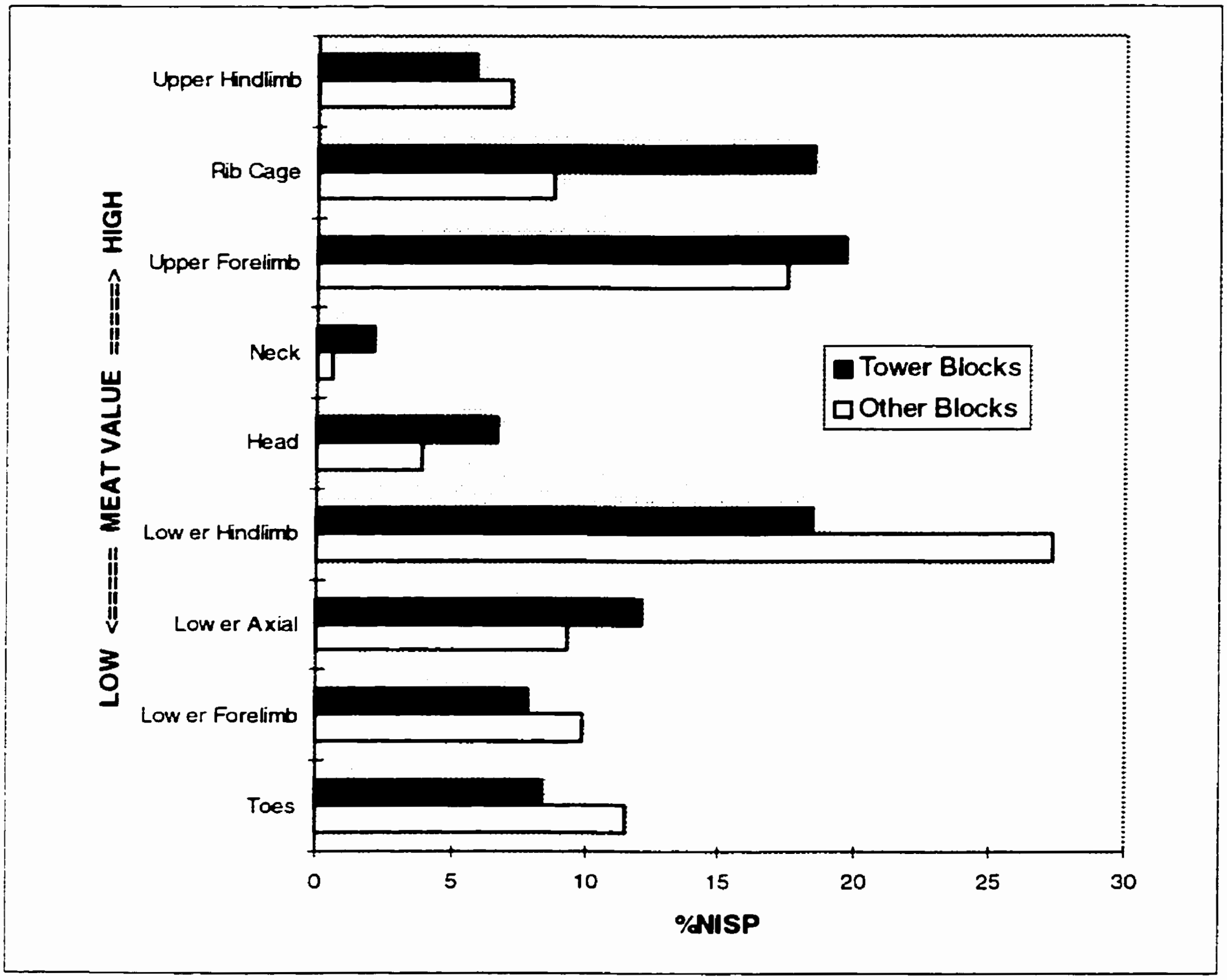

Figure 24. Bar graph indicating the relative frequency (%NISP) of common butchery unit for artiodactyl remains from blocks 100, 200, and 1000 (pooled) compared to all other areas at Sand Canyon Pueblo. Butchery units are listed according to meat value rankings for caribou (after Binford 1981).

lower hindlimb remains among both the block 200 and 'other area' remains. In contrast blocks 100 and 1000 display relatively few lower hindlimb elements and greater abundances of rib cage remains. Overall, the distribution of artiodactyls appears to differ little between the 'tower blocks' and other portions of the site (see Figure 24). Distinctions between assemblages are not pronounced and do not appear to represent consistent and repeated patterns. If indeed the 'tower blocks' did act as society offices where game were processed and then redistributed, it appears that the animals were apportioned relatively equally throughout the community.

Concentrations of 'other bird'. The second most prevalent pattern which is suggestive of ritual refuse at Sand Canyon Pueblo is the abundance of 'other bird' remains associated with the D-shaped structure. As noted above, the feathers of many types of birds were commonly used in ceremonial costumes and paraphernalia. Given the architecturally unique nature of the D-shaped structure it would not be surprising if it served as a focal point for community ceremonies. The abundance of 'other bird' remains may reflect the use of this structure for preparation and storage of costumes, masks, prayer sticks, prayer bundles and other similar items. While it is recognized that the ethnographic data suggest that feathers were the primary bird elements incorporated into such items, entire wings were sometimes used and the skeletal remains of birds obtained for their feathers are likely to be found within or near locations where ritual paraphernalia is prepared and stored.

Table 21 presents the 'other bird' taxa identified in association with the D-shaped structure and in what contexts they were found. The remains include at least 8 species, and potentially many more are represented by the general categories 'jay, crow, and raven'; small passeriform; small bird; and falconid. The remains were found in association with all major contexts, though the vast majority were recovered from roof and midden deposits. A number of birds of prey are included in this list. While these latter taxa did not appear to be significantly abundant during the contingency analyses presented in Chapter 4, they were grouped with the 'other bird' remains during cluster analysis, which indicated at least two moderate concentrations of such remains (cluster type F) associated with the D-shaped structure.

While it is probably impossible to determine the true ritual significance of the bird remains, the ethnographic record provides a basis for speculation. All taxa recovered from the D-shaped structure are documented as having had specific spiritual associations among historic Pueblos (see Table 20 above). Though a wide array of associations are represented by these taxa, some common themes are apparent. A number of the taxa are documented as having been associated with water, specifically rain, including: Mourning Dove, Sandhill Crane, Raven, and Owl. Of these the relationship between the Mourning

Dove and rain is most firmly documented. Tyler cites various ethnographic accounts of traditional Puebloan stories in which doves, particularly the Mourning Dove, invoke rain or are indicators of rain pools and springs (Tyler 1979:105-112). Similarly Tyler notes that the Sandhill Crane is associated with the "Rain Bird" kachina (*kwapiye ohuwah*) described as "a bird that comes only with continuous rain" (Henderson and Harrington 1914:46, cited in Tyler 1979:129). Flocks of Ravens and Crows are also associated with rain clouds, which are in turn associated with kachina spirits "passing over the villages occasionally to bring rain" (Tyler 1979:173). Finally, owls have a fairly tenuous association with rain indicated only by a rain making game involving the use of owl feathers documented by Parsons (1939:774, cited in Tyler 1979:164).

Table 21. 'Other birds' and birds of prey found in association with the D-shaped structure (NISP data).

Common Name	Context						Totals
	Kiva Floor	Kiva Roof	Room Floor	Room Roof	Midden	Other*	
Poor-will				1			1
Morning Dove				1		2	3
Sandhill Crane		2					2
Raven					4	6	10
Jay, Crow or Raven			3	3	8	16	30
Small Passeriform		2		1	6		9
Small Bird		4		1		10	15
Great Horned Owl	1						1
Owl				1			1
Hawk					7		7
Falconid		1			1	2	4
Turkey Vulture			8			1	9
Totals:	1	9	11	8	26	37	92

* "Other" contexts includes all disturbed and indeterminate deposits.

It is notable that these four taxa also have spiritual links to agriculture. According to Tyler (1979:106) doves are associated with winnowing of grain due to their seed eating habits. The Sandhill Crane is associated with the harvest, specifically as a guardian of harvested corn, but also as a bringer of seeds (Tyler 1979:128-129). Crows and Ravens can also be thought of as birds of agriculture due to their habit of 'joining in on the harvest' (Tyler 1979:173), and owls, (particularly the Great Horned Owl) are associated with the bringing of hot weather for the ripening of corn and other crops (Tyler1979:165).

Most of the birds of prey are associated with war and hunting to various degrees. The hawk has a particularly strong association, though the smaller falconids (specifically the kestrel) also have lesser 'spiritual roles' in such activities (Tyler 1979). Crows and ravens are associated with war and death, likely because they eat carrion (Tyler 1979:181-182), as does the Turkey Vulture which is specifically associated with recovery of war-dead and purification, after battle (Tyler 1979:225-229). This theme of death extends to the Sandhill Crane and owls. As well as being guardians of corn, Sandhill Crane are considered guardians of clowns, *kachina* dancers and the dead (Tyler 1979:129). Owls, particularly the Burrowing Owl, are associated with night, the underworld and the god of death (Tyler 1979:164).

These are the major spiritual themes represented by the birds identified among the D-shaped structure deposits. Common associations have been emphasized here, but it is important to recognize that the taxa listed above also have many other spiritual associations which have not been discussed, some of which are even contradictory to those presented above. For example, while crows and ravens are associated with rain, they are also an omen of drought (Tyler 1979:180). Such contradictions are not uncommon and reflect the variety of roles that birds played among the different Pueblo communities and the limitations and potential problems of trying to synthesize this diversity. However, perhaps more important than the commonalities, is the range of associations that are represented. Clearly the birds are not all linked by a single theme, such as agriculture, hunting, or war, but represent at least two or three different activities. This suggests that the D-shaped structure may have acted as a multi-purpose ceremonial facility for the Pueblo as whole, rather than as the 'house' or 'office' of a single (*e.g.*, war or hunting) society. While this interpretation is quite speculative, it is consistent with the unique architectural nature of the D-shaped structure and its central location within Sand Canyon Pueblo.

Concentrations of birds of prey and *Lynx*. The third pattern highly suggestive of ritual refuse is the concentration of birds of prey and *Lynx* remains identified within the courtyard of Block 1000. Much like the concentration of 'other bird' remains associated with the D-shaped structure, this pattern is not likely the result of disposal or storage of common food animals. However, the significance of this pattern is questionable. It is represented by only a single deposit and furthermore likely consists of a small number of relatively complete animal skeletons. A closer examination of the data reveals that only one bird of prey species is actually represented among the deposit: the American Kestrel (*Falco sparverius*). Furthermore it appears that only one individual kestrel is represented based on the frequency of elements (MNI = 1). Similarly the *Lynx* remains recovered from the deposit collectively produce a MNI value of 1. Given this information it appears that the 'pattern' may be more accurately described as an anomaly, in that the remains do not clearly represent repeated and consistent use of space.

It is notable, however, that both bobcat and kestrel are spiritually associated with hunting and war (Tyler 1975, 1979). That the concentration occurs within Block 1000 (a tower block) is particularly intriguing given the evidence for communal hunting of artiodactyls associated with this block discussed above. Ethnographically both war and hunting societies are documented as having been principally responsible for the organization of communal hunts of deer and other large game. The presence of bobcat and kestrel remains are consistent with the interpretation that the 1000 Block functioned as a war or hunting society house or office. The occurrence of relatively complete animal skeletons, particularly birds is also consistent with the storage of ritual paraphernalia (Gnabasik 1981:263).

Summary

In summary, the faunal remains from Sand Canyon Pueblo display patterns in their distribution and organization which, in many respects, are consistent with ethnographically documented faunal utilization. Both turkey and lagomorphs are documented as having been primary sources of meat among many historic Pueblos. The distribution of these taxa within Sand Canyon Pueblo appears to be consistent with that of common daily food refuse. Lagomorphs remains do not appear to be strongly associated with any particular structure, but rather are found distributed widely throughout the site, while turkey remains are especially common among midden deposits. It has been argued that this is what would be expected of animals which are used for domestic activities on a daily basis, while a more discrete distribution would be expected of animals which were used less frequently for special events or ceremonies.

The distribution and organization of other taxa suggest that some structures within Sand Canyon Pueblo were focal points for specific non-domestic activities. These have been broadly defined here as 'ritual' activities in the sense that they likely involved the observance of formalized ceremonies and rites. Specifically, the D-shaped structure appears to have functioned as a multi-faceted ritual activity centre. The abundance and variety of wild birds found there represent a very wide range of spiritual associations, while the use of such birds (particularly bird feathers) in ritual costumes and other paraphernalia is well documented ethnographically.

The 'tower blocks' appear to have been associated with the organization of ritualized communal hunting activities. The concentration of artiodactyl remains within the kivas and on the roofs of towers in blocks 100 and 1000 is particularly suggestive that these structures were focal points for the processing, storage, and perhaps redistribution of large game. The occurrence of kestrel and bobcat (animals spiritually associated with hunting) remains within a courtyard associated with these structures (block 1000) adds further to this argument. It is also notable that artiodactyl remains are found in lesser quantities throughout the pueblo. This may indicate differential access to these animals among individuals within the community, though the skeletal representation apparent among these remains suggests that there was little variation in terms of access to high quality meat.

CHAPTER 6
PUEBLO III SITES
OF THE SAND CANYON LOCALITY

Introduction

As mentioned in Chapter 1, several additional Pueblo III sites in the Sand Canyon Locality have been excavated as part of the Sand Canyon Archaeological Project. These include 13 small hamlets situated within and near Sand Canyon as well as one medium-sized site (Castle Rock Pueblo) located at the junction of Sand and McElmo Canyons (see Figure 3). Some of these sites were occupied at the same time as Sand Canyon Pueblo while others predate its primary period of occupation, though collectively the small sites span the entire Pueblo III period (AD 1150 to 1300). Faunal remains from all these sites have been previously analysed and reported elsewhere (Walker 1990; Brand 1991; Munro 1994; Driver 1996; Driver *et al.* 1999). In this chapter Sand Canyon Pueblo will be compared to these sites in order to investigate local temporal and spatial trends in faunal exploitation and utilization during the Pueblo III period. This, in turn, will be used to elucidate cultural and environmental phenomena potentially associated with the development of aggregated communities.

Investigated Pueblo III Sites within the Sand Canyon Locality

The 14 additional sites investigated as part of the Sand Canyon Archaeological Project were selected in order to obtain data from a variety of environmental settings (*i.e.*, mesa top, upper canyon, and lower canyon), as well as from throughout the Pueblo III period. Table 22 presents the size, environmental setting, and latest occupation period for each of these sites. Excavations conducted over four field seasons (1988-1991) followed a standardized stratified random sampling strategy (Kuckelman *et al.* 1991:16; Varien *et al.* 1992), which attempted to obtain representative samples from various structural and non-structural contexts within each site. Generally sampling strata were defined on the basis of surficially evident structural remains and features. Typical sampling strata included:

Table 22. Characteristics of Additional Pueblo III Sites Investigated in the Sand Canyon Locality (after Varien *et al.* 1992; Huber and Lipe 1992; Kuckelman *et al.* 1991).

Site Name	**Number**	**Size: Number of Kivas**	**Environmental Setting**	**Primary PIII Occupation**
G and G Hamlet	5MT11338	Small: 1	Mesa Top	AD 1180-1225
Kenzie Dawn Hamlet	5MT5152	Small: 3	Mesa Top	AD 1180-1240
Green Lizard Site	5MT3901	Small: 2	Upper Canyon Bench	AD 1200-1280
Shorelene's Site	5MT3918	Small: 1	Mesa Top	AD 1210-1250
Roy's Ruin	5MT3930	Small: 1	Mesa Top	AD 1210-1250
Lillian's Site	5MT3936	Small: 1	Mesa Top	AD 1210-1250
Troy's Tower	5MT3951	Small: 1	Mesa Top	AD 1210-1300
Mad Dog Tower	5MT181	Small: 1	Lower Canyon Bench	AD 1210-1300
Catherine's Site	5MT3967	Small: 2	Upper Canyon Bench	AD 1240-1300
Saddlehorn Hamlet	5MT262	Small: 1	Lower Canyon Cliff	AD 1240-1300
Stanton's Site	5MT10508	Small: 1	Upper Canyon Cliff	AD 1250-1300
Lookout House	5MT10459	Small: 2	Upper Canyon Cliff	AD 1250-1300
Castle Rock Pueblo	5MT1825	Medium: 12-15	McElmo Canyon	AD 1250-1300
Lester's Site	5MT10246	Small: 2	Upper Canyon Cliff	AD 1260-1300

surface architecture (room blocks and towers), pit structures (kivas), courtyard, midden, inner periphery, and outer periphery. In some cases additional strata were defined due to the presence of unique features or disturbed deposits. At each site randomly placed 1 m^2 units were excavated within each of these sampling strata. The total number of randomly placed units excavated within each stratum varied from site to site. Judgmentally placed units were also excavated within some strata (particularly pit structures) at most sites. These latter excavations were conducted primarily to facilitate interpretation of the random units, as well as to ensure that readily dateable wood samples were recovered from each site. In some cases judgmental units were necessary to allow completion of the random tests (*i.e.*, to allow access to tightly confined spaces and to expose and remove obstructive features). In addition to the sampling program, more extensive excavations were conducted at two sites (the Green Lizard Site and Castle Rock Pueblo). A description of each site and the nature and extent of excavations is presented below. More detailed information regarding these investigations can be found elsewhere (*i.e.*, Kuckelman *et al.* 1991; Varien *et al.* 1992; Huber and Lipe 1992).

Mesa Top Sites

G and G Hamlet (5MT11338). G and G hamlet is located approximately 1 km north of Sand Canyon Pueblo. Surficially evident features at the site include a kiva depression, rubble mound (room block), courtyard, and two distinct midden areas. The site has at least two distinct components (Varien n.d.). The late component (*ca.* A.D. 1180 - 1225) includes the masonry structures (room block, kiva) and associated courtyard and midden areas. The earlier component (*ca.* A.D. 1050-1100) was made apparent by the discovery of an adobe room block beneath the masonry structures. The second midden area was determined to also be associated with this earlier occupation.

