THE DESCRIPTIVE PALEONTOLOGY AND APPLIED ICHTHYOARCHAEOLOGY OF THE PONSIPA FAUNA

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The archaeology of the Northern Rio Grande region of New Mexico has recently received an increased amount scholarly attention. In particular, understanding past trends in demographics, agricultural productivity, violence, and social networks have been primary goals of archaeological research. Understanding patterns in animal exploitation has, however, received far less attention due to a small yet growing regional zooarchaeological database. Through the identification of animal remains from a site called Ponsipa (occupied ca. A.D. 1300 to 1600), this thesis adds one large dataset to this growing database. In addition, this thesis expands on the pre-impoundment distribution of an endangered native freshwater fish species in the state of New Mexico called the blue sucker (*Cycleptus elongatus*). The blue sucker is a unique fish that is currently experiencing range reduction across all of its known North American distribution due to anthropogenic habitat fragmentation and degradation. Skeletal remains that were identified from Ponsipa represent the farthest known northern record of its occurrence in the state of New Mexico and highlight the extent of range restriction of the species in the area. The data concerning the historical biogeography of the blue sucker from Ponsipa have implications for the effective conservation and restoration of blue sucker located in the Rio Grande Basin.

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CHAPTER 1

INTRODUCTION

Ponsipa'akeri (hereafter Ponsipa; LA 297) is an archaeological site located in an area of north central New Mexico and south central Colorado called the Northern Rio Grande region (Fig. 1). One reason anthropologists are fascinated by Northern Rio Grande prehistory is that the area seems to have important cultural ties to the Mesa Verde region after it depopulated around the turn of the 14th century. Ponsipa is important to study in this context because it was occupied from A.D. 1300 to 1600, which corresponds to this critical time period. Ponsipa itself was thoroughly excavated in the late 1970s and early 1980s, and it is of particular interest to study the animal remains that were excavated there because they have, up until now, gone unanalyzed.

The identification of animal remains from Ponsipa represents a single new assemblage added to the small, but growing, Northern Rio Grande zooarchaeological database. Because this database is still somewhat small, regional questions, such as how Northern Rio Grande animal exploitation relates to that from Mesa Verde, are not considered in this thesis. Analysis of the Ponsipa fauna, however, led to the identification of fish remains, which are important in terms of applied zooarchaeology. Thus, this thesis has two goals: 1) to provide high quality data for future regional analyses, and 2) to add new information on the historical biogeography of the blue sucker (*Cycleptus elongatus*), which is an endangered fish species in the state of New Mexico.

This introduction is broken into five sections that serve to briefly situate Ponsipa in its research, cultural, or environmental contexts. The first two sections are aimed at setting up the Ponsipa fauna's current and future utility, which is accomplished through a discussion on applied zooarchaeology (its current utility) and the archaeological research that has been conducted on Northern Rio Grande connections to the Mesa Verde region (its future utility). The discussion on applied zooarchaeology serves to answer the questions: What is applied zooarchaeology and why does it matter? The next section, regarding the archaeological context of Ponsipa, serves to answer two more questions: How is it thought that the Northern Rio Grande is connected to Mesa Verde and how do animal remains factor into this? The last three sections are site specific, and they serve to expand on the environmental setting of Ponsipa, the excavation history of the site, and data limitations. The environmental context of Ponsipa is important to discuss because New Mexico consists of six different life zones; the distributions of which are mainly affected by elevation differences across the landscape (Bailey, 1913). The Northern Rio Grande comprises five of the six life zones because elevation drastically changes as one moves across the region. Ultimately, this situates Ponsipa in a very diverse and unique landscape, and, because the area varies so drastically, it is important to briefly discuss the environment that immediately surrounds the site. Finally, the excavation history of Ponsipa is important to elaborate on because there are some data limitations that relate to how the site was excavated, and, for heuristic purposes, it helps to consider the excavation history and data limitations separately.

Applied Zooarchaeology

The primary goal of this thesis is to provide new applied zooarchaeological information from the Northern Rio Grande region on blue sucker, thus it is important to define applied zooarchaeology is first. Zooarchaeology, which is the study of animal remains from archaeological sites to understand subsistence practices and environmental conditions that is used to inform conservation biology and wildlife management has come to be known as applied zooarchaeology (Lyman, 1996). Applied zooarchaeological research provides a unique perspective towards the goal of conserving and managing threatened taxa.

Zooarchaeological data chronicles the presence of species in a given area through the accumulation of animal hunting events. Therefore, faunal assemblages formed by human action serve as repositories of how animals were generally distributed on the landscape in the past. Understanding the past distributions of animals is known as historical biogeography, and applied zooarchaeologists have provided important information regarding the historical biogeography of threatened taxa (Lyman, 1988, 1991; Randklev et al., 2010). The utility of applied zooarchaeological research, however, goes beyond just the presence of species on the landscape through time. Applied zooarchaeologists have used their data to tackle a host of problems that include: identifying past breeding areas (Bovy, 2012; Newsome et al., 2007), addressing the importance of different anthropogenic impacts on current extirpations (Butler and Delacorte, 2004), identifying migration corridors (Sanders and Miller, 2004), identifying suitable areas for species translocations or reintroductions (Darwent and Darwent, 2004; Cannon and Cannon, 2004), defining the sustainable harvest of animal resources (Braje et al., 2012; Etnier, 2007; Frazier, 2007; McKechnie, 2007; McKechnie et al., 2014), or addressing and refuting the core assumptions of proposed ecological restorations (Nagaoka, 2012; Wolverton, 2010). Indeed, the applied zooarchaeological perspective has much to offer conservation biology and wildlife management.

Echoing Wolverton et al. (2011), there are two reasons that the applied zooarchaeological perspective is important to the conservation of threatened taxa. First, the temporal perspective offered by the zooarchaeological record can provide conservation biologists with a shift in scale that offers a different way to think about modern ecological data. This shift in scale relates to the time depth that faunal assemblages from archaeological sites provide. Second, because zooarchaeological faunal assemblages are often associated with humans from the Holocene epoch, the temporal scale zooarchaeologists offer is appropriate for wildlife conservation. That is, the zooarchaeological record does not reach too far back in geological time, like the paleontological record often does. To conclude, zooarchaeological data is important to wildlife conservation and management because it provides evidence of human interactions with biota that extends past the historical record.

In chapter 3, the applied zooarchaeology of the blue sucker in the Rio Grande basin is discussed. Ponsipa and other archaeological sites from the Northern Rio Grande region are used to show that the blue sucker's range reached the upper Rio Grande, when today they are only found in a limited area in the lower Pecos River. Although the most proximate goal of this thesis is to provide new applied zooarchaeological information in the Northern Rio Grande, the faunal remains from Ponsipa might be useful for answering more anthropologically oriented questions in the future.

Archaeological Context

A steady stream of research regarding the archaeology of the Northern Rio Grande region of New Mexico has been produced in recent years (Duwe, 2011; Ortman, 2012; Vierra, 2013 and references therein). One reason that the archaeology of the Northern Rio Grande is important to study is that it has been posited that the people of Mesa Verde immigrated to the Northern Rio Grande region after it depopulated ca. A.D. 1300 (Jeançon, 1923). The initial line of archaeological evidence for this was a decrease in population density in the Mesa Verde area, around the time of depopulation, followed by a corresponding increase in the Northern Rio Grande. Yet there is scarce evidence of the Mesa Verde cultural complex found during this time in the north central New Mexico. Some examples of material culture that are absent from the area include the construction of pilasters and "keyhole" chambers in kivas or the presence of unique pottery styles such as Mesa Verde Black-on-white, which dominated the Mesa Verde region during this time. The absence of Mesa Verde material culture is not anticipated had there been a large and rapid movement of people from that region. Though whether or not such a migration occurred is still debated, new anthropological work in the Northern Rio Grande has introduced a large body of less direct evidence that indicates a mass migration of people from Mesa Verde took place. In particular, one area in the Northern Rio Grande shows circumstantial connections to the Mesa Verde region. Through analyses of past demographics, oral traditions, place names, and skull morphology, Ortman (2012, 2014) has argued that sites in the Tewa Basin, also known as the Española Basin, exhibit some of the strongest linkages to Mesa Verde. Thus, the current weight of evidence suggests that in-migration from Mesa Verde played a large part in the origins, or ethnogenesis, of the Tewa culture, which is the main cultural group in the Northern Rio Grande (Ortman, 2012).