A total of 49 random and three judgmentally placed units were excavated at the site. These excavations primarily focused on the later component, though early deposits were encountered below the masonry structures and some tests were placed within the early midden deposit. Faunal remains recovered from these excavations consisted of 152 specimens, approximately half of which (NISP = 72) could be identified. The early deposits contributed 16 of the identified faunal remains. These latter specimens are excluded from the analyses presented below.

Kenzie Dawn Hamlet (5MT5152). Kenzie Dawn Hamlet is located approximately 1.2 km west of Sand Canyon Pueblo at an elevation of approximately 2120 m. It is a multicomponent site consisting of structures and refuse associated with Basketmaker III, Pueblo II, and Pueblo III occupations (Kuckelman n.d.; Varien n.d.). Testing of the site primarily focused on the later occupations and included investigation of a kiva, room block, courtyard, and midden associated with the PIII component (*ca.* A.D. 1180-1240). Forty-eight randomly placed units were excavated. A total of 1475 faunal specimens were recovered from these excavations, 884 of which could be identified. Of these, 373 are clearly associated with the early (PII and Basketmaker) occupations of the site and have been excluded from analyses presented below.

Shorelene's Site (5MT3918). Shorelene's site is located at an elevation of 2115 m. approximately 1 km west of Sand Canyon Pueblo. Surficially evident structures at the site include a masonry room block. a single kiva. a masonry tower. and a large concentrated midden deposit. Excavation revealed additional room structures and an earlier pit structure beneath the kiva (Varien *et al.* 1992:54-55). Ceramics recovered from the site suggest that it was primarily occupied during the Pueblo III period. though Basketmaker III through Pueblo II components are also apparent (Varien *et al.* 1992:55).

Excavations at the site focused on the Pueblo III structures and associated features. A total of 39 randomly placed units were excavated. Faunal remains recovered from these excavations included 206 bone fragments. of which 121 could be identified. Some of the remains were clearly associated with the earlier occupations of the site and thus have been excluded from analyses presented below. These include 29 identifiable specimens.

Roy's Ruin (5MT3930). Located approximately 1 km north-northeast of Sand Canyon Pueblo. Roy's Ruin is a small multicomponent site located at an elevation of approximately 2076 m. Both Pueblo II and III occupations are represented at the site. though testing focused almost exclusively on the Pueblo III component. Pueblo III structures and features identified at the site include a masonry room block. a single kiva. a masonry tower and a large midden area. These structures and features are aligned along a north-south axis. such that the centers of the room block. kiva. tower and midden can be connected by a straight north to south line (Varien *et al.* 1992:50. 53). Testing of these structures and peripheral areas included excavation of 53 probabilistic and three judgmental sampling units (Varien *et al.* 1992:53). A total of 184 faunal specimens were recovered from these excavations. including 85 specimens which could be positively identified.

Lillian's Site (5MT3936). Lillian's site is located approximately 1.7 km north-northwest of Sand Canyon Pueblo at an elevation of 2073 m. The site includes cultural materials associated with both Pueblo II and III periods, though the Pueblo III component is by far predominant (Varien *et al.* 1992:52). Testing of the site focused on structures and midden areas associated with the Pueblo III component. Such structures identified at the site include two masonry room blocks connected by a single curved masonry wall. A single kiva was identified in "front" of the two room blocks and an associated masonry tower was found south of these structures. A large midden area was clearly apparent in the southern portion of the site and a wall-enclosed "courtyard" area was identified immediate adjacent to the tower.

Testing of the site included excavations within the room blocks, kiva, tower, midden, courtyards, as well as inner and outer peripheral areas. In total 36 randomly-placed and five judgmental units were excavated. A total of 435 faunal specimens were recovered, 241 of which could be identified.

Troy's Tower (5MT3951). Situated on the mesa top overlooking the upper part of Sand Canyon, approximately 1 km west-southwest of Sand Canyon Pueblo, Troy's Tower is a small single occupation site. The site includes a collapsed masonry tower connected to a kiva by a masonry lined tunnel. A small midden is located immediately south of the tower and two large bell shaped pits were found elsewhere at the site. One of these pits was determined to have functioned as a roasting pit. The absence of any evidence of a room block makes this site unique among those tested. The site is also the only small mesa-top site known to be contemporaneous with the occupation of Sand Canyon Pueblo. Varien *et al.* (1992:56) speculate that "the site may have had a specialized function, as a ritual, defensive, economic, or communications feature closely associated with Sand Canyon Pueblo". Stratified random testing of the site produced a total of 159 faunal specimens, 93 of which could be identified.

Sites of Upper Sand Canyon

Green Lizard Site (5MT3901). The Green Lizard site is located approximately 1 km southwest of Sand Canyon Pueblo. The site is situated on a small, south-facing erosional bench within Sand Canyon at an elevation of 2025 m (Huber and Lipe 1992:69). Structures and features associated with the Pueblo III occupation of this site include two kivas, room blocks, associated courtyards and a large and relatively deep midden area. Excavations revealed a low-intensity Pueblo II occupation of the site, beneath some of the structures, though investigation of this component was extremely limited (Huber and Lipe 1992:75).

Excavation of the site included a combination of intensive investigation and a stratified random test unit sample. Intensive excavation focused on the architectural features in the western half of the site (Huber and Lipe 1992:70), while the stratified random testing was conducted in non-structural areas. Faunal remains recovered from the site were analysed by Walker (1990) and included 3580 specimens, 1707 of which were identified beyond the Class level.

Catherine's Site (5MT3967). Catherine's site is located at an elevation of 2060 m on a bench within upper Sand Canyon, approximately 1.5 km south-southwest of Sand Canyon Pueblo. It is a small habitation site consisting of a room block, two kivas and a large midden area. While there is limited evidence of Pueblo II use of the site, the predominance of Pueblo III style pottery and archaeomagnetic dating strongly suggest primary occupation of the site occurred post A.D. 1200 (Varien *et al.* 1992:56). Stratified random testing of the site produced a relatively large number (844) of faunal specimens, 397 of which could be identified.

Stanton's Site (5MT10508). Approximately 100 m up slope (east) from Catherine's site is Stanton's site at an elevation of approximately 2160 m. The site is situated at the junction of the talus slope and cliff face, just below the canyon rim. Primary cultural features include a kiva, connected by a tunnel to a boulder-top tower, at least two small room blocks and an unusually deep (1.25 m) midden area. Varien *et al.* (1992:58) note that the boulder-top masonry tower would have had "...a commanding view of Sand Canyon. From this structure, Lower Sand Canyon is visible to the south as far as its confluence with McElmo Creek. To the north, one can see Troy's Tower, a mesa-top site near the west rim of Sand Canyon."

Stratified random testing of this site produced a very large number of faunal remains (2253 specimens), 990 of which could be confidently identified.

Lester's Site (5MT10246). Lester's site is located on a narrow bench and talus slope immediately below the north rim of Sand Canyon, approximately 550 m west of the canyon head and 140 m southwest of Sand Canyon Pueblo. The site slopes steeply to the south and ranges in elevation from 2066 m (bench) to 2042 m (lower talus slope). Features evident at the site include two walled alcoves, three surface structures, several rubble piles, sections of retaining wall, two pit structures, and a soil-stained midden (Kuckelman *et al.* 1991:85). A total of 43 randomly placed units were excavated at Lester's site. In addition five units and two small trenches were judgmentally placed and excavated. Of 379 bone fragments recovered from the site only 182 could be identified.

Lookout House (5MT10459). Lookout House is situated on a narrow sloping terrace below the north rim of Sand Canyon, 675 m west of the canyon head. This places the site approximately 220 m southwest of Sand Canyon Pueblo. The site ranges in elevation from 2066 m to 2042 m. Surficially evident features at the site include two kiva depressions, sections of retaining wall, rubble piles (room block remnants), a midden area, and remnants of a masonry tower situated on top of a boulder (Kuckelman *et al.* 1991:145-146). The name of the site was inspired by this latter structure. Testing included excavation of 45 random and five judgmentally placed units. No units were located within the boulder-top structure as no sedimentary deposits are present there. Faunal remains recovered from the site include 517 specimens, though only 173 of these could be identified.

Sites of Lower Sand Canyon

Mad Dog Tower (5MT181). Mad Dog Tower is situated on the crest of a ridge on the first (lowest) terrace of Sand Creek, at the eastern side of the mouth of Sand Canyon. The site is located within the sparsely vegetated lower portion of Sand Canyon at an elevation of approximately 1789 m. Surface remains at Mad Dog Tower include a tower, a sandstone rubble mound and a midden area. The location of a kiva, immediately west of the tower, was inferred on the basis of topography and the observed distribution of surface structures (Kuckelman *et al.* 1991: 42). Excavation of this area indicated that this inference was accurate. A total of 29 randomly placed units were excavated at the site. Three additional units were judgmentally placed within the kiva, tower, and rubble areas (room block remnants), in order to further investigate the structures at the site. A total of 37 bone fragments were recovered during these excavations, only three of which could be identified.

Saddlehorn Hamlet (5MT262). Saddlehorn Hamlet is located at an elevation of 1769 - 1800 m (a.s.l.) on the lowest terrace of Sand Creek, near the mouth of Sand Canyon. Structures and deposits were observed on the top of a south facing 30 to 40 m high cliff as well as lying within and in front of (south of) a small sheltered alcove at the cliff's base (Kuckelman *et al.* 1991:20). Surficially evident structures at the site include two masonry rooms (located within the alcove), several wall segments, rubble mounds and a large concentrated midden deposit. Surficial evidence for a kiva at the site is minimal, though one was assumed to be situated on the talus slope immediately in front of the small alcove (Kuckelman *et al.* 1991:20). Excavations in this area subsequently confirmed this assumption (Kuckelman *et al.* 1991:28).

Excavations at the site focused on the talus slope immediately in front of the alcove. A total of 21 randomly placed units were excavated. In addition, judgmentally placed units were excavated within the kiva, and courtyard sampling areas. The structures within the alcove were determined to be too fragile to allow for excavation, thus no units were placed in this area. Faunal remains recovered from excavations Saddlehorn Hamlet included 621 bone fragments. 249 of which could be identified.

Castle Rock Pueblo (5MT1825). Castle Rock Pueblo is located approximately 0.3 km north of McElmo creek. about 1.0 km downstream from (west of) the mouth of Sand Creek. The site is situated on and around a small. narrow butte in McElmo Canyon at the mouth of Sand Canyon. The elevation of the site is approximately 1682 m. Structural remains evident at the site prior to excavation included 12 circular depressions. numerous areas of sandstone rubble. several exposed masonry walls. and four partially intact room structures (Kuckelman *et al.* 1991: 63). Testing of Castle Rock Pueblo included excavation of 54 randomly selected sampling units and 3 judgmentally selected units. These excavations produced approximately 2485 bone fragments. 1058 of which could be identified. Additional investigations of the site have been conducted since the testing program was conducted. Materials recovered during these latter excavations are not included here. as analyses are still ongoing.

Intersite Comparisons

Faunal remains from all but one of the above mentioned sites were analysed by researchers at Simon Fraser University using standardized procedures defined by Driver (1991) and presented in Chapter 2 above. The single exception includes materials recovered from the Green Lizard Site which were analysed by Walker (1990). Though Walker's methodology differs somewhat from that of Driver. his data are presented in sufficient detail to allow standardization of observations between the Green Lizard Site and the other investigated sites. Specifically. this has been done by excluding specimens which Walker could not identify as representing a specific skeletal element. but were instead assigned inexact designations such as "bone fragment". or "long bone shaft". Removing these specimens from consideration actually has little impact on overall taxon frequencies. as most of these specimens had also been assigned to very general taxonomic categories such as "medium mammal". "rodent". or simply "mammal". A detailed summary of the faunal remains identified from Green Lizard and the other sites considered here is presented in Appendix C.

As stated in Chapter 1, one of the primary objectives of this dissertation was to determine if the faunal remains frequency patterns identified by Driver (1996) accurately characterize the variability in faunal remains distributions in the Sand Canyon Locality during the Pueblo III period. This is done here through detailed comparisons of the Sand Canyon Locality sites. The analyses presented differ from those of Driver (1996) in a number of ways. First, a larger sample of faunal remains from Sand Canyon Pueblo is considered here. Approximately only half of the faunal assemblage considered here was available at the time of Driver's analysis. Second, the assemblage of fauna from the Green Lizard site is used here to supplement the small sites sample. This assemblage was not considered in Driver's analysis. Third, when possible, deposits associated with pre-Pueblo III occupations of the sites are excluded from the comparisons (as mentioned above). This also includes exclusion of materials from structural block 1600 at Sand Canyon Pueblo which was determined to be associated with a Pueblo II occupation of the site (as mentioned in Chapter 4). Finally, a detailed comparison of sub-assemblages recovered from individual contexts (*i.e.*, room, kiva, courtyard, and midden) is conducted here.

To evaluate the variability between assemblages, contingency analyses similar to those presented in Chapter 4 are performed. These analyses look at frequency variations through time as well as among site contexts. In these analyses all rodents, amphibians and reptiles are excluded from consideration. This is based on the premise that the majority of these remains represent animals which died naturally at the sites, as was suggested by the Sand Canyon Pueblo assemblage analysis (above), and also concluded by Driver *et al.* (1999) and Walker (1990:33-34) in their analyses.

Major Temporal Trends

In order to examine temporal patterns the small sites have been grouped according to their primary Pueblo III occupations as either 'early', 'middle' or 'late'. Early sites include those that were occupied and abandoned prior to the establishment of Sand

Canyon Pueblo (*ca.* A.D. 1250). Five sites: G and G Hamlet, Kenzie Dawn Hamlet, Shorelene's Site, Roy's Ruin, and Lillian's Site make up this group. The 'middle' sites include all those that appear to have been established prior to Sand Canyon Pueblo, but which continued to be occupied for sometime after A.D. 1250, specifically the Green Lizard site, Troy's Tower, Mad Dog Tower, Catherine's Site, and Saddlehorn Hamlet. The final group, the 'late' sites, includes those that do not appear to have been occupied until after A.D. 1250. This includes the three remaining small sites: Stanton's Site, Lookout House and Lester's Site. Sand Canyon Pueblo and Castle Rock Pueblo also fall within the 'late' group although they are considered independently in many of the analyses presented below.

Table 23 presents the pooled frequency of major taxonomic groups for each of the three groups of small sites. The standardized residuals for these frequencies are presented in Table 24. The contingency analysis indicates pronounced differences in the frequency of several taxa between the 'early' and 'late' site groups, while the 'middle' sites collectively display little deviation from expected values. Specifically, marked differences in the frequency of 'Galliformes and large birds', lagomorph and artiodactyl are apparent. Relative to the other sites, Galliformes and large birds are scarce among the 'early' sites, representing approximately only 37% of the identified remains. In contrast, Galliformes and large birds represent 69% of the identified remains among the late period sites. The lagomorph and artiodactyl remains display an inverse pattern, being well represented at the 'early' sites, but relatively scarce at the 'late' sites. In all instances the 'middle' sites display intermediate or transitional values for these taxa. The nature and magnitude of these frequency fluctuations are illustrated by Figure 25 below.

A secondary pattern evident from the pooled assemblage comparisons is the abundance of birds of prey among the 'early' sites relative to their virtual absence among the 'late' sites, and again, the middle period sites display an intermediate value. As indicated by the contingency analysis (Table 24) the 'early' sites contain substantially higher than expected frequencies of these taxa. Though birds of prey represent only a little over 1% (1.2%) of the 'early' site assemblages (excluding rodents, reptiles and amphibians), this is much higher than the average frequency of these remains among the small middle (f = 0.2%) or late (f = 0.1%) period sites. It is notable that bird of prey remains were recovered from three of the five 'early' sites, so the relatively high frequency is not simply the result of an isolated cluster encountered at one site. It is also important to point out that in contrast to the birds of prey, the other wild birds display only a very a slight (statistically insignificant) decrease in frequency from early to late sites.

In examination of Table 23 and Figure 25 one might be lead to believe that there is a decrease in taxonomic diversity through time among the small sites. Specifically, the major taxonomic group (Galliformes and large birds) appears to become increasingly dominant through time, while all other taxa become increasingly scarce. However, when the data are subjected to analyses of richness and evenness (Figures 26 and 27) a substantial decrease in taxonomic diversity through time is not readily apparent.

Figure 26 presents a plot of evenness values for the three site groups compared to the range of expected values (90% confidence interval) according to sample size. The graph indicates that all three site groups display very similar evenness values ranging between 0.36 for the late period sites to 0.41 for the early period sites. In terms of evenness, the late period sites do display slightly lower values than expected, when compared to the other small sites. That is, the evenness value for the small late period sites falls below the 90% interval of expected values for the all of the small sites pooled. This low value, no doubt, reflects the dominance of Galliformes and large birds. However, the late period sites actually display greater richness (*i.e.*, a greater number of taxa) than the other groups of small sites relative to sample size (Figure 27), though it is notable that the richness values do not deviate significantly from expected values (all fall well within the same 90% confidence interval). Overall, the diversity analysis indicates that despite decreases in the frequency of most taxa relative to Galliformes and large birds, the number of taxa represented at the small sites does not change significantly through time.

Table 23. Frequency (NISP) of major taxonomic groups by occupation period for all investigated small sites from the Sand Canyon Locality.

Taxon	Primary Pueblo III Occupation Period			Total
	Early	**Middle**	**Late**	
	Pre *A.D.* 1250	***A.D.* 1250 Overlap**	**Post *A.D.* 1250**	
Artiodactyl	23	45	4	72
Lagomorph	330	819	290	1439
Canid	7	6	2	15
Lynx sp.	2	2	3	7
Other Carnivore	2	3	1	6
Galliformes & L. Bird	220	1066	678	1964
Birds of Prey	7	4	1	12
Other Bird	5	15	6	26
Total:	596	1960	985	3541

Table 24. Standardized residuals* for major taxonomic groups by time period for all investigated small sites from the Sand Canyon Locality.