Despite the prodigious amount of evidence used to study Tewa ethnogenesis, one line of evidence has received far less attention. The zooarchaeological record has not been employed to understand differences and similarities in animal procurement strategies between Mesa Verde and the Northern Rio Grande. It is possible that a better understanding of how animal resources were procured in both regions could elucidate possible connections between the two regions, show how such a large influx of people might have impacted the subsistence of endemic Northern Rio Grande populations, or perhaps highlight pull factors for Mesa Verde migrants into the Northern Rio Grande (*sensu* Cameron, 1995). The lack of attention to the zooarchaeological record may be explained in two interrelated ways. First, hunting is generally viewed as a secondary food acquisition strategy among the people of the greater American Southwest during this time. With the domestication of corn (*Zea mays*), beans (*Phaseolus* spp.), and squash

(*Cucurbita* spp.), it has long been known that the first farmers in the southwest were able to create a stable and nutritious resource base for future generations (Kaplan, 1965). However, not only do animal resources provide important secondary sources of protein, they are likely primary sources of fat (Speth and Spielmann, 1983; Stiner, 1994). Second, and also problematic, is that very few large and well preserved faunal assemblages have been comprehensively analyzed from sites in the Northern Rio Grande region, making comparison to the Mesa Verde region during this critical time period difficult. In contrast, the zooarchaeology of Mesa Verde leading up to and during the terminal occupation period has been thoroughly researched (Badenhorst and Driver, 2009; Driver, 2002; Driver and Woiderski, 2008; Muir and Driver, 2002, 2003; Rawlings and Driver, 2010; Schollmeyer and Driver, 2013).

There is one recent regional diachronic study of Northern Rio Grande animal subsistence; Akins (2013) studied animal procurement patterns in the uplands and lowlands of the Northern Rio Grande. She utilized faunal assemblages from sites that reported specimen counts and that had good temporal control. In total she utilized 38 samples to study animal procurement. Some of the samples that Akins (2013) used were relatively small. Out of the 38 samples, four did not exceed a samples size of 100 and nine did not exceed a sample size of 1000. However, if Akins' (2013) samples are representative and thus sufficient samples to understand animal acquisition strategies in the Northern Rio Grande, at a finer spatial scale, none exist for the Tewa Basin during the critical A.D. 1300 time period. The only faunal assemblages Akins (2013) was able to include from the Tewa Basin were from five sites that were occupied during the Developmental Period (approximately A.D. 900 to A.D. 1200), which corresponds to the Pueblo II period in the San Juan chronology (Fig. 2). If researchers are to more fully understand animal resource use between these two regions during this time of demographic change, then a more representative regional zooarchaeological database needs to be created. Ultimately, this can only be done one site a time. In hopes of developing such a database, the zooarchaeology of Ponsipa, which is one large archaeological located in the Tewa Basin is detailed in the following chapters. Ponsipa yielded around 6,300 well preserved faunal specimens.

The Environmental Setting of Ponsipa

Landscape

Ponsipa itself is elevated around 1860 m above sea level, and it is situated on top of an alluvial bench, or terrace. The site is adjacent to, and approximately 20 m above, the Rio Ojo Caliente (Fig. 3), a tributary of the Rio Chama. This alluvial bench is derived from the Santa Fe formation, which consists of sedimentary and volcanic rocks that were deposited between the late Miocene and Pleistocene (Baldwin, 1956). The dominant soil that is found around the site is Vibo sandy loam that is found on top of Quaternary gravels (Bugé, 1978). The Vibo soil series is typical of the moderately dark colored soils that are associated with the pinyon-juniper woodlands that cover most of the area (Dick-Peddie, 1993; Maker et al., 1974).

The Rio Grande rift was formed during the Cenozoic extension, which started approximately 30 Mya. The Cenozoic extension is characterized by two extension events that occurred in the mid-Oligocene and in the late Miocene (Morgan et al. 1986). The first extension event is thought to have contributed most to the extension of the rift, and the Española Basin was formed during this time. Ponsipa is located within the Española Basin, which is one of three drainage basins that follow the Rio Grande Rift in the state of New Mexico. It is flanked by the Jemez Mountains to the west and the Sangre de Cristo mountain range to the east. The northwest of the basin is confined by the Brazos and Tusas mountains, and the southern extent is marked by the Cerrillos Hills. Within the basin, one of the main rivers in the region, the Rio Chama, became connected to the Rio Grande sometime in the Pliocene (Dethier and Demsey, 1984).