Taxon	Primary Pueblo III Occupation Period			Total+
	Early	**Middle**	**Late**	
	Pre *A.D.* 1250	***A.D.* 1250 Overlap**	**Post *A.D.* 1250**	
Artiodactyl	**3.13**	0.82	**-3.58**	7.52
Lagomorph	**5.64**	0.80	**-5.51**	11.95
Canid	2.82	-0.80	-1.06	4.68
Lynx sp.	0.76	-0.95	0.75	2.46
Other Carnivore	0.99	-0.18	-0.52	1.68
Galliformes & L. Bird	**-6.08**	-0.64	**5.63**	12.35
Birds of Prey	**3.50**	-1.03	-1.28	5.81
Other Bird	0.30	0.16	-0.46	0.92
Total+:	23.21	5.37	18.80	47.38

Pearson Chi-square = 183.55, d.f. = 14, P = 0.00

Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

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* Calculated as: (Observed-Expected)/√Expected. Values which fall beyond (high or lower than) one standard deviation of the mean standardized residual value (*i.e.*, 0.13 ± 2.82) are bolded.

\+ Totals represent sums of absolute values.

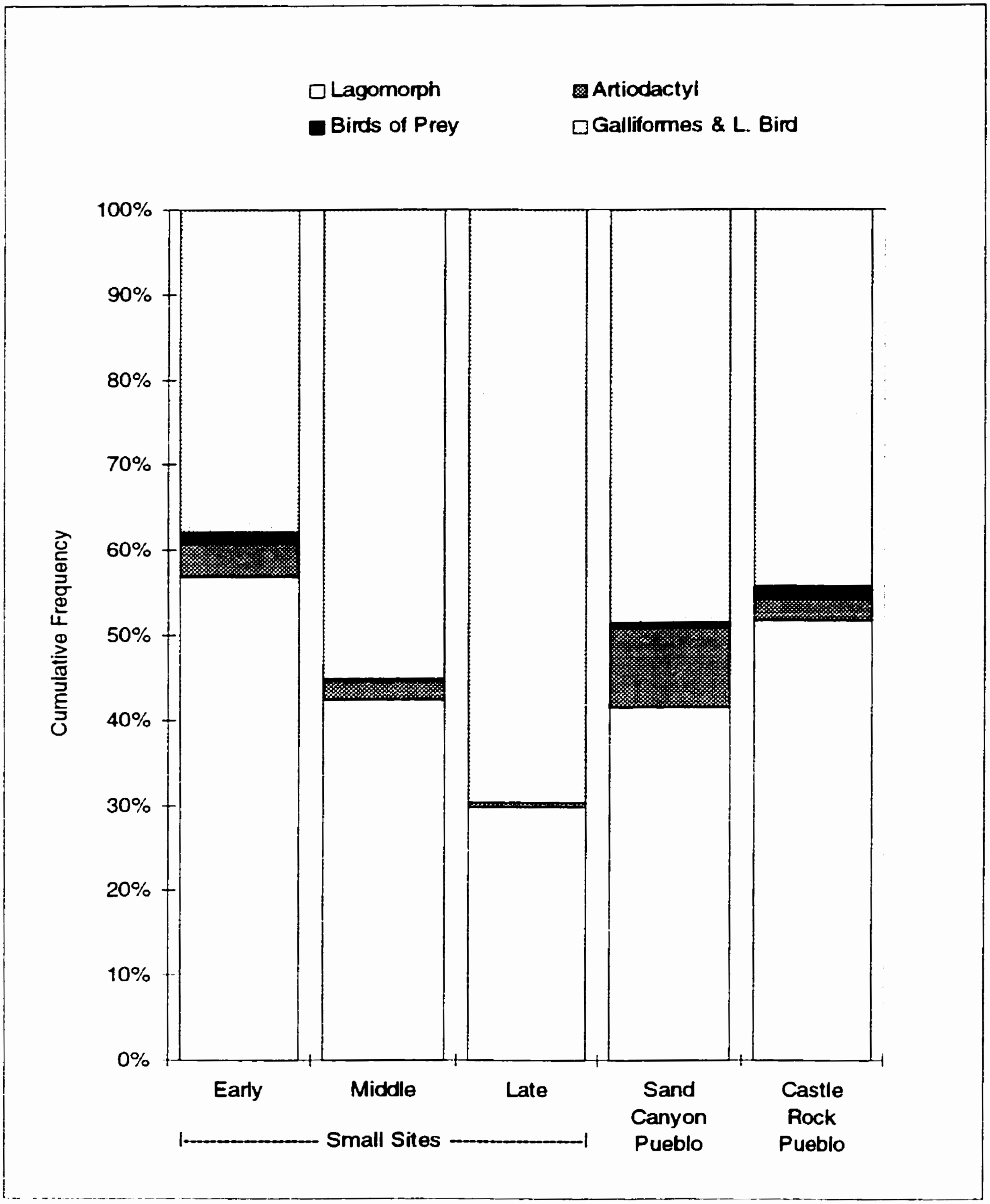

Figure 25. Cumulative frequency of four selected taxa from small sites in the Sand Canyon Locality, grouped by occupation period, compared to Sand Canyon Pueblo and Castle Rock Pueblo.

Sand Canyon Pueblo and Castle Rock Pueblo differ considerably from the smaller late period sites. Artiodactyl, lagomorph, and birds of prey remains are more abundant at these two pueblos than at the smaller contemporary sites (see Figure 25). This is particularly apparent at Sand Canyon Pueblo where artiodactyl remains are comparatively very numerous, while at Castle Rock Pueblo lagomorph remains are dominant. Birds of prey are also substantially more abundant among the two larger late period sites, comprising 0.9% and 1.4% of the total faunal assemblages (excluding rodents, reptiles and amphibians) respectively.

When Sand Canyon Pueblo and Castle Rock Pueblo are added to the diversity analysis some additional patterns are apparent (Figures 28 and 29). Perhaps most striking is that Sand Canyon Pueblo displays significantly greater diversity in terms of both richness and evenness than all of the other sites, while in contrast Castle Rock Pueblo is very similar to the small sites. The evenness value for Sand Canyon Pueblo falls clearly above the expected values for the pooled assemblages, while all the other sites, including Castle Rock Pueblo, display significantly low values. Similarly the richnness value for Sand Canyon Pueblo falls above the range of expected values while all the other sites fall below. This apparent diversity of taxa among Sand Canyon Pueblo is not surprising given the patterns already discussed above. The relatively high evenness value reflects the abundance of 'secondary' taxa such as artiodactyls, carnivores, and birds of prey relative to lagomorphs and Galliformes. The relatively high richness value is a reflection of the variety of carnivores and birds identified at the site.

Contextual Comparisons

While the patterns discussed above are consistent with those observed previously by Driver (1996), a more detailed analysis of the data provides greater resolution with respect to the nature of the apparent temporal variability. In Tables 25 and 26 below the site assemblages have been sub-divided according to major contextual units and a second contingency analysis performed. Unfortunately, the assemblages were much too small to allow comparison of precise contexts such as floor or roof deposits. The contextual

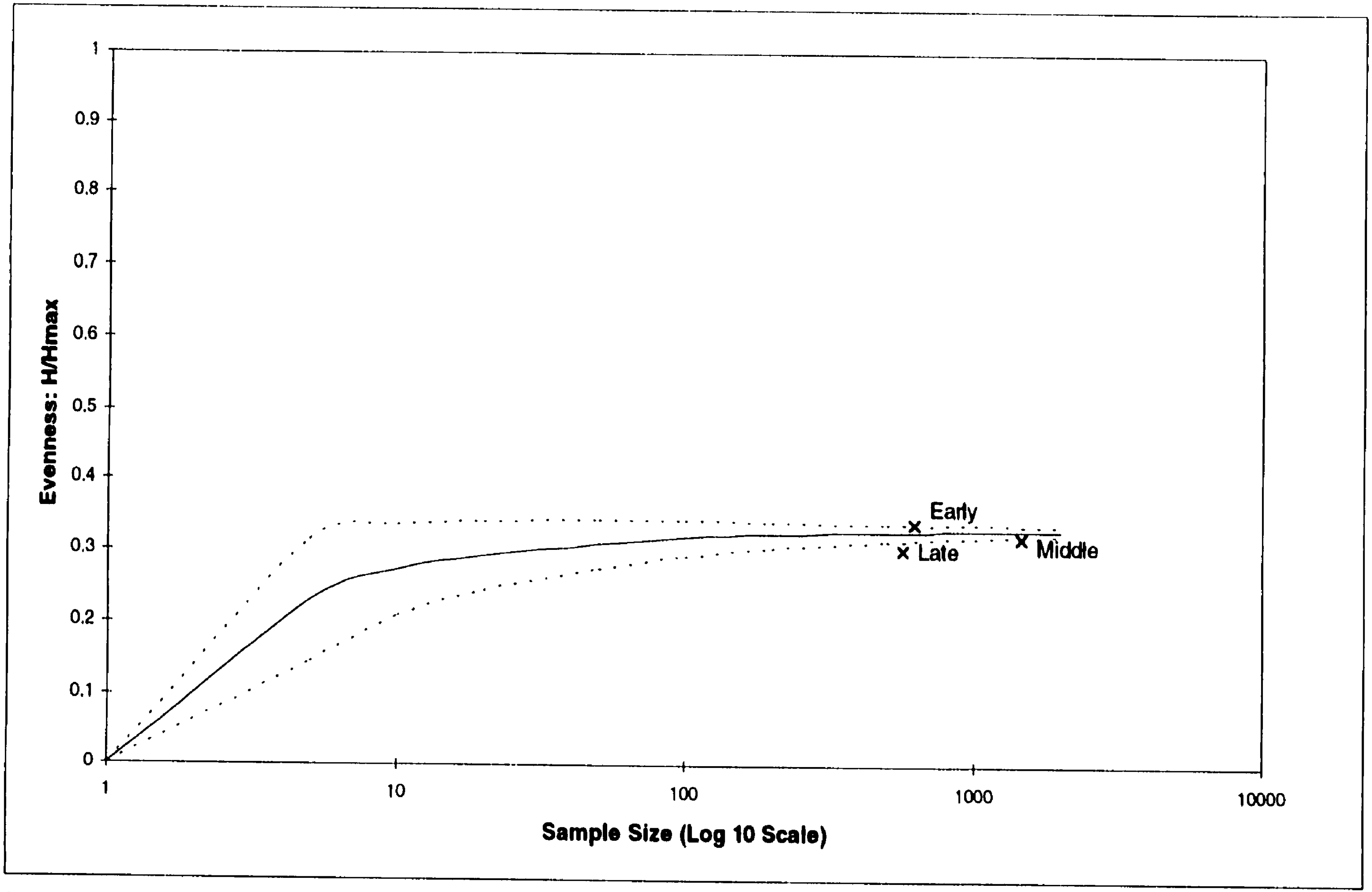

Figure 26. Plot of sample size *versus* evenness for taxa recovered from small early, middle, and late period sites in the Sand Canyon Locality. Solid line indicates predicted mean values for all assemblages pooled. Dotted lines indicate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 5, 10, 20, 50, 100, 200, 500, 1000, and 2000).

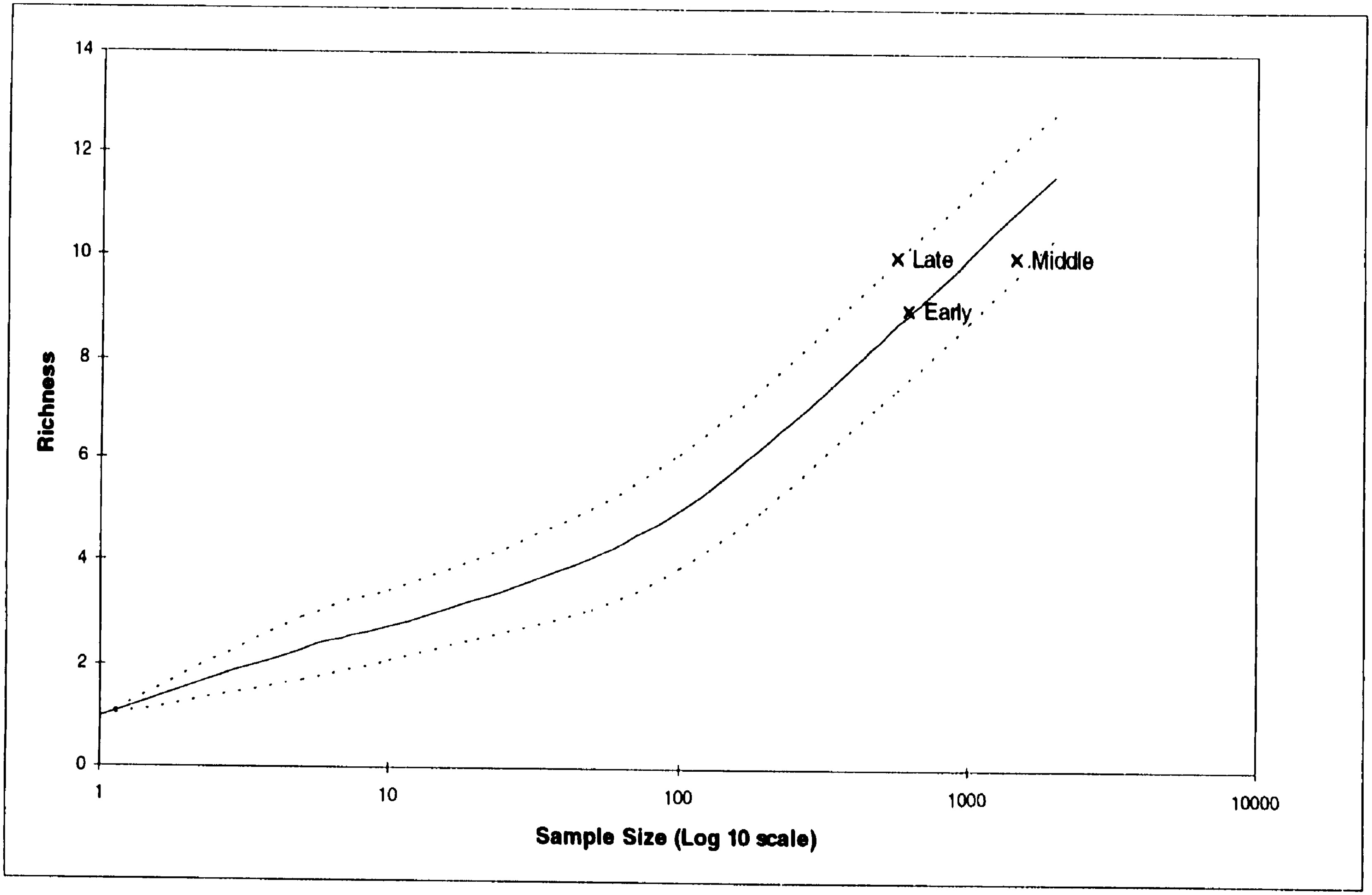

Figure 27. Plot of sample size *versus* richness for taxa recovered from small early, middle, and late period sites in the Sand Canyon Locality. Solid line indicates predicted mean values for all assemblages pooled. Dotted lines indicate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 5, 10, 20, 50, 100, 200, 500, 1000, and 2000).

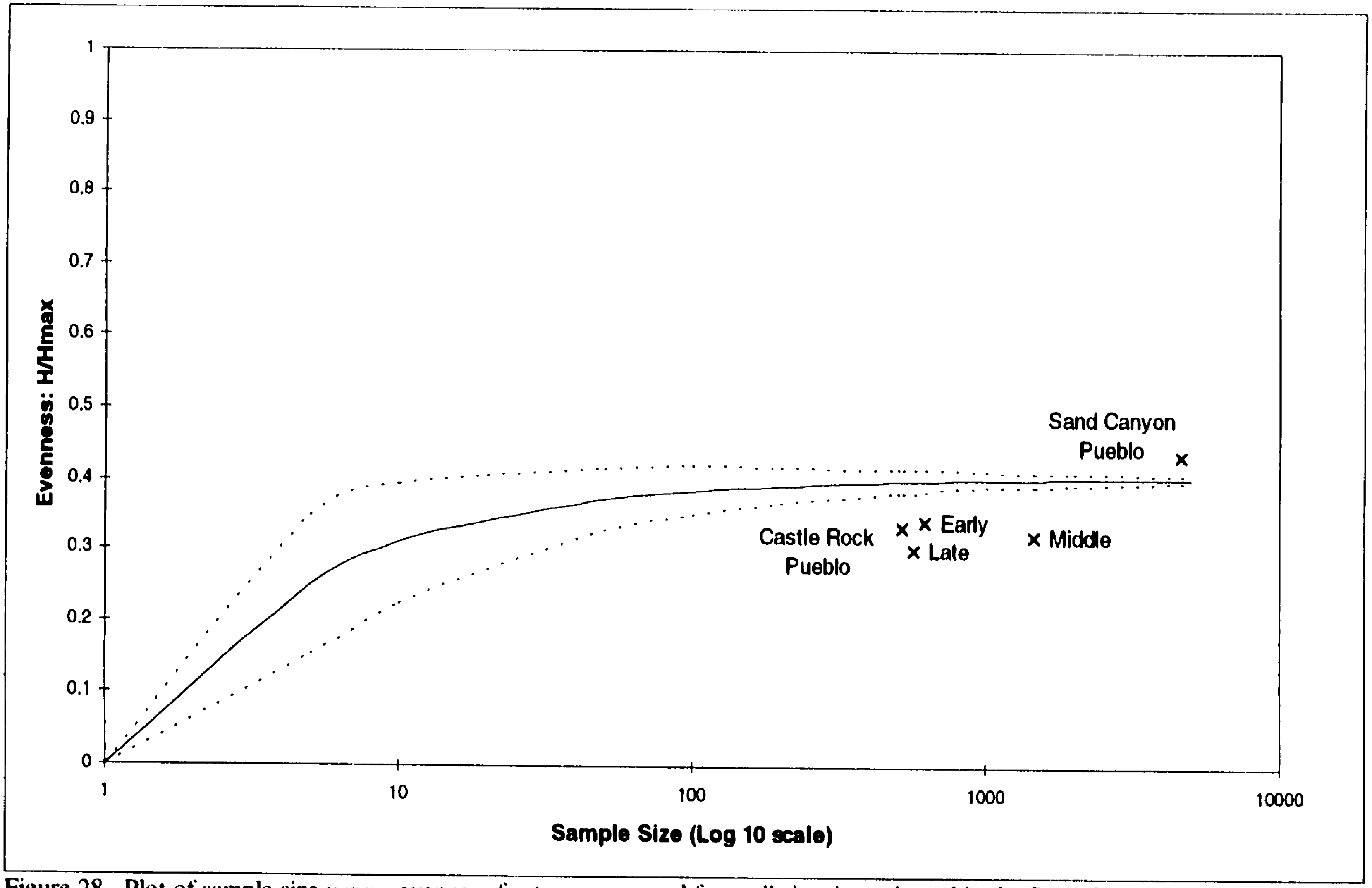

Figure 28. Plot of sample size *versus* evenness for taxa recovered from all sites investigated in the Sand Canyon Locality. Solid line indicates predicted mean values for all assemblages pooled. Dotted lines indicate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000).

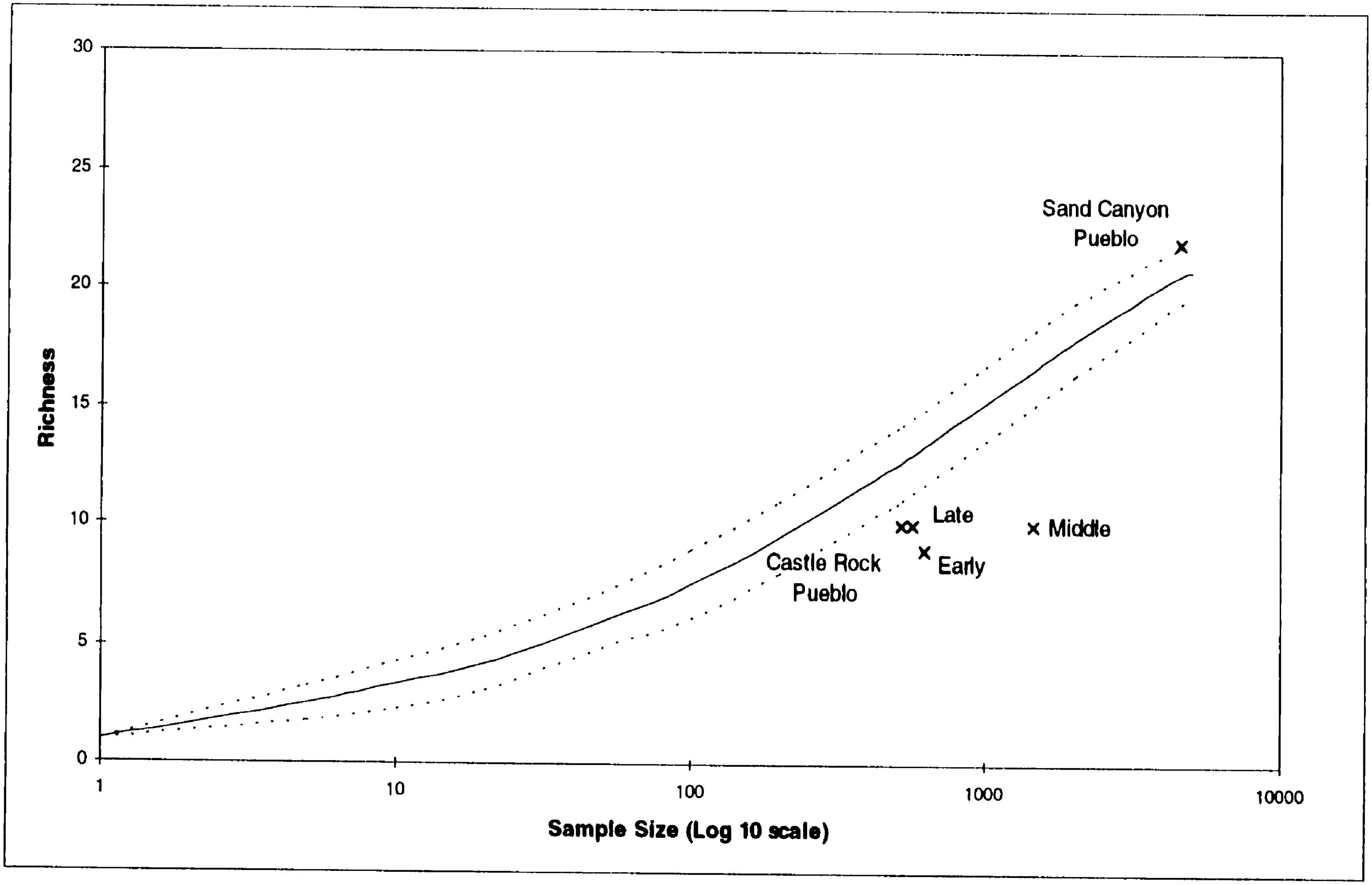

Figure 29. Plot of sample size *versus* richness for taxa recovered from all sites investigated in the Sand Canyon Locality. Solid line indicates predicted mean values for all assemblages pooled. Dotted lines indicate predicted 90% confidence interval. Predicted values are based on 1000 random trials for selected sample sizes (*i.e.*, 1, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000).

divisions used here include kiva, room block, and courtyard/midden. Midden and courtyard sub-assemblages have been lumped together due to ambiguity with respect to definition of these contexts at some sites. Remains recovered from disturbed, poorly understood, or poorly represented (*i.e.*, towers) contexts have been excluded from the analysis. Furthermore, in the interest of clarity and to avoid statistical problems associated with extremely small samples, only taxa that displayed substantial variability in the above analysis (*i.e.*, artiodactyl, lagomorph, birds of prey, and Galliformes and large bird) are included here.

This second contingency analysis presents several distinct patterns. Generally, it is apparent that there is marked variation in the organization of taxa between time periods. In particular, contexts within the early and middle period sites display considerable variability in taxon frequencies, as indicated by absolute total standardized residual values of 15.61 and 25.68 respectively, while the 'late' sites display a relatively uniform distribution of taxa between contexts with an absolute total standardized residual value of only 3.36 (see Table 26). The pronounced variability among the 'early' sites is largely due to the unique composition of remains recovered from the room blocks. An abundance of artiodactyl remains and a corresponding lack of Galliformes and large birds are evident among these structures. In addition, the early period kivas display a marked abundance of birds of prey relative to the other contexts.

The middle period sites display the greatest gross variability. This is primarily a product of substantial differences in taxa recovered from the kiva and midden/courtyard contexts. Specifically, lagomorphs are far more abundant than expected among the kivas while Galliformes and large birds are relatively rare. Not surprisingly the midden/courtyard contexts from the 'middle' sites display the opposite pattern (*i.e.*, a distinct lack of lagomorphs and abundance of Galliformes and large birds). Artiodactyl remains recovered from these sites are found in both the kiva and courtyard/midden contexts, though they are substantially more abundant than expected among the former.

Table 25. Frequency (NISP) of selected taxa by context for investigated small sites from the Sand Canyon Locality grouped according to occupation period.

Early PIII	**Context**			
Taxon	**Kiva**	**Room Block**	**Midden/Courtyard**	**Total**
Artiodactyl	4	10	6	20
Lagomorph	74	73	166	313
Galliformes & L. Bird	57	26	119	202
Birds of Prey	5	0	2	7
Total:	140	109	293	542
Middle PIII				
Artiodactyl	19	0	23	42
Lagomorph	246	19	511	776
Galliformes & L. Bird	157	8	843	1008
Birds of Prey	1	0	3	4
Total:	423	27	1380	1830
Late PIII				
Artiodactyl	0	0	4	4
Lagomorph	12	8	260	280
Galliformes & L. Bird	36	14	617	667
Birds of Prey	0	0	1	1
Total:	48	22	882	952

Perhaps most striking is the relatively uniform distribution of taxa evident among the 'late' sites. As mentioned above the relatively small absolute total standardized residual value reflects the distinct lack of taxonomic variability between contexts. This homogeneity stands in stark contrast to the considerable variability observed among contexts at Sand Canyon Pueblo (see Chapter 4) and the patterns observed among the earlier sites, above.

Overall, the detailed intersite contextual comparisons present some interesting patterns which further illuminate the nature of the temporal variability displayed by the small sites. The concentration of birds of prey among the 'early' kivas is particularly interesting given that, as was discussed above, birds of prey are unusually abundant among

Table 26. Standardized residuals* for selected taxa by context for investigated small sites from the Sand Canyon Locality grouped according to occupation period.

Early PIII		**Context**		
Taxon	**Kiva**	**Room Block**	**Midden/Courtyard**	**Total^{+}**
Artiodactyl	-0.51	**2.98**	-1.46	4.95
Lagomorph	-0.76	1.27	-0.25	2.28
Galliformes & L. Bird	0.67	**-2.29**	0.94	3.90
Birds of Prey	**2.37**	-1.19	-0.92	4.48
Total^{+}:	4.31	7.73	3.57	15.61

Pearson Chi-square = 28.01, d.f. = 6, P = 0.00.
Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

Middle PIII				
Artiodactyl	**2.98**	-0.79	-1.54	5.31
Lagomorph	**4.97**	2.23	**-3.07**	10.27
Galliformes & L. Bird	**-4.98**	-1.78	**3.01**	9.77
Birds of Prey	0.08	-0.24	-0.01	0.33
Total^{+}:	13.01	5.04	7.63	25.68

Pearson Chi-square = 88.08, d.f. = 6, P = 0.00.
Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

Late PIII				
Artiodactyl	**-0.45**	-0.30	0.15	0.90
Lagomorph	**-0.56**	**0.60**	0.04	1.20
Galliformes & L. Bird	**0.41**	-0.36	-0.04	0.81
Birds of Prey	-0.22	-0.15	0.08	0.45
Total^{+}:	1.64	1.41	0.31	3.36

Pearson Chi-square = 1.38, d.f. = 6, P = 0.97.
Note: Level of significance (P) is suspect as more than 20% of cells are sparse.

* Calculated as: (Observed-Expected)/$\sqrt{\text{Expected}}$. Values which fall beyond (high or lower than) one standard deviation of the mean standardized residual value (*i.e.*, 0.07 ± 1.59, 0.07 ± 2.83, and -0.07 ± 0.35 for early, middle, and late period sites respectively) are bolded.

\+ Totals represent sums of absolute values.

the early sites compared to the later small site assemblages. If these taxa are presumed to represent evidence of ritual activities (as postulated for Sand Canyon Pueblo in Chapter 5) their abundance and distribution at the early sites compared to the later sites suggest a change in the intensity and/or location of such activities through time. The homogenous distribution of taxa at the late small sites is not indicative of distinct activity areas, and in particular does not suggest a clear division between domestic and ritual refuse deposition. Instead evidence of ritual refuse as postulated for Sand Canyon Pueblo (*i.e.*, concentrations of bird of prey, and/or artiodactyl remains) is not readily apparent at the small late period sites. The implications of this interpretation are discussed in more detail below (Chapter 7), but it is worth noting here that this pattern is consistent with a shift in occurrence of ritual activity from household kivas to communal/civic structures as well as a shift in the scale of such activity, from extended family groups to larger communal gatherings.

The implications of the patterns observed among the middle period sites are less clear. In this analysis these sites do not appear to be transitional between the early and late periods as they did in the more general comparisons presented above. Instead, the middle period sites are quite unique in character with respect to the organization of the selected taxa.

Midden Deposits

It is important to note that the sampling strategy utilized in excavation of the sites favored investigation of structural features. As mentioned earlier, in the stratified sampling strategy employed, the most common and most densely concentrated accumulation of cultural remains, midden deposits, were sampled least intensively. This is understandable given the emphasis on identifying *de facto* refuse and recovering materials in clearly defined cultural contexts. However, by pooling sub-assemblages from all contexts the composition of faunal remains from the sites is disproportionately weighted toward representation of remains associated with structures. This effect is undoubtedly most pronounced at Sand Canyon Pueblo, where excavation of structures was most intensive. This investigative bias toward structural features hinders the validity of making direct comparisons among site assemblages, in that they are largely represented by 'exceptional' accumulations of materials, consisting largely of items that were intentionally stored in structures or debris which accumulated shortly before abandonment of the site. In contrast, the midden remains probably better reflect the overall composition of average domestic refuse and ultimately the overall utilization of animal resources.

When comparisons between sites are limited to midden deposits (Figure 30) the nature of the variability appears somewhat different from that discussed above. The small sites maintain the overall temporal patterns with respect to the changes in abundance of Galliformes and large birds relative to lagomorphs. That is, the increase in Galliformes and large birds through time is still readily apparent. The differences in artiodactyl frequencies are not as significant, though the late period small sites still display relatively fewer artiodactyl remains than the other sites (but sample sizes are very small). Perhaps more significant is the radical change in appearance of the Sand Canyon Pueblo faunal assemblage. The midden deposits from Sand Canyon Pueblo stand in striking contrast to the site assemblage as a whole, particularly with respect to the abundance of Galliformes and large bird remains relative to lagomorphs. In this comparison Sand Canyon Pueblo closely resembles the small late period sites. Artiodactyls and birds of prey are still relatively more abundant, but the variability is much less pronounced than in the earlier comparisons. This indicates that the differences between Sand Canyon Pueblo and the contemporaneous small sites, presented and discussed earlier, are largely due to deposits associated with structures, and thus likely represent 'exceptional' depositional events (as argued above) rather than daily subsistence activities. Figure 31, clearly illustrates the disparity between midden and "other" deposits from Sand Canyon Pueblo. In contrast the "other" deposits from the contemporaneous small sites display little difference from the associated midden refuse.

Castle Rock Pueblo continues to display a distinctive pattern, more closely resembling the early small sites than any of its contemporaries. The considerable abundance of lagomorph, artiodactyl, and bird of prey remains are all clearly evident among the midden deposits from this site. In contrast to Sand Canyon Pueblo and the other late period sites it appears that lagomorphs persisted as a substantial component of daily subsistence activities at Castle Rock Pueblo.

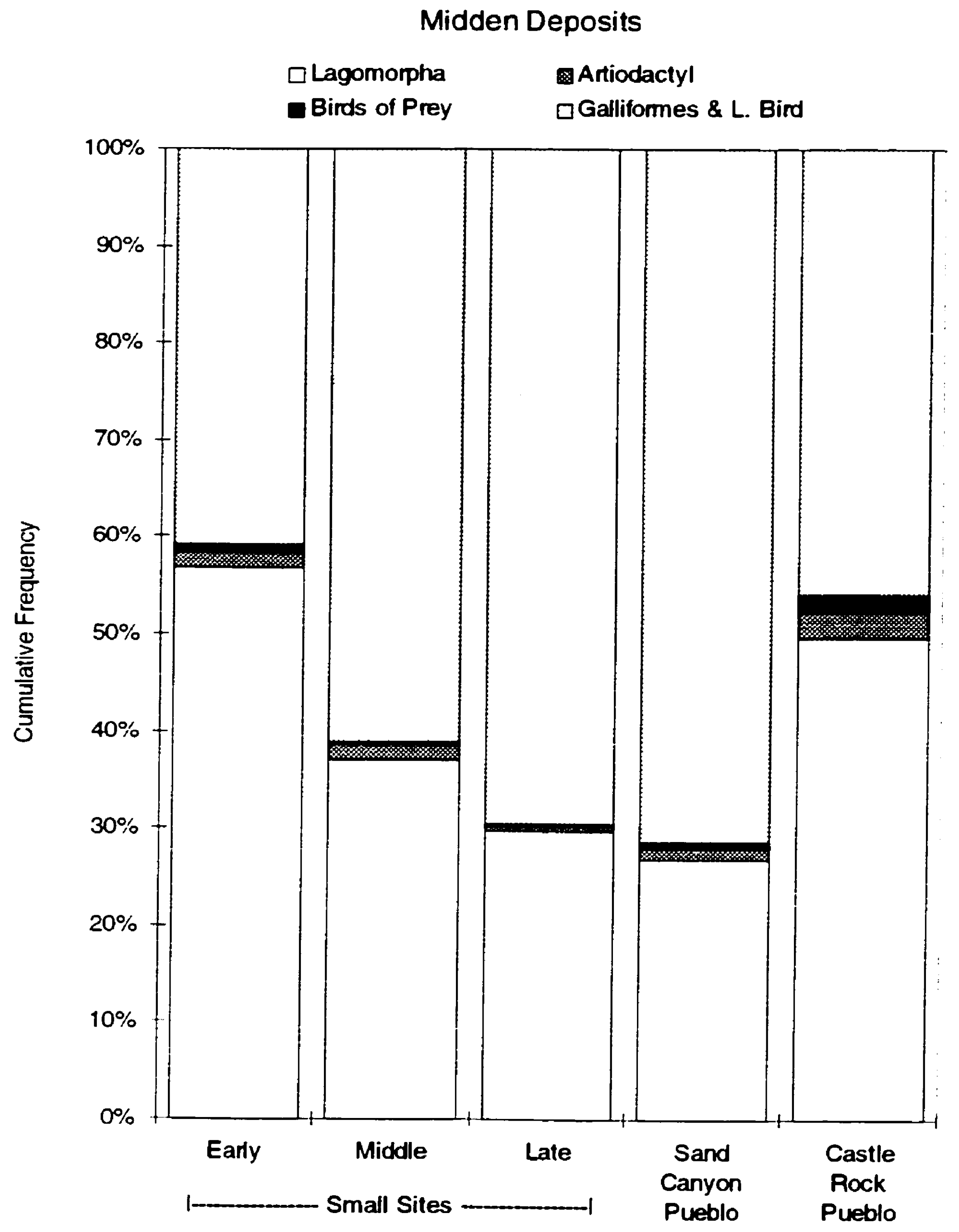

Figure 30. Cumulative frequency of four selected taxa from midden deposits from sites in the Sand Canyon Locality.