Vegetation and Climate

Dick-Peddie (1993) refers to the vegetation zone that predominates the Tewa Basin as the Juniper Savana ecotone. This ecotone is characterized by the mixing of grasslands and pinyon-juniper woodlands, and the area immediately surrounding Ponsipa demonstrates this mixing well. The terrace that Ponsipa is located upon is covered by grass, mostly blue grama (*Bouteloua gracilis*), but to the east of the site the landscape is dominated by juniper (*Juniperus* spp.) with some pinyon (*Pinus* spp.) occurring as well (Figs. 4 and 5). One-seed juniper (*Juniperus monosperma*) and Colorado pinyon (*Pinus edulis*) are the most common species in the area, and it is likely they are the species represented at Ponsipa. Close to the site, along the Ojo Caliente, there are also cottonwoods (*Populus wislizeni*) (Fig. 6), which are common in the flood-plains riparian zone that is located in this area (Dick-Peddie, 1993).

There are two main precipitation regimes in the southern Colorado Plateau (Dean and Funkhouser, 1995). The first pattern typifies the northwest portion of the plateau and is characterized by a bimodal pattern whereby precipitation is heaviest in the winter and summer seasons. The southeast portion of the plateau, however, includes the Northern Rio Grande and is characterized by a summer-dominant pattern. Between A.D. 1250 and 1450 the northwest pattern became erratic and the southeast pattern remained persistent (Dean and Funkhouser, 1995). From this, Ahlstrom et al. (1995) inferred that an environmental gradient existed from the Four Corners area to the Rio Grande, and that this gradient could have played a large part in the proposed immigration of people from the Mesa Verde area to the Northern Rio Grande. Recently it was found that the Chama area, which is where Ponsipa is located, was wetter and less variable than other subregions in the Northern Rio Grande during this critical time period (Towner and Salzer, 2013).

Excavations at Ponsipa

Ponsipa was first excavated by Sylvanus Morley in 1910; during 1978, 1979, and 1981, David E. Bugé led excavations at Ponsipa as the Occidental College Field School. During 1978 and 1979, eight rooms and a trench in a kiva depression were excavated at the site, and during the 1981 field season one of the main plazas was targeted for excavation. The faunal remains identified in this thesis derive from Bugé's extensive excavation of the site.

Only two preliminary reports (1978 and 1979) were written from the three field seasons. It is difficult to reconstruct the exact methodology and chronology of Bugé's excavations at Ponsipa because the reports and papers written about the site are general (Bugé, 1978, 1979, 1981), and the only field techniques that are mentioned in the reports derive from seven sentences of the 1978 report. Information that can be gleaned from the 1981 field season comes from the field notes of a student completing data collection for her master's research (Self, 1982). The provenience system utilized at Ponsipa is unknown. And while the provenience designation and field specimen numbers of archived materials from the site have been transcribed by Crow Canyon Archaeological Center, it is still unclear what these numbers represent. Unfortunately, basic questions regarding how many units were excavated and exactly where they were located cannot be answered at Ponsipa.

A general description of the excavation can, however, be reconstructed thanks to recent cartographic work done at the site. Duwe (2011) was able to create a high resolution topographic map of Ponsipa that is accurate within 20 cm. He was able to infer where excavations had taken place (see Fig. 7). Cross referencing his work with the preliminary reports, papers, and notes from Ponsipa creates a better, though still broad, understanding of its excavation history. Bugé's (1978, 1979) room labeling system is straightforward, rooms are labeled according to the year and the order they were excavated. For example, room 78-1 is the first room excavated during the 1978 field season. The 1978 excavations were not difficult to locate at Ponsipa because the only map Bugé provided that detailed where excavation took place was for this field season. According to Duwe's (2011) labeling scheme, Room Blocks 2 and 6 and the trench at Kiva 4 were excavated during 1978. Bugé's rooms 1 through 4 were dug from Room Block 6, and room 5 was excavated in Room Block 2 along with a partial area of Plaza A. The exact location of the 1979 excavations were not mentioned by Bugé, but can be inferred from Duwe's map. Room 1 was excavated in the western portion of Room Block 4, room 2 was excavated in Room Block 3, and room 3 was located in the eastern portion of Room Block 4. Only a broad area could be identified for the 1981 excavations. According to Self's field notes, the 1981 excavations took place in the plaza between Room Block 4 and 5, which is not labeled in Duwe's scheme.