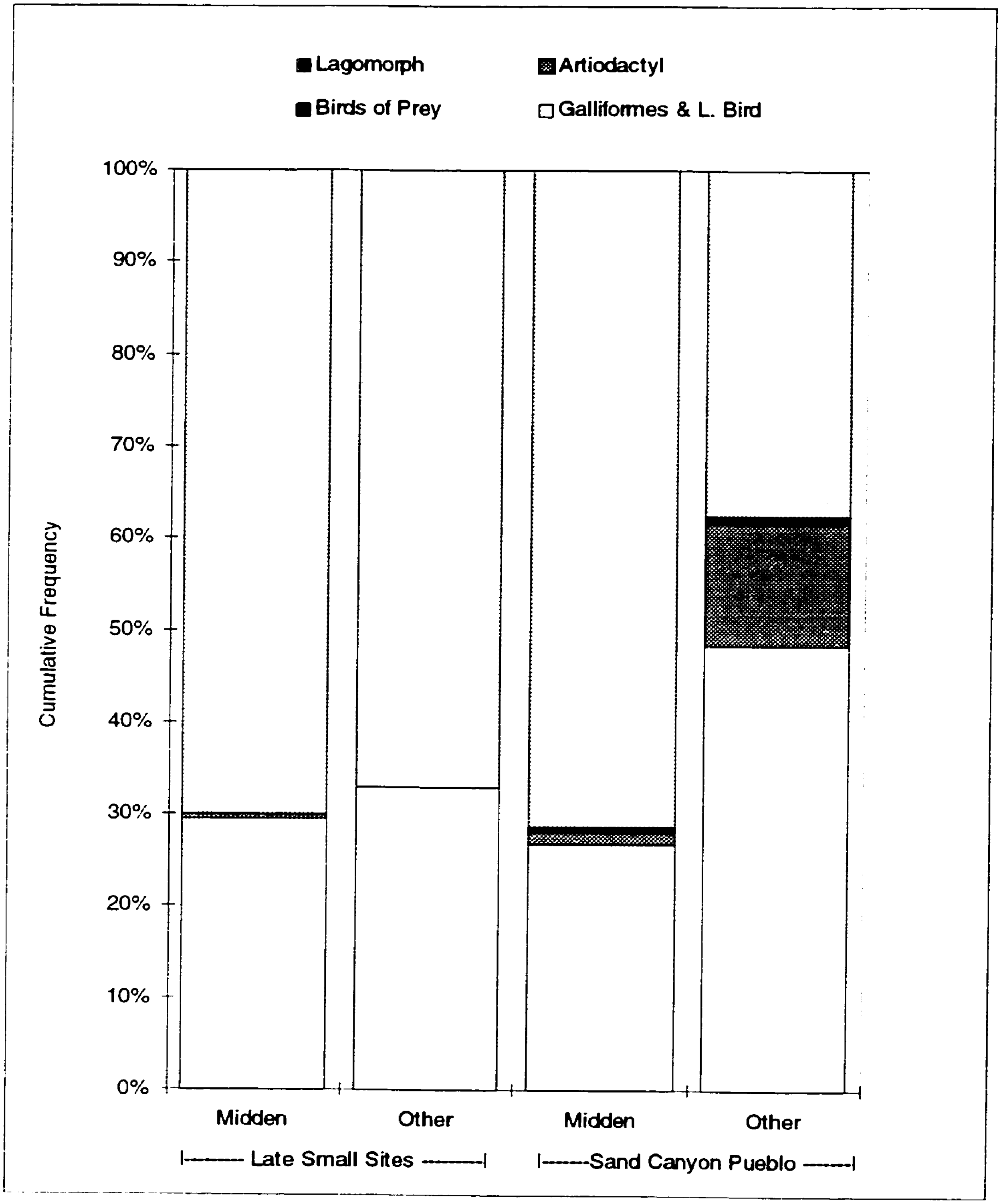

Figure 31. Cumulative frequency of four selected taxa from midden and "other" deposits from late period small sites in the Sand Canyon Locality, compared to those from Sand Canyon Pueblo.

Summary

This chapter has presented a comparison of faunal assemblages from investigated Pueblo III sites in the Sand Canyon Locality in an attempt to identify and define the nature of the variability that they display. The analyses indicate several pronounced temporal trends in the frequency of major taxa recovered from the sites. In particular, a marked decrease in lagomorph and corresponding increase in Galliformes and large bird appears to occur through time at small sites in the Sand Canyon Locality. This pattern is also apparent at Sand Canyon Pueblo when analysis is limited to consideration of midden deposits. The only 'late' Pueblo III site which clearly does not display a marked decrease in lagomorphs is Castle Rock Pueblo. The lagomorph to Galliformes and large bird ratio at this latter site is most similar to the 'early' Pueblo III sites. There also appears to be a consistent reduction in artiodactyl and bird of prey remains through time, though both Sand Canyon Pueblo and Castle Rock Pueblo differ considerably from the smaller 'late' Pueblo III sites in this respect. Specifically, both display a marked abundance of artiodactyls and birds of prey when compared to the smaller contemporary sites. Sand Canyon Pueblo is further distinguished by nature of its substantially greater taxonomic diversity, largely due to the considerable quantities of artiodactyl, lagomorph, and "other bird" remains associated with structures at the site.

In many respects the above analyses seem to support the major patterns identified previously by Driver (1996). Clearly there is a temporal trend toward increase in the abundance of Galliformes and large bird remains at the small sites and a marked concentration of artiodactyl remains at the larger sites in the locality. However, the nature of the variability as presented here is somewhat more complex than that described previously by Driver. Sub-division of the Sand Canyon Pueblo assemblage has revealed it to have a two-faced character. The faunal remains recovered from structural deposits display exceptional diversity including an abundance of relatively rare taxa, while the midden deposits are very similar to the assemblages recovered from the small sites. It has been argued here that the midden deposits best represent daily subsistence activities, as they likely consist of accumulation of refuse which span the entire occupation of the site and are the net product of daily food use. On the other hand the deposits associated with structures are more likely to largely consist of 'exceptional' refuse accumulations, reflecting storage or specific activities which occurred in or around the structures shortly before abandonment of the site. From this perspective it can be argued that the differences between Sand Canyon Pueblo and the smaller contemporary sites are not so much due to daily subsistence activities but to the occurrence of a considerable number of unique activities at Sand Canyon Pueblo. The implications of this conclusion will be discussed in more detail in the following chapter.

CHAPTER 7

CONCLUSIONS

Introduction

Having described and compared the faunal assemblages from the Sand Canyon Locality it is now appropriate to examine each of the research objectives presented at the outset of this study. As presented in Chapter 1 this study has focused on three specific questions:

1. Is there significant variability among the faunal assemblages from the 15 Pueblo III sites sampled in the Sand Canyon Locality?
2. If so. to what extent is the nature of this variability consistent with environmental. economic. social. and/or ideological factors?
3. What are the implications of the faunal data with respect to the emergence. growth and decline of aggregated communities in the Northern San Juan Region?

These questions will now be addressed in light of the data presented in the preceding chapters. First. the nature and significance of the variability displayed by faunal assemblages in the Sand Canyon Locality are briefly summarized. This is followed by a comparison of the predominant spatial and temporal patterns. to the model of expected variability presented in Chapter 1 (Table 2). A discussion of the implications of this study with respect to the emergence. growth and decline of aggregated communities during the Pueblo III period. in the Sand Canyon Locality and on the Colorado Plateau as a whole. is then presented. The chapter concludes with an evaluation of the strengths. weaknesses. and limitations of this study. and suggestions for further research.

Assemblage Variability

As presented in the previous chapter. there does indeed appear to be significant variability in faunal assemblages in the Sand Canyon Locality. This variability is most apparent when sites are stratified by age and by size. Specifically. there are several apparent (and statistically significant) temporal trends among faunal remains recovered from the small sites. Some of these were identified by previous researchers (Driver 1996; Munro 1994), while others are presented here for the first time. Most apparent is the increase in turkey remains through time at the small sites. This is a strong and consistent trend, verified previously by Munro (1994). Accompanying this trend is a steady reduction in the other two common taxonomic groups (lagomorphs and artiodactyls). Additionally, this study has identified a reduction in the occurrence of wild birds, particularly birds of prey at the small sites, through time.

Also in accordance with the conclusions of previous researchers, the two larger sites in the locality (Sand Canyon Pueblo and Castle Rock Pueblo) display faunal assemblages that are distinct from the smaller contemporary sites. In comparison to other 'late' Pueblo III sites they both exhibit a marked abundance of lagomorphs, artiodactyls, and birds of prey. This analysis suggests that while this pattern appears to characterize the overall taxonomic composition of Castle Rock Pueblo, it is not a precise representation of faunal remains from Sand Canyon Pueblo. When midden deposits from Sand Canyon Pueblo are examined in isolation they appear to be extremely similar to the contemporaneous small site assemblages. As presented in the previous chapter the distinctiveness of Sand Canyon Pueblo is primarily due to the composition of remains associated with specific structures at the site.

The detailed spatial analyses of Sand Canyon Pueblo further clarify the nature of this variability. Lagomorphs remains do not appear to be strongly associated with any particular structure, but rather are found distributed widely throughout the site, while turkey remains are especially common among midden deposits. As argued in Chapter 5, these distributions are consistent with what would be expected of animals which are used for domestic activities on a daily basis. The distribution and organization of other taxa suggest that some structures within Sand Canyon Pueblo were focal points for specific non-domestic activities. Assemblages from the D-Shaped structure and the 'tower blocks' are particularly unique. The abundance and variety of wild birds found within and immediately adjacent to the D-shaped structure are consistent with paraphernalia used in ritual activities. The concentrations of artiodactyl remains within the kivas and on the roofs of towers in blocks 100 and 1000 is suggestive of processing, storage, and perhaps redistribution of large game. The occurrence of kestrel and bobcat remains within a courtyard associated with these structures (block 1000) also supports the argument that they were related to ritualized hunting activities.

Potential Causal Factors

Environmental Factors

As discussed in Chapter 1 the "Great Drought" of the late 13th century A.D. may have been a contributing factor in the temporal changes in taxon frequencies displayed by sites in the Sand Canyon Locality. Specifically, if drought had a significant impact on the availability of game in the region, the frequency of desert adapted species should increase relative to animals adapted to moister environments. Furthermore large temperate game such as deer, may become scarce in the locality and require changes in hunting patterns and the overall distribution of game within the locality may become patchy, concentrated around reliable water sources. Similarly, changes in settlement patterns in the Sand Canyon locality during the Pueblo III period included a general movement from the mesa top to the canyon benches and valley bottom, which may have influenced opportunities to hunt different animals. If regional or microenvironmental variability has had a significant effect on the faunal assemblages it should be possible to identify positive correlations between physical or temporal settings and taxon frequencies.

Unfortunately small sample sizes and the general absence of "indicator" species severely limit assessment of these factors in the Sand Canyon Locality. Examination of fluctuations in the relative frequency of various species of artiodactyls is not possible since most artiodactyl remains could not be identified to genus or species. The majority of sites document only the presence of "medium-sized Artiodactyla" or simply Artiodactyla. While *Odocoileus* sp. was positively identified in very small numbers at several sites, multiple artiodactyl species were documented at only two: Sand Canyon Pueblo and the Green Lizard site. This scarcity of data is not due to deficiencies in analysis, but rather reflect extremely small sample sizes and difficulties in distinguishing between the various species of artiodactyl. Given these limitations the presence of a small number of pronghorn at Sand Canyon Pueblo is not sufficient evidence to support an argument for significant impacts on animal procurement due to drought. Similarly other taxa which may have been useful in the analysis of environmental factors are extremely scarce, (*e.g.*, sage hen, quail, poorwill and grouse) impossible to positively identify (*e.g.*, desert cottontail *vs.* Nutall's cottontail) or more commonly completely absent from most sites.

However, some information can be extracted from the limited data that are available. As presented in Chapter 6, there is clearly a reduction in wild game, relative to domestic (or potentially domestic) turkey through time within the locality. This appears to have occurred at all of the small sites, as well as at Sand Canyon Pueblo (though perhaps to a lesser extent). This change in abundance may reflect a reduction in the availability of wild game throughout the locality due to the onset of drought. The data from Castle Rock Pueblo, can also be considered consistent with expected variability due to drought. Castle Rock Pueblo is the only late PIII site that does not clearly display a relative decrease in exploitation of wild game. It is also the only site situated near a major permanent water source (McElmo Creek). The site's close proximity to McElmo Creek may have mitigated the impact of drought, with respect to the availability of wild game.

However, other data are not consistent with the expected consequences of drought. If large game were becoming scarce within the locality, one might expect hunting to occur increasingly further from habitation sites. Long-range hunting expeditions required to obtain these animals should result in portions of animals being brought back to the site in portable butchery units, rather than as complete carcasses. As presented in Chapters 3 and 5, the frequency of artiodactyl skeletal elements suggest that complete animals were being brought back to the site, consistent with local rather than long-range hunting expeditions. Finally, there is no indication of an increase in faunal assemblage diversity, as would be expected if a significant shift in animal utilization resulted from drought. As indicated by the diversity analyses in Chapter 6, the small sites maintain an essentially constant variety of exploited species through time. Variability in assemblage diversity is seen only in the relatively large number of species identified at Sand Canyon

Pueblo and a very slight decrease in assemblage richness through time among the small sites.

Variability according to microenvironmental setting is also difficult to evaluate. Driver (1996:369) has argued that "there is no strong evidence that site location or site catchment areas affected hunting patterns" in the Sand Canyon Locality. He bases his arguments on the extreme variability evident among the upper canyon sites (*i.e.*, the contrast between Sand Canyon Pueblo and the contemporaneous small sites) and the similarity between sites in radically different micro-environments (*i.e.*, those on the mesa top compared to those in the lower canyon). The analyses presented above provide a slightly different perspective to this question. In some respects the more detailed comparison of the sites, presented above, support Driver's argument. In particular the assemblage from Castle Rock Pueblo closely resembles the early sites (which are all located on the mesa top), even when only midden deposits are considered, as presented above. On the other hand, the differences between Sand Canyon Pueblo and the late small sites (all upper canyon), as presented here, are less pronounced than previously realized. If we accept that midden deposits are better indicators of daily subsistence activities than the site assemblages as a whole, then it appears that the decrease in lagomorphs is strongly correlated with the movement from the mesa top to the upper canyon bench. However, this variability does not appear to be consistent with change in microenvironmental setting given that cottontails prefer creek gullies and rock crevices to open grassland (Wooding 1982:202). Access to these animals would not be naturally inhibited by relocation to the more sheltered upper canyon bench area. In addition, the change in microenvironmental setting does not adequately explain why concentrations of artiodactyls and birds of prey occur exclusively at Sand Canyon Pueblo during the late Pueblo III period. The similar environmental setting, elevation, and close proximity of Lester's Site and Lookout House (both late period sites) to Sand Canyon Pueblo preclude a reasonable explanation for the differences in frequency of these taxa based on site catchment area.

Economic Intensification

Munro (1994) has argued that the increase through time in relative abundance of turkey remains at the small sites may reflect an intensification of domestic turkey production. She believes that increased human populations during the Pueblo III period resulted in habitat infringement and overhunting of large game, and that the intensification of turkey production was undertaken to provide an alternative meat source (Munro 1994:156). As presented in the previous chapter, the small sites clearly display a marked increase in the use of turkey through time, and midden deposits from Sand Canyon Pueblo further support this pattern. Though the increase in turkey utilization is difficult (perhaps impossible) to quantify precisely; if the upper canyon sites are viewed as an integrated community, the net use of turkey does seem to increase approximately two-fold during the Pueblo III period. These patterns satisfy several of the expectations of economic intensification postulated in Chapter 1. Specifically, the increased abundance of turkey appears to occur throughout the community, suggesting an overall increased reliance on domesticated animals; and the remains are particularly concentrated within domestic refuse assemblages (middens), indicating their primary importance in daily subsistence activities.

As discussed in Chapter 1 other economic changes resulting from decreased availability of local wild game may include intensified exploitation of large game through communal hunting. This again appears to be evident in the concentrations of artiodactyl remains at Sand Canyon Pueblo. While the remains are not concentrated within public or communal areas and do not appear to represent the spoils of long-range hunting expeditions as postulated in Chapter 1, they are distributed in a manner which is consistent with ethnographic documentation of communal hunting activities. As well, the unusual abundance of lagomorph remains associated with structures at Sand Canyon Pueblo may also reflect intensified communal hunting activities. Communal hunting of lagomorphs as documented ethnographically requires large numbers of individuals and the aggregated site of Sand Canyon Pueblo may have been uniquely suited to successful hunts, particularly if these animals were becoming scarce. Overall, there appears to be ample evidence of economic intensification consistent with the decreased availability of wild animal resources.

Economic Specialization

None of the expectations associated with economic specialization were met. As discussed above, while there does appear to be evidence of increased dependence on and even 'intensification' of turkey production throughout the region, there does not appear to be any evidence of specialization *per se*. There is no apparent disparity between the small sites and Sand Canyon Pueblo with respect to the abundance of turkey, nor is there any indication of specialized turkey production areas. Furthermore the distribution of turkey remains throughout Sand Canyon Pueblo is relatively uniform, based on the homogenous composition of midden deposits. The significance of these pattern is that there does not seem to be a difference in access to turkey among sites or between residents within sites. Thus it seems unlikely that turkey was a controlled, highly valued, or prestigious commodity, which could be profitably exploited through specialized production.

These data add further to the considerable argument already constructed against specialization of turkey production. As determined previously by Munro (1994:147-148) the demographic profile of the large birds is not indicative of specialized flock management or production of surplus animals for exchange:

> "the distribution of the sexes in the Sand Canyon Locality is virtually equal which suggests that one sex was not preferred over the other. In terms of age the population is dominated by adult individuals (94%). ...it is expected that a profile of a turkey assemblage raised for meat would indicate high proportions of young adult males as they would be culled when they reach their maximum size to minimize energy expenditure. Females are expected to survive longer as they are required not only for reproduction, but potentially also as egg producers".

Social Differentiation

It has been argued elsewhere that the residents of Sand Canyon Pueblo may have maintained control over mesa-top farm land forcing the residents of the small sites to utilize marginal farm lands and rely on intensified production of turkey (Munro 1994). This scenario is not supported by the nature of the variability evident among the assemblages in this study. While the patterns may suggest increasing inequality with respect to access to ritual-knowledge (see below) and communally hunted resources, the data indicate that though ritual activity seems to have been concentrated at Sand Canyon Pueblo, overall the subsistence economy in the locality remained relatively undifferentiated. This conclusion is largely based on the similarity of midden deposits among contemporaneous sites during the Late Pueblo III period. These similarities suggest that the dramatic differences between the faunal assemblages from the small sites and Sand Canyon Pueblo are rooted in the 'special' events and activities which occurred at Sand Canyon Pueblo rather than daily subsistence activities. Specifically, when midden refuse from Sand Canyon Pueblo is compared to the composition of similar remains from contemporaneous small sites there are few significant differences in the relative abundance of major taxa. Artiodactyls are slightly more common among the Sand Canyon Pueblo midden deposits, but only marginally, while the ratio of lagomorphs to turkey is consistent among sites. In particular, there is little evidence of disproportionate utilization of turkey between sites (as discussed above). Overall this suggests that households throughout the locality shared similar access to all animal resources.

The possibility that a class of 'elites' emerged at Sand Canyon Pueblo is worthy of consideration. Clearly there is evidence for communal activities occurring at Sand Canyon Pueblo which would likely have required some type of leadership or facilitation, however whether or not these individuals had special 'status' in terms of social standing, economic wealth, or political power is less obvious. Analysis of the distribution of artiodactyl remains at Sand Canyon Pueblo suggests that although these taxa are concentrated within some structures, the overall element distribution is relatively homogenous throughout the Pueblo. In this respect there does not appear to be significant economic stratification within the community. However, this does not preclude the possibility of the procurement and distribution of these animals being organized and controlled by particular individuals or households, who may have acquired special status as a result. As populations increased and competition for resources intensified, the ability to facilitate successful hunts may have become an increasingly 'prestigious' quality. It has been observed that public display of successful and sustained access to (and sharing of) hunted game, particularly rare and/or large bodied animals, is one of the principal ways social prestige is achieved and status reinforced in small-scale societies (Godelier 1982; Kensinger 1983; Kent 1989; Hawkes 1990; Brandt 1994). Given the dense concentrations of artiodactyl remains associated with the roofs of the D-shaped towers it is possible that these structures played a role in the public display of the success of communal hunting activities.

Intensified Communal Ritual Activity

It is argued here that most of the variability evident among the faunal assemblages is best explained as resulting from changes in community organization with respect to the location, scale, and perhaps control, of ritual activities. It appears that by the late Pueblo III period, Sand Canyon Pueblo and Castle Rock Pueblo were foci for ritual activity, while the frequency or intensity of ritual activities at the small sites had diminished. This is strongly indicated by the relative abundance of birds of prey and other wild birds at these sites, as well as the organization of remains within Sand Canyon Pueblo.

Specifically, the faunal data clearly indicate that birds of prey are initially fairly common among most of the small mesa top sites, however, by the 'late' Pueblo III period they are restricted almost exclusively to the large sites. If we accept that the frequency of birds of prey is an indicator of the occurrence of ritual activity, this pattern suggests that rituals which were initially conducted within the mesa top hamlets, presumably by and for the benefit of the residents of each individual site, changed in terms of scale and location by the late Pueblo III period. The D-Shaped structure at Sand Canyon Pueblo appears to have been the location of much of this later activity, though other structures may have also played a role (particularly the Great Kiva). It seems probable that these structures functioned as specialized communal ritual facilities for the inhabitants of Sand Canyon Pueblo as well as for the residents of the small contemporaneous sites located nearby. Furthermore, variability in the frequency and distribution of artiodactyl remains parallel, to some extent, the variability evident among the birds of prey. Artiodactyl remains appear to have also become more spatially restricted within the community as a whole through time, occurring most frequently at Sand Canyon Pueblo and densely concentrated in specific structures there-in. It seems likely that this phenomenon is directly linked to the concentration of communal ritual activity, of which communal hunting of large game would have been a part.

While the D-shaped structure conforms to what might be expected of a "communal" or "civic" structure used during large gatherings of the community, the Block 100 and 1000 structures appear to be insufficient in size to accommodate such large gatherings. It seems likely that ritual activities that may have occurred in these structures would have been limited to small numbers of individuals, perhaps ritual elites, analogous to the *cacique* and hunting or war society members observed ethnographically. While this would seem to support an argument for economic power and special status among certain members of the community, these elites do not appear to have taken advantage of this status in economic terms (as discussed above).

Ethnographic data and previous faunal analyses (Munro 1994) have suggested that turkeys may also have been a ritually important animal in Pueblo Society both prehistorically and historically. Others have argued that domesticated animals, such as turkey, may have been viewed as "prestige" resources appropriate for use during ritual activities such as communal feasts (Hayden 1995). It is notable however, that Munro (1994) found no conclusive evidence to support the use of turkey in ritual activities among the Pueblo III sites in the Sand Canyon Locality. Further analysis of the Sand Canyon Pueblo faunal data presented here do not seem to support the interpretation of turkey being a ritually significant animal during the Pueblo III period. While turkey feathers may have been used for ritual paraphernalia there is no evidence that turkey was an animal which was procured, consumed, or disposed of in a ritualized manner. The distribution of Galliformes and large bird remains within the Pueblo appears to be consistent with the interpretation that these animals were regularly utilized during common domestic subsistence activities. A strong argument can be made that turkey was the primary source of meat on a day to day basis, while ritual procurement and consumption was associated with large wild game.

Discussion

It has been argued above, that while a number of factors were 'at play' in the Sand Canyon Locality during the Pueblo III period, much of the variability evident among the faunal assemblages can be explained in terms of: 1) intensified exploitation of turkey, 2) communal hunting of wild game and 3) intensification of communal ritual activity. Furthermore, it is unlikely that these factors acted independently of one another. Increased competition for limited natural resources, due to regional population increases, may have prompted the need to intensify resource extraction by pooling labor and knowledge. An integrated communal effort may have been perceived to be a successful (or perhaps essential) means of reducing risk of subsistence failure in an increasingly competitive regional economic environment. From this perspective it is argued that the coordination of communal ritual events at Sand Canyon Pueblo, acted as a mechanism to encourage co-operation, group unity and community identity within the locality. In turn, this would facilitate activities requiring large groups, such as communal hunts. Under such circumstances economic competition between individuals or households would likely have been counter-productive to the success of the community. On the other hand it is conceivable that the organization of successful communal hunts or other large scale subsistence activities was considered a prestigious ability and engendered special status on the organizers. However, the social authority of these individuals or groups may have been limited, in that while they may have had the ability to influence or persuade other members of the community, they did not have any coercive or true economic power. As recently argued by Hockett (1998:295):

> "It seems logical that the spatial patterning of faunal remains within "mid-range" inequalities may show differential numbers of animal species in ceremonial structures or in leaders' residences, but the deposition of prime cuts of meat may not take place in these same locations. Leaders who relied on influence and persuasion may have used animals for private ceremonies and feasts, but they probably either did not or could not control differential access to the prime cuts of animal carcasses. Leaders who had the power to coerce should have been able to monopolize and control the consumption of prime cuts of meat."

It is conceivable that ones ability to organize and conduct successful communal subsistence activities would have been the primary criteria on which such social status was acquired; though whether such 'ability' would have been assessed primarily on material or ideological grounds is questionable. It could be argued that the establishment of specialized ritual structures at Sand Canyon Pueblo are consistent with a regime of 'ritual-based' (rather than prestige or economically-based) social power. Numerous scholars have recently argued that authority in small scale societies may reside primarily in the control of both esoteric knowledge and the meaning of symbols, and is thus intimately linked with religion and ritual (e.g., Aldenderfer 1993, Grier 1996, Potter 1997). Potter (1997:101) sees such power relations illustrated well in the ethnographic record of the American Southwest:

> "In the American Southwest, the greatest perceived threat to the survival of the community is the shortage and unpredictability of rainfall, and among many groups the most powerful individuals in the community are those in possession of the ritual knowledge that pertains to the control of rain. Among the Zuni, for instance, the council of priests, of which the rain priest is one of the most important members, wields incredible authority and decision-making power, and even has an 'executive arm', the bow priests, whose role, among other duties, is to carry out punishment against witchcraft. The pueblos exhibit enduring, unchallengable centralized social hierarchy that is based on the control of ritual knowledge pertaining to the most important yet uncertain aspect of the society."

Potter (1997) further argues that such social differentiation in small-scale societies may be very subtle and not necessarily correspond to obvious economic differentiation.

Conceivably, if the observance of rites and ceremonies were considered essential components in the success of subsistence activities, individuals who were perceived to posses the appropriate ritual knowledge or spiritual 'abilities' may have risen to prominence at Sand Canyon Pueblo.

Regional Implications

While examination of a single locality is an insufficient basis on which to draw conclusions about an entire region, the above analysis and discussion do present some interesting contributions to the debate concerning aggregation and abandonment of the northern San Juan area. In the discussion above it has been emphasized that the faunal data indicate intensification of subsistence activities in terms of resource exploitation, demographic scale, and ritualization. Implicit in this argument is that the development of large aggregated communities was related to the desire or need to increase subsistence reliability by pooling knowledge and labor. This scenario is consistent with the emergence of large aggregated communities as a response to increasing population densities, associated regional environmental degradation, and ultimately regional economic competition. Evidence for the intensity of such competition is difficult to produce on the basis of a single locality, however, analyses of human remains from Castle Rock and Sand Canyon Pueblos suggest a high level of intercommunity conflict and violence during the Pueblo III period (Lightfoot and Kuckleman 1994; Lipe 1995).

Intensified communal subsistence activities may have ultimately contributed significantly to the abandonment of Sand Canyon and other communities in the Northern San Juan region. Though largely speculative, it is argued here that the relatively rapid intensification of community subsistence activities and increase in community size may have resulted in an increased rate of environmental degradation, as well as an increase in intra or inter community conflicts. Specifically, the development and widespread adoption of intensified resource exploitation such as communal hunting, while initially beneficial, may have quickly depleted an already marginal supply of natural resources. At the same time the development of new forms of social and religious organization may have proved to be inadequate to allow for the redefinition and expansion of the community. As argued by Kintigh (1985:116) for Pueblo IV abandonment of the El Morro Valley:

> "I suggest that once constituted, these pueblos had insufficiently developed mechanisms of social integration, and as a result, conflicts bred factions, and eventually broke apart the communities."

If community integration was based on the success of intensified communal subsistence activities, the status of the organizers and the practical-abilities or ritual-knowledge they represent would have plummeted dramatically in the event of recurrent marginal subsistence returns or failures. This would likely have eroded the persuasive abilities of activity organizers and ultimately undermined group co-operation and unity.

Evaluation and Suggestions for Further Research

This dissertation has attempted to identify, define, and explain the major patterns displayed by the faunal remains from Sand Canyon Pueblo and other Pueblo III sites in the locality. Many potential capabilities of the data have not been fully exploited. In particular, there has been little analysis or discussion of nutrition, bone processing, cooking methods, or bone tool types. These are not oversights, but rather intentional omissions, in the interest of exploring other aspects of the data. Certainly there are other analyses that could have been conducted, and indeed many were performed which are not presented here because the significance of results were determined to be irrelevant, incomprehensible, or more commonly rejected on the basis of ambiguity due to confounding variables. In this respect it should be emphasized that the information available from the Sand Canyon Locality faunal data is far from exhausted.

Potential for error exists in any analysis. This is particularly true of archaeological investigations, where a vast number of unknown and uncontrolled variables are at work. The analyses presented here are no exception. Throughout this dissertation attempts have been made to account for, or at least identify, inherent biasing factors. Notable among these include, taphonomic processes which may have altered the composition and organization of the remains, variations in sampling strategies between sites, problems associated with the identification and quantification of faunal remains and differences in sample sizes between assemblages and sub-assemblages. In many cases there is little that can be done to either assess or account for such factors and undoubtedly some biases will have influenced the results without detection. This is not intended as an excuse for possible errors, but rather a statement of reality which is often overlooked as archaeological interpretations become entrenched in the literature. Like all archaeological investigations this dissertation should be treated as a work in progress, requiring further investigation.

In the process of conducting this analysis a number of factors which have limited the scope of the research and confidence in the results have become apparent. The random stratified sampling scheme employed by Crow Canyon Archaeological Center is unquestionably an excellent strategy for producing comparable assemblages for investigation of multiple sites. However, the small samples obtained during test excavations have severely limited some aspects of this analysis. In particular, the faunal assemblages recovered from the small sites were insufficient in size to allow detailed intrasite analyses. Pooling of data from multiple small sites was necessary to allow reasonable comparisons to be made and may have obscured some characteristics of the spatial or temporal variability. Also taxa which are valuable in the investigation of environmental change are commonly quite rare and consequently large faunal assemblages are required in order to precisely determine their frequency or even their presence. Clearly, much larger samples are required if detailed faunal analyses, such as this, are to be valuable and considered statistically reliable. The size of screens used during excavation has undoubtedly also influenced (biased) the faunal assemblages. The use of 6 mm mesh has long been recognized to result in the loss of many small elements and potentially the complete loss of entire species. As indicated in Chapter 3, small elements such as phalanges and caudal vertebrae are conspicuously scarce for many taxa from Sand Canyon Pueblo. While it has also been noted that many small animal remains were recovered, potentially many more have been lost. This may be particularly true of small bird remains which, unlike small rodents, are not likely to be found as complete articulated skeletons and thus are not easily spotted during excavation. Such losses limit the potential capabilities of the data and confidence in their interpretation.

This analysis has been conducted largely in isolation from other analysts working on the Sand Canyon Locality archaeological project. This has been done in part by design, in that it was intended that initial investigations of the various datasets be conducted independently of one another to allow a degree of objectively which may not have been otherwise possible. This ('windowless room') approach is one to which zooarchaeologists are accustomed and it arguably does allow for a relatively unprejudiced examination of the data. However, in hindsight, it is recognized that this approach has probably resulted in more limitations than advantages, with respect to a complete and accurate understanding of the archaeological record. In order for the potential of Sand Canyon faunal data to be fully exploited it is important that data from all aspects of the investigation be integrated. Clearly the patterns, inferences, and speculation presented here would benefit from comparison to the other archaeological datasets.

Finally, the Sand Canyon Locality data represent a small sample obtained from a single community within the Northern San Juan Region. Examination of regional phenomena such as aggregation and abandonment require a regional sample. Additional community oriented investigations of Pueblo III occupations within the region are necessary if the interpretations and conclusions of the Sand Canyon Locality investigations are to be properly evaluated.

Summary

This study has employed analyses of faunal remains to investigate environmental, economic, social, and ideological factors associated with the emergence of a large aggregated Pueblo town in southwestern Colorado, during the Pueblo III period (*ca.*, A.D. 1100 - 1300). Detailed spatial analyses of fauna recovered from Sand Canyon Pueblo and comparisons to fourteen other sites in the Sand Canyon Locality have indicated several distinct patterns consistent with changes in the location, scale, and organization of subsistence and ritual activities from the 'early' to 'late' Pueblo III period. Specifically, utilization of turkey appears to intensify throughout the locality, while the distribution of artiodactyls, birds of prey, and other wild birds become increasingly spatially restricted within and among communities through time. These latter taxa are initially distributed broadly throughout sites in the locality, but by the 'late' Pueblo III period are found to be concentrated within specific structures at Sand Canyon Pueblo.

It has been argued here that the changes in frequency and distribution of faunal remains indicate that significant social and economic reorganization accompanied the development of the large aggregated community of Sand Canyon Pueblo. In particular, there appears to be evidence of increased centralization, scale, and perhaps control of ritualized subsistence events, such as communal hunting. These activities appear to have been organized by specific individuals, households, or societies at Sand Canyon Pueblo.

It has been further argued that community aggregation during the late Pueblo III period may have been largely a response to increased competition for limited wild resources, due to regional population increases, environmental degradation, and regional economic competition. These factors prompted the need (or desire) to pool labor and knowledge in an integrated communal effort. The coordination of communal ritual events at Sand Canyon Pueblo, would have encouraged co-operation, group unity, and community identity and facilitated activities requiring large groups, such as communal hunts and other large scale subsistence activities. Communal activities would presumably require organization and direction. Whether this was provided by specific individuals, societies, households or other groups is uncertain; as is the status of the person(s) involved. The apparent use of the D-Shaped structure as a specialized ritual facility certainly lends support to the existence of societal or community based organization. On the other hand, evidence for the organization of communal hunting is found within what appear to be essentially private structures. However, it is notable that as concentrations of artiodactyls occur within three of six room blocks investigated at Sand Canyon Pueblo, control of communal hunting of large game was clearly not limited to a single individual or household. Similarly the distribution of lagomorphs is extremely homogenous throughout the pueblo and does not suggest exclusive or even restricted access or control of this resource within the community. Given these distributions it is difficult to argue that these activities were controlled by specific individuals or indicate the emergence of political 'elites' *per se*.

Finally it has been suggested that intensified communal subsistence activities may have contributed to regional abandonment. Rapid intensification of community subsistence activities and increase in community size may have resulted in an increased rate of environmental degradation, increased regional economic competition, intra and inter community conflicts, and ultimately failure of the mechanisms of social integration.

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APPENDIX A:

CROW CANYON ARCHAEOLOGICAL CENTER

ZOOARCHAEOLOGICAL IDENTIFICATION AND RECORDING STANDARDS

(After Driver 1992)

Taxon

The identification of bone fragments is a complex process, and different zooarchaeologists approach this task in different ways. It is important to observe the following rules:

1. The only bones which are to be considered "identifiable" are those for which the element can be specified. No identification to any taxonomic level (even of the :large mammal" or "small bird" variety) will be allowed unless the element is identified. Terms such as "long bone" or "axial" do not qualify as element descriptions.

2. It is very important to define a "universe" of species from which the animal remains are assumed to derive. (Most zooarchaeologists do this unconsciously, and rarely make their decisions explicit). This is because virtually all zooarchaeological identification presupposes that certain animals are likely to be represented at a certain time and location. To take an example, when we are working on 13th century Anasazi sites, we will assume that the bears we find may be black bears or grizzlies; we will not bother to check our archaeological specimens against polar bears or Old World bear species, even though it might be difficult to distinguish those species from North American species on the basis of osteology. For analyses of faunal assemblages of the last few thousand years, it will be assumed that the extant and historically known faunas of southern Colorado and Utah and northern New Mexico and Arizona provide the universe from which our specimens are drawn. Definition of this universe does not preclude the possibility of more exotic species being identified. However, these will normally only be identified when it can be positively demonstrated that an Anasazi area species cannot be represented by a particular bone.

3. Identification may be made to standard zoological classifications, such as species, genus, family etc. Zooarchaeologists often use less formal categories such as "large bird", "medium artiodactyl", and terms such as these can also be used. Definitions of such categories are provided below:

Non-standard descriptions for mammals

Small mammal	Jackrabbit size or smaller
Medium mammal	Deer size or smaller
Large mammal	Larger than deer
Small rodent	Woodrat or smaller rodent
Large rodent	Rodent larger than woodrat
Large carnivore	Wolf size or larger carnivore
Medium carnivore	Fox size or larger carnivore
Small Carnivore	Carnivores smaller than fox

Medium artiodactyl	Deer sized artiodactyl
Large artiodactyl	Wapiti/bison sized artiodactyl

Non-standard descriptions for birds

Large birds	Birds larger than mallard
Medium birds	Mallard size and smaller
Small bird	Robin size and smaller
Large Falconiformes	Vulture size and larger Falconiformes
Medium Falconiformes	Larger than Prairie Falcon
Small Falconiformes	Prairie Falcon and smaller

4. In order to be confident of identifications, you must be able to justify your choice of taxon. This is best done by comparing your specimen with all taxa from the local faunal "universe". In practice this is achieved rapidly, because your general knowledge of anatomy will allow you to eliminate most taxa from consideration. However, you should only identify to a particular "level of identifiability" if you are sure that the identification will bear scrutiny.

5. Each bone or bone fragment must be identified on its own merits. For example, if a burial of a dog was excavated, some bones would be referred to species while others (e.g., the ribs and vertebrae) would be referable only to the genus or family level. You can note articulating specimens in the "comments" section of the catalogue.

6. Remember that there is no disgrace in not being able to identify bone fragments to the species level. Most species are defined by a host of characters, most of which will not preserve in the skeleton. It is much better to be conservative than over-confident. Once the analysis is finished and the interpretation begins, you may wish to make some assumptions about the bones identified. For example, if all the artiodactyls identified to species are from deer, you may wish to assume (perhaps for purposes of body parts represented) that all "medium artiodactyls" are also deer. This can be stated in the faunal report, and would be quite a reasonable assumption; it would be unreasonable to make such an assumption while bone fragments were being identified.

Element

Element refers to the whole bone of which you may either find a complete specimen or fragment. There are fairly well standardized names for most of the individual bones in vertebrate skeletons, although fish bones are not particularly well standardized and there is still controversy about which system should be used. Although we should ideally be able to specify elements fairly exactly, this is not always possible. For example, we may be able to identify the proximal phalanx of a deer, yet not determine whether it is from digit III or digit IV. Cranial fragments present something of a problem because the cranium is composed of many named bones. When coding cranial fragments, use the names of individual bones if the majority of the fragment is made up of a particular bone; otherwise use the general code for cranial fragment.

Part

For each major type of element there are a series of numeric codes to designate different portions. The code "1" always refers to a complete element, but other vary depending on the element being described. Confusion may result when dealing with bones in which epiphyses are not fused. For example, a complete mammal longbone with unfused epiphyses would be coded as "1" even if the unfused epiphyses were not recovered, because it is likely that the bone was originally deposited as a complete unit. If unfused epiphyses are present and can be fitted back to the diaphysis, they should be considered as part of a single element, and should not be coded as separate fragments.

Side

These can be recorded as left (L), right (R), irrelevant (I) (*e.g.*, vertebral column), or unknown (N).

Fusion

Each fragment must receive a two letter code for fusion, even if it not possible to define the fusion states. The fusion code is designated to record the state of fusion for the entire element, not simply for the fragment described. The first letter is used to define the state of fusion for the proximal end (in the case of limb bones) or the anterior end (in the case of axial elements). The second letter refers to the distal or posterior end. As many fragments will be incomplete, it will often be necessary to code one or both ends as "unknown" (N). "Fused" (F) includes those specimens which display no gap between the epiphysis and diaphysis, though a line of fusion may be present. "Just fused" (J) includes those in which fusion has begun, but spaces can still be seen between the epiphysis and diaphysis. "Unfused" (U) includes those for which the epiphysis is separate from the rest of the bone. Any specimens which are clearly from fetal or neonatal specimens can be coded "BB".

Breakage

A two letter code must be provided for each bone fragment. The first letter refers to the proximal or dorsal or anterior end; the second letter refers to the distal or ventral or posterior end. For tooth fragments the first letter refers to the occlusal surface and second to the root. Break types include:

> <u>Intact (I).</u> The end of the bone has suffered no significant damage.
> <u>Broken during excavation (E)</u>. Break surface should be markedly different in color from the rest of the bone, usually lighter.
> <u>Made into an artifact (A)</u>. End of bone was purposefully worked by humans. This includes offcuts, waste from tool manufacture, unfinished artifacts etc.
> <u>Chewed by carnivores (C)</u>. Look for scoring, furrowing and punctures.
> <u>Eroded (D)</u>. The end of the bone has been worn smooth or rounded by natural processes such as sand abrasion or water.
> <u>Splintered (P)</u>. The bone exhibits a series of transverse fractures, terminating at different points.
> <u>Gnawed by rodents (R)</u>. Look for many shallow parallel grooves.

Spiral fracture (S). As well as exhibiting a spiral morphology, the break surfaces should be fairly smooth.
Transverse fracture (T). Essentially a simple snap break running perpendicular to the long axis of the bone.
Irregular fracture (V). Breaks which display a "zig-zag" appearance.

Modification

This refers to either natural or cultural alteration to the bone. More than one letter code may be used to describe a number of alterations. Modification types include: modified as an artifact, burnt black, burnt white (calcined), carnivore damaged, humanly produced cutmarks, localized burning, pathological conditions, rodent gnawing, and weathered/eroded.

Length

Each fragment is measured using a centimeter scale. Exact lengths are not requires, and the following coding system should be used:

1	less than 1 cm
2	1 to 1.99 cm
3	2 to 2.99 cm
4	3 to 3.99 cm
	etc..

Cortical Thickness

This is measured (in mm) only for long bones. It is designated mainly to allow the analyst to assign a size range for otherwise unidentifiable long bone fragments. As cortical thickness varies, use the thickest portion of cortex to define the thickness. The measurement is taken perpendicular from the outside to the inside of the fragment. The following codes should be used:

1	less than 2 mm
2	2 to 3.99 mm
3	4 to 5.99 mm

APPENDIX B:

ADDITIONAL CONTINGENCY ANALYSES

Table B1. Frequency (NISP) of major taxonomic groups by architectural block from Sand Canyon Pueblo (excluding rodents, amphibians, and reptiles).

Taxon	Architectural Block								Total
	100	200	300	500	800	1000	1200	1500	
Artiodactyls	141	93	5	6	2	220	35	101	603
Lagomorphs	438	249	7	176	82	691	221	847	2711
Canids	8	14	0	2	19	30	8	149	230
Lynx	2	1	0	2	1	26	1	1	34
Oth. Carnivores	0	1	0	0	0	0	0	9	10
Galliformes	147	149	12	97	95	235	181	250	1166
Birds of Prey	1	1	0	1	4	19	1	22	49
Other Birds	11	9	0	1	2	7	6	70	106
Total	748	517	24	285	205	1228	453	1449	4909

Table B2. Standardized residuals* for major taxonomic groups by architectural block from Sand Canyon Pueblo (excluding rodents, amphibians, and reptiles).

Taxon	Architectural Block								Total[+]
	100	200	300	500	800	1000	1200	1500	
Artiodactyls	**5.12**	**3.70**	1.20	**-4.90**	**-4.62**	**5.63**	-2.77	**-5.77**	33.71
Lagomorphs	1.23	-2.16	-1.72	1.48	-2.93	0.49	-1.84	1.65	13.51
Canids	**-4.57**	-2.08	-1.06	-3.11	3.03	**-3.63**	-2.87	**9.84**	30.19
Lynx	-1.40	-1.36	-0.41	0.02	-0.35	**6.00**	-1.21	-2.85	13.60
Oth. Carnivores	-1.23	-0.05	-0.22	-0.76	-0.65	-1.58	-0.96	**3.52**	8.98
Galliformes	-2.30	2.36	2.64	**3.56**	**6.64**	**-3.32**	**7.08**	**-5.08**	32.97
Birds of Prey	-2.37	-1.83	-0.49	-1.09	1.37	1.93	-1.66	1.98	12.71
Other Birds	-1.28	-0.65	-0.72	-2.08	-1.15	**-3.79**	-1.21	**6.92**	17.80
Total[+]	19.50	14.20	8.45	17.01	20.74	26.37	19.59	37.62	163.47

* Calculated as: (Observed-Expected)/√Expected. Values which fall beyond (higher or lower than) one standard deviation of the mean standardized residual value (*i.e.*, -0.14 ± 3.27) are in bold.

\+ Totals represent sums of absolute values.

Table B3. Frequency (NISP) of major taxonomic groups by structure type from Sand Canyon Pueblo (excluding rodents, amphibians, and reptiles).

Taxon	Structure Type							Total
	Room	**Kiva**	**Tower**	**Plaza**	**Courtyard**	**Great Kiva**	**D-Shaped**	
Artiodactyls	124	170	173	13	14	1	113	608
Lagomorphs	504	665	309	261	173	52	674	2638
Canids	9	31	2	69	13	18	89	231
Lynx	2	6	1	0	25	1	1	36
Oth. Carnivores	1	0	0	3	0	0	9	13
Galliformes	284	171	13	235	121	15	168	1007
Birds of Prey	1	1	0	9	19	2	14	46
Other Birds	14	8	2	19	2	2	52	99
Total	939	1052	500	609	367	91	1120	4678

Table B4. Standardized residuals* for major taxonomic groups by structure type from Sand Canyon Pueblo (excluding rodents, amphibians, and reptiles).

Taxon	Structure Type							Total[+]
	Room	**Kiva**	**Tower**	**Plaza**	**Courtyard**	**Great Kiva**	**D-Shaped**	
Artiodactyls	0.18	2.85	**13.40**	**-7.44**	**-4.88**	-3.15	-2.70	34.58
Lagomorphs	-1.11	2.95	1.61	**-4.45**	-2.36	0.10	1.69	14.26
Canids	**-5.49**	-2.91	**-4.57**	**7.10**	-1.20	**6.37**	4.53	32.16
Lynx	-1.94	-0.74	-1.45	-2.16	**13.20**	0.36	-2.60	22.45
Oth. Carnivores	-1.00	-1.71	-1.18	1.01	-1.01	-0.50	3.34	9.74
Galliformes	**5.76**	-3.69	**-9.12**	**9.07**	**4.73**	-1.04	**-4.71**	38.11
Birds of Prey	-2.71	-2.91	-2.22	1.23	**8.10**	1.17	0.90	19.23
Other Birds	-1.32	-3.02	-2.64	1.70	-2.07	0.05	**5.81**	16.62
Total[+]	19.50	20.76	36.18	34.16	37.54	12.73	26.27	187.15

* Calculated as: (Observed-Expected)/√Expected. Values which fall beyond (high or lower than) one standard deviation of the mean standardized residual value (*i.e.*, 0.03 ± 4.50) are in bold.

[+] Totals represent sums of absolute values.

APPENDIX C:

SAND CANYON LOCALITY FAUNAL DATA

(Tables C1 through C13 after Driver *et al.* 1999: Table C14 after Walker 1990).

Table C1. Frequency of taxa from G and G Hamlet (5MT11338).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Artiodactyla	*Odocoileus spp.*	Deer	1	1.8	1.4
	Medium Artiodactyl	Deer-sized artiodactyl	4	7.1	5.6
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	2	3.6	2.8
	Sylvilagus spp.	Cottontail	14	25.0	19.4
Rodentia	*Cynomys spp.*	Prairie dog	3	5.4	4.2
	Eutamias spp.	Chipmunk	3	5.4	4.2
	Sciuridae	Squirrel	2	3.6	2.8
	Thomomys spp.	Small pocket gopher	8	14.3	11.1
	Geomyidae	Pocket gopher	1	1.8	1.4
	Neotoma spp.	Woodrat	5	8.9	6.9
	Peromyscus spp.	Mouse	4	7.1	5.6
	Muridae	Mouse, vole	1	1.8	1.4
	Small Rodent	Woodrat or smaller	1	1.8	1.4
	Rodentia	Rodent	1	1.8	1.4
Miscellaneous	Small mammal		5	8.9	6.9
	Medium mammal		1	1.8	1.4
		Mammal Total:	56	100.0	77.8
Birds			**NISP**	**% Bird**	**% All Taxa**
Galliformes	*Meleagris gallopavo*	Turkey	10	62.5	13.9
Miscellaneous	Large Bird		5	31.3	6.9
	Medium Bird		1	6.3	1.4
		Bird Total:	16	100.0	22.2
		Identified Total:	72	47.3	
		Undetermined Total:	80	52.6	
		Grand Total:	152	100.0	

Table C2. Frequency of taxa from Kenzie Dawn Hamlet (5MT5152) excluding pre-Pueblo III materials.

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Artiodactyla	*Odocoileus spp.*	Deer	3	0.8	0.6
	Medium Artiodactyl	Deer-sized artiodactyl	8	2.1	1.6
Carnivora	*Canis* spp.	Dog, wolf, coyote	2	0.5	0.4
	Small Carnivore	Smaller than fox	1	0.3	0.2
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	27	7.2	5.3
	Sylvilagus spp.	Cottontail	157	42.1	30.7
	Lagomorpha	Pika, rabbit, hare	1	0.3	0.2
Rodentia	*Cynomys spp.*	Prairie dog	1	0.3	0.2
	Spermophilus variegatus	Rock squirrel	4	1.1	0.8
	Spermophilus spp.	Ground squirrel	2	0.5	0.4
	Large Sciurid	Ground squirrel or larger	1	0.3	0.2
	Sciuridae	Squirrel	11	2.9	2.2
	Thomomys spp.	Small pocket gopher	1	0.3	0.2
	Geomyidae	Pocket gopher	17	4.6	3.3
	Neotoma spp.	Woodrat	12	3.2	2.3
	Peromyscus spp.	Mouse	15	4.0	2.9
	Microtus spp.	Vole	5	1.3	1.0
	Muridae	Mouse, vole	11	2.9	2.2
	Dipodomys ordii	Ord's kangaroo rat	10	2.7	2.0
	Small Rodent	Woodrat or smaller	1	0.3	0.2
	Rodentia	Rodent	29	7.8	5.7
Miscellaneous	Small mammal		53	14.2	10.4
	Large mammal		1	0.3	0.2
		Total:	373	100.0	73.0
Birds			**NISP**	**% Bird**	**% All Taxa**
Falconiformes	*Falco sparverius*	Kestrel	5	4.3	0.9
Galliformes	*Meleagris gallopavo*	Turkey	51	44.0	10.0
Passeriformes	Passeriformes	Perching Birds	2	1.7	0.4
Miscellaneous	Large Bird		57	49.1	11.2
	Medium Bird		1	0.8	0.2
			116	100.0	22.7
Amphibians			**NISP**	**% Amph.**	**% All Taxa**
	Pelobatidae	Spadefoot Toad	22	100.0	4.3
		PIII Identified Total:	511	34.6	
		Pre-PIII Identified Total:	373	25.3	
		Undetermined Total:	591	40.1	
		Grand Total:	1475	100.0	

Table C3. Frequency of taxa from Shorelene's Site (5MT3918) excluding pre-Pueblo III materials.

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Artiodactyla	*Odocoileus spp.*	Deer	1	1.4	1.1
	Medium Artiodactyl	Deer-sized artiodactyl	2	2.7	2.2
	Artiodactyla	Even-toed ungulate	1	1.4	1.1
Carnivora	*Canis familiaris*	Domestic dog	2	2.7	2.2
	Medium Carnivore	Smaller than wolf	1	1.4	1.1
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	9	12.2	9.8
	Sylvilagus spp.	Cottontail	26	35.1	28.3
Rodentia	*Spermophilus variegatus*	Rock squirrel	2	2.7	2.2
	Eutamias spp.	Chipmunk	1	1.4	1.1
	Sciuridae	Squirrel	5	6.8	5.4
	Thomomys spp.	Small pocket gopher	1	1.4	1.1
	Neotoma spp.	Woodrat	3	4.1	3.3
Miscellaneous	Small mammal		15	20.3	16.3
	Medium mammal		5	6.8	5.4
		Mammal Total:	74	100.0	80.4
Birds			**NISP**	**% Bird**	**% All Taxa**
Falconiformes	*Buteo spp.*	Misc. Hawk	1	5.6	1.1
Galliformes	Phasianidae	Misc. Quail	1	5.6	1.1
	Meleagris gallopavo	Turkey	8	44.4	8.7
Miscellaneous	Large Bird		8	44.4	8.7
		Bird Total:	18	100.0	19.6
		PIII Identified Total	92	44.7	
		Pre-PIII Identified Total	29	14.1	
		Undetermined	85	41.3	
		Grand Total	206	100.0	

Table C4. Frequency of taxa from Roy's Ruin (5MT3930).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Carnivora	*Lynx spp.*	Lynx, bobcat	2	3.2	2.4
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	1	1.6	1.2
	Sylvilagus spp.	Cottontail	19	30.6	22.6
Rodentia	Sciuridae	Squirrel	10	16.1	11.9
	Thomomys spp.	Small pocket gopher	1	1.6	1.2
	Geomyidae	Pocket gopher	1	1.6	1.2
	Neotoma spp.	Woodrat	2	3.2	2.4
	Peromyscus spp.	Mouse	12	19.4	14.3
Miscellaneous	Small mammal		14	22.6	16.7
		Mammal Total	62	100.0	73.8
Birds			**NISP**	**% Bird**	**% All Taxa**
Falconiformes	*Falco spp.*	Misc. Falcon	1	4.5	1.2
Galliformes	*Meleagris gallopavo*	Turkey	12	54.5	14.3
Miscellaneous	Large Bird		7	31.8	8.3
	Medium Bird		2	9.1	2.4
		Bird Total	22	100.0	26.2
		Identified Total	84	45.7	
		Undetermined	100	54.3	
		Grand Total	184	100.0	

Table C5. Frequency of taxa from Lillian's Site (5MT3936).

Mammals	Taxon	Common Name	NISP	% Mammal	% All Taxa
Artiodactyla	Large Artiodactyl	Elk/Bison	2	1.2	0.8
	Artiodactyla	Even-toed ungulate	3	1.7	1.2
Carnivora	*Canis familiaris*	Domestic dog	1	0.6	0.4
	Canis spp.	Dog, wolf, coyote	1	0.6	0.4
	Urocyon or *Vulpes*	Fox	1	0.6	0.4
	Small Carnivore	Smaller than fox	1	0.6	0.4
	Medium Carnivore	Smaller than wolf	1	0.6	0.4
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	7	4.1	2.9
	Sylvilagus spp.	Cottontail	69	40.1	28.6
Rodentia	*Spermophilus variegatus*	Rock squirrel	1	0.6	0.4
	Spermophilus spp.	Ground squirrel	1	0.6	0.4
	Large Sciurid	Ground squirrel or larger	1	0.6	0.4
	Sciuridae	Squirrel	8	4.7	3.3
	Thomomys spp.	Small pocket gopher	5	2.9	2.1
	Neotoma spp.	Woodrat	21	12.2	8.7
	Peromyscus spp.	Mouse	3	1.7	1.2
	Microtus spp.	Vole	1	0.6	0.4
	Muridae	Mouse, vole	1	0.6	0.4
	Small Rodent	Woodrat or smaller	10	5.8	4.1
Miscellaneous	Small mammal		33	19.2	13.7
	Medium mammal		1	0.6	0.4
		Mammal Total	172	100.0	71.4
Birds			**NISP**	**%Bird**	**% All Taxa**
Columbiformes		Pigeons and Doves	1	1.5	0.4
Galliformes	*Meleagris gallopavo*	Turkey	37	54.4	15.4
Passeriformes	Passeriformes	Perching Birds	1	1.5	0.4
Miscellaneous	Large Bird		26	38.2	10.8
	Medium Bird		2	2.9	0.8
	Small Bird		1	1.5	0.4
		Bird Total	68	100.0	28.2
Amphibians			**NISP**	**% Amp.**	**% All Taxa**
		Frog	1	100.0	0.4
		Identified Total	241	55.4	
		Undetermined	194	44.6	
		Grand Total	435	100	

Table C6. Frequency of taxa from Troy's Tower (5MT3951).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Carnivora	*Canis spp.*	Dog, wolf, coyote	1	1.4	1.1
	Spilogale putorius	Spotted skunk	1	1.4	1.1
	Small Carnivore	Smaller than fox	1	1.4	1.1
Lagomorpha	*Sylvilagus spp.*	Cottontail	14	19.7	15.1
Rodentia	Sciuridae	Squirrel	8	11.3	8.6
	Geomyidae	Pocket gopher	9	12.7	9.7
	Neotoma spp.	Woodrat	2	2.8	2.2
	Small Rodent	Woodrat or smaller	26	36.6	28.0
Miscellaneous	Small mammal		6	8.5	6.5
	Medium mammal		3	4.2	3.2
		Mammal Total	71	100.0	76.3
Birds			**NISP**	**% Bird**	**% All Taxa**
Galliformes	*Meleagris gallopavo*	Turkey	7	31.8	7.5
Passeriformes	Passeriformes	Perching Birds	1	4.5	1.1
Miscellaneous	Large Bird		12	54.5	12.9
	Medium Bird		2	9.1	2.2
	Small Bird			0.0	0.0
		Bird Total	22	100.0	23.7
		Identified Total	93	58.5	
		Undetermined	66	41.5	
		Grand Total	159	100	

Table C7. Frequency of taxa from Mad Dog Tower (5MT181).

Birds	**Taxon**	**Common Name**	**NISP**	**% Bird**	**% All Taxa**
Galliformes	*Meleagris gallopavo*	Turkey	1	33.3	33.3
Miscellaneous	Large Bird		2	66.7	66.7
		Bird Total	3	100.0	100.0
		Identified Total	3	8.1	
		Undetermined	34	91.9	
		Grand Total	37	100.0	

Table C8. Frequency of taxa from Catherine's Site (5MT3967).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Carnivora	*Canis spp.*	Dog, wolf, coyote	1	0.8	0.3
	Urocyon or *Vulpes*	Fox	1	0.8	0.3
	Lynx spp.	Lynx, bobcat	1	0.8	0.3
	Medium Carnivore	Smaller than wolf	1	0.8	0.3
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	11	8.3	2.8
	Sylvilagus spp.	Cottontail	83	62.9	20.9
Rodentia	*Cynomys spp.*	Prairie dog	7	5.3	1.8
	Eutamias spp.	Chipmunk	1	0.8	0.3
	Thomomys spp.	Small pocket gopher	1	0.8	0.3
	Neotoma spp.	Woodrat	11	8.3	2.8
	Microtus spp.	Vole	1	0.8	0.3
Miscellaneous	Small mammal		12	9.1	3.0
	Medium mammal		1	0.8	0.3
		Mammal Total	132	100.0	33.2
Birds			**NISP**	**% Bird**	**% All Taxa**
Falconiformes	*Buteo sp.*	Misc. Hawk	1	0.5	0.3
Galliformes	*Meleagris gallopavo*	Turkey	87	45.5	21.9
Passeriformes	*Corvus sp.*	Raven	1	0.5	0.3
Miscellaneous	Large Bird		102	53.4	25.7
		Bird Total	191	100.0	48.1
Reptiles			**NISP**	**% Rep.**	**% All**
		Snake	74	100.0	18.6
		Identified Total	397	47.0	
		Undetermined	447	53.0	
		Grand Total	844	100	

Table C9. Frequency of taxa from Saddlehorn Hamlet (5MT262).

Mammals	Taxon	Common Name	NISP	% Mammal	% All Taxa
Artiodactyla	Medium Artiodactyl	Deer-sized artiodactyl	4	2.6	1.6
	Artiodactyla	Even-toed ungulate	1	0.6	0.4
Carnivora	*Canis spp.*	Dog, wolf, coyote	1	0.6	0.4
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	19	12.3	7.6
	Sylvilagus spp.	Cottontail	94	60.6	37.8
	Lagomorpha	Pika, rabbit, hare	2	1.3	0.8
Rodentia	*Cynomys spp.*	Prairie dog	2	1.3	0.8
	Sciuridae	Squirrel	1	0.6	0.4
	Thomomys spp.	Small pocket gopher	6	3.9	2.4
	Neotoma spp.	Woodrat	13	8.4	5.2
	Muridae	Mouse, vole	1	0.6	0.4
Miscellaneous	Small mammal		10	6.5	4.0
	Medium mammal		1	0.6	0.4
		Mammal Total	155	100.0	62.2
Birds			**NISP**	**% Bird**	**% All Taxa**
Galliformes	*Meleagris gallopavo*	Turkey	47	50.0	18.9
Miscellaneous	Large Bird		47	50.0	18.9
		Bird Total	94	100.0	37.8
		Identified Total	249	40.1	
		Undetermined	372	59.9	
		Grand Total	621	100.0	

Table C10. Frequency of taxa from Stanton's Site (5MT10508).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Artiodactyla	Medium Artiodactyl	Deer-sized artiodactyl	3	0.7	0.3
Carnivora	Canidae	Fox, coyote, dog, wolf	1	0.2	0.1
Lagomorpha	Lepus spp.	Jackrabbit or hare	10	2.2	1.0
	Sylvilagus spp.	Cottontail	213	47.5	21.5
Rodentia	Cynomys spp.	Prairie dog	2	0.4	0.2
	Spermophilus variegatus	Rock squirrel	6	1.3	0.6
	Eutamias spp.	Chipmunk	1	0.2	0.1
	Sciuridae	Squirrel	39	8.7	3.9
	Geomyidae	Pocket gopher	5	1.1	0.5
	Neotoma spp.	Woodrat	105	23.4	10.6
	Peromyscus spp.	Mouse	1	0.2	0.1
	Large Rodent	Larger than woodrat	2	0.4	0.2
	Rodentia	Rodent	7	1.6	0.7
Miscellaneous	Small mammal		52	11.6	5.3
	Medium mammal		1	0.2	0.1
		Mammal Total	448	100.0	45.3
Birds			**NISP**	**% Bird**	**% All Taxa**
Falconiformes	Falco sparverius	Kestrel	1	0.2	0.1
Galliformes	Meleagris gallopavo	Turkey	182	33.6	18.4
Passeriformes	Corvidae	Jays, Crows and Ravens	1	0.2	0.1
	Corvus sp.	Raven	1	0.2	0.1
	Passeriformes	Perching Birds	1	0.2	0.1
Miscellaneous	Large Bird		348	64.2	35.2
	Medium Bird		7	1.3	0.7
	Small Bird		1	0.2	0.1
		Bird Total	542	100.0	54.7
		Identified Total	990	44.0	
		Undetermined	1262	56.0	
		Grand Total	2252	100	

Table C11. Frequency of taxa from Lookout Site (5MT10459).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mammal**	**% All Taxa**
Artiodactyla	*Odocoileus spp.*	Deer	1	1.2	0.6
Carnivora	*Urocyon* or *Vulpes*	Fox	1	1.2	0.6
	Lynx spp.	Bobcat, Lynx	2	2.4	1.2
	Felidae	Lynx, Cougar	1	1.2	0.6
	Taxidea taxus	Badger	1	1.2	0.6
	Medium Carnivore	Smaller than wolf	1	1.2	0.6
Lagomorpha	*Sylvilagus spp.*	Cottontail	43	51.8	24.9
Rodentia	*Cynomys spp.*	Prairie dog	2	2.4	1.2
	Eutamias spp.	Chipmunk	1	1.2	0.6
	Sciuridae	Squirrel	5	6.0	2.9
	Neotoma spp.	Woodrat	12	14.5	6.9
	Microtus spp.	Vole	1	1.2	0.6
	Small Rodent	Woodrat or smaller	2	2.4	1.2
Miscellaneous	Small mammal		8	9.6	4.6
	Medium mammal		2	2.4	1.2
		Mammal Total	83	100.0	48.0
Birds			**NISP**	**% Bird**	**% All Taxa**
Galliformes	Tetraonidae	Grouse	2	2.3	1.2
	Meleagris gallopavo	Turkey	47	53.4	27.2
Passeriformes	Passeriformes	Perching Birds	1	1.1	0.6
Miscellaneous	Large Bird		37	42.0	21.4
	Medium Bird		1	1.1	0.6
		Bird Total	88	100.0	50.9
Reptiles			**NISP**	**% Rep.**	**%All**
	Misc. Reptile		1	50.0	0.6
	Lizard		1	50.0	0.6
		Reptile Total	2	100.0	1.2
		Identified Total	173	33.5	
		Undetermined	344	66.5	
		Grand Total	517	100.0	

Table C12. Frequency of taxa from Castle Rock Pueblo (5MT1825).

Mammals	Taxon	Common Name	NISP	% Mammal	% All Taxa
Artiodactyla	*Odocoileus spp.*	Deer	6	0.9	0.6
	Medium artiodactyl	Deer size artiodactyl	14	2.1	1.3
Carnivora	*Urocyon* or *Vulpes*	Fox	1	0.1	0.1
	Canidae	Canids	1	0.1	0.1
	Medium Carnivore	Smaller than wolf	1	0.1	0.1
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	52	7.6	4.9
	Sylvilagus spp.	Cottontail	340	50.0	32.1
	Lagomorph	Pika, rabbit, hare	1	0.1	0.1
Rodentia	*Cynomys spp.*	Prairie dog	4	0.6	0.4
	Eutamias spp.	Chipmunk	7	1.0	0.7
	Spermophilus variegatus	Rock squirrel	9	1.3	0.9
	Spermophilus spp.	Ground squirrel	4	0.6	0.4
	Sciuridae	Squirrel	59	8.7	5.6
	Geomyidae	Pocket gopher	10	1.5	0.9
	Neotoma spp.	Woodrat	47	6.9	4.4
	Peromyscus spp.	Mouse	2	0.3	0.2
	Muridae	Mouse, vole	5	0.7	0.5
	Rodent	Misc. Rodent	20	2.9	1.9
Miscellaneous	Small mammal		95	14.0	9.0
	Medium mammal		2	0.3	0.2
		Mammal Total	680	100.0	64.3
Birds			**NISP**	**% Bird**	**% All**
Anseriformes	*Anas spp.*	Mallards and relatives	1	0.3	0.1
Columbiformes		Pigeons and Doves	1	0.3	0.1
Falconiformes	Falconiformes	Vulture, hawks, eagles	4	1.1	0.4
	Buteo spp.	Hawks	6	1.7	0.6
	Falco spp.	Falcons	1	0.3	0.1
Galliformes	Phasianidae	Quail	2	0.6	0.2
	Meleagris gallopavo	Turkey	105	29.5	9.9
Passeriformes	*Corvus corax*	Raven	1	0.3	0.1
	Passeriformes	Perching Birds	2	0.6	0.2
Miscellaneous	Large Bird		229	64.3	21.6
	Medium Bird		2	0.6	0.2
	Small Bird		2	0.6	0.2
		Bird Total	356	100.0	33.6
Amphibians			**NISP**	**% Amp.**	**% All**
	Misc. Amphibian		2	100.0	0.2
Reptiles			**NISP**	**% Rep.**	**% All**
	Misc. Reptile		9	45.0	0.9
	Misc. Snake		5	25.0	0.5
	Misc. Lizard		6	30.0	0.6
		Reptile Total	20	100.0	1.9
		PIII Identified Total	1058	42.6	
		Undetermined	1427	57.4	
		Grand Total	2485	100	

Table C13. Frequency of taxa from Lester's Site (5MT10246).

Mammal	Taxon	Common Name	NISP	% Mammal	% All Taxa
Carnivora	Medium Carnivore	Smaller than wolf	1	0.9	0.6
Lagomorpha	*Lepus spp.*	Jackrabbit or hare	7	6.0	3.9
	Sylvilagus spp.	Cottontail	17	14.5	9.4
Rodentia	*Cynomys spp.*	Prairie dog	1	0.9	0.6
	Eutamias quadrivittatus	Colorado chipmunk	2	1.7	1.1
	Eutamias spp.	Chipmunk	65	55.6	35.9
	Neotoma spp.	Woodrat	5	4.3	2.8
	Small Rodent	Woodrat or smaller	4	3.4	2.2
Miscellaneous	Small mammal		5	4.3	2.8
	Medium mammal		2	1.7	1.1
	Large mammal		8	6.8	4.4
		Mammal Total	117	100.0	64.6
Birds			**NISP**	**% Bird**	**% All Taxa**
Galliformes	*Meleagris gallopavo*	Turkey	38	60.3	21.0
				0.0	0.0
Piciformes	*Colaptes auratus*	Common Flicker	1	1.6	0.6
				0.0	0.0
Miscellaneous	Large Bird		24	38.1	13.3
				0.0	0.0
		Bird Total	63	100.0	34.8
Amphibian			**NISP**	**% Amp.**	**% All Taxa**
	Frog		1	100.0	0.6
		Identified Total	181	47.8	
		Undetermined	198	52.2	
		Grand Total	379	100.0	

Table C14. Frequency of taxa from the Green Lizard Site (5MT3901).

Mammals	**Taxon**	**Common Name**	**NISP**	**% Mam.**	**% All**
Artiodactyla	*Odocoileus hemionus*	Mule Deer	8	0.4	0.2
	Ovis canadensis	Bighorn	1	0.1	0.0
	Medium artiodactyl	Deer size artiodactyl	31	1.7	0.9
Carnivora	Canidae	Canids	2	0.1	0.1
	Small Felidae	Cat, Bobcat, Lynx	1	0.1	0.0
	Martes americana	Marten	1	0.1	0.0
	Small Carnivore	Smaller than fox	1	0.1	0.0
	Medium Carnivore	Smaller than wolf	1	0.1	0.0
Lagomorpha	*Lepus californicus*	Black-tailed jackrabbit	77	4.3	2.2
	Sylvilagus audubonii	Desert cottontail	5	0.3	0.1
	Sylvilagus nutallii	Nutall's cttontail	1	0.1	0.0
	Sylvilagus spp.	Cottontail	467	25.8	13.0
	Leporidae	Rabbit, hare	46	2.5	1.3
Rodentia	*Cynomys spp.*	Prairie dog	75	4.1	2.1
	Spermophilus spp.	Ground squirrel	30	1.7	0.8
	Sciuridae	Squirrel	12	0.7	0.3
	Dipodomys ordii	Ord's kangaroo rat	2	0.1	0.1
	Thomomys bottae	Botta's pocket gopher	14	0.8	0.4
	Neotoma albigula	White throated woodrat	7	0.4	0.2
	Neotoma spp.	Woodrat	17	0.9	0.5
	Peromyscus spp.	Mouse	8	0.4	0.2
	Perognathus apache	Apache pocket mouse	13	0.7	0.4
	Perognathus sp.	Pocket mouse	1	0.1	0.0
	Microtus montanus	Montane vole	1	0.1	0.0
	Microtus spp.	Vole	2	0.1	0.1
	Small Rodent	Woodrat or smaller	47	2.6	1.3
	Medium/Large Rodent	Larger than woodrat	48	2.7	1.3
Miscellaneous	Small mammal		603	33.4	16.8
	Medium mammal		74	4.1	2.1
	Large mammal		2	0.1	0.1
	Indet. Mammal		210	11.6	5.9
		Mammal Total	1808	100.0	50.5
Birds	**Taxon**	**Common Name**	**NISP**	**% Bird**	**% All**
Strigiformes	Otus kennicottii	Western Screech Owl	1	0.1	0.0
Falconiformes	Small Raptor	Hawks, Falcons	1	0.1	0.0
	Buteo jamaicensis	Red-tailed Hawk	1	0.1	0.0
Galliformes	Meleagris gallopavo	Turkey	531	30.2	14.8
Passeriformes	Small passerines	Small Perching Birds	10	0.6	0.3
Miscellaneous	Large Bird		230	13.1	6.4
	Non-turkey bird		3	0.2	0.1
	Indet. Bird		982	55.8	27.4
		Bird Total	1759	100.0	49.1
Amphibians			**NISP**	**% Amp.**	**% All**
	Large amphibian	Salamander	7	100.0	0.2
Reptiles			**NISP**	**% Rep.**	**% All**
	Pituophis sp.	gopher snake	2	33.3	0.1
	Large Lizard		4	66.7	0.1
		Grand Total	3580	203.5	100.0