Duwe's (2011) research also furthered what is known about Ponsipa because he provided a rough estimate of the occupational history and population size of the site. There are three main components at Ponsipa that increase in age as one moves from the southwest to the northeast of the site (Fig. 8). Using ceramic mean dating, Duwe (2011) showed that the first component was occupied from A.D. 1312 to 1405, the second component was utilized from A.D. 1342 to 1500, and the last component was peopled from A.D. 1361 to 1550. By pairing an estimation of the numbers of rooms in each room block with his estimation of the occupation of each component, Duwe (2011) was able to deduce that the population of Ponsipa peaked around A.D. 1400 with somewhere around 1350 people.

Data Limitations

Though faunal remains from Ponsipa are well preserved and provide a large sample, there are limitations related to how the site was excavated that inhibit a comprehensive intrasite analysis related to animal procurement (*sensu* Ferring, 1984). Only two occupational components were excavated (labeled as components 2 and 3 by Bugé), and these components significantly overlap in occupation. This would not be an issue if excavation units at Ponsipa had clearly recorded provenience information. Without the ability to link units together, and subsequent room blocks in terms of spatio-temporal context, trends in spatial and temporal patterning cannot be inferred. Also, there are sampling issues with the current collections. Bugé (1978) states, “Shovels were used to remove the majority of the room fill, although unusually productive areas were troweled. The majority of the fill was not screened, but the lower 30 cm. of the fill in each room was screened with ¼ inch mesh.” At what levels shovels were exchanged for trowels and at what levels screening took place are unknown. Thus, the effects of recovery and sample bias are difficult to test at Ponsipa (*sensu* Nagaoka, 1994, 2005; Payne, 1972; Shaffer and Sanchez, 1994). Furthermore, faunal remains were only recovered from rooms and kivas; midden deposits were not excavated. The data limitations explicated above are the reason to focus on the applied zooarchaeology of the blue sucker in the state of New Mexico because information on their historical biogeography on requires nominal scale data.

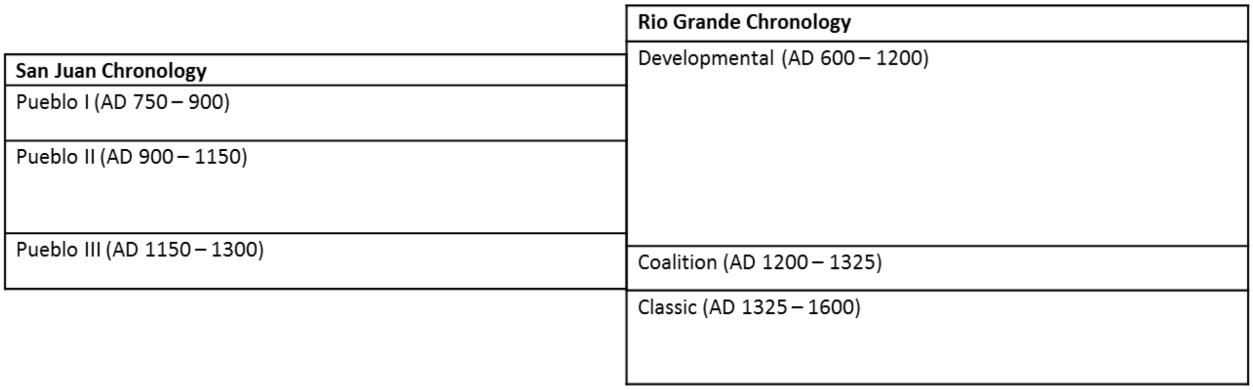
Summary

The primary goal of this thesis is to utilize the Ponsipa fauna to aid in blue sucker conservation. The zooarchaeological record is commonly used to understand the cultural ecology of past human populations, but in some circumstances it can be used to understand past environmental conditions based off of animal biogeography, or zoogeography (Grayson, 1987).

Further, animal remains from archaeological sites can be used to understand past distributions of currently threatened taxa. This information can be of particular use to conservation biologists and wildlife managers. The Ponsipa fauna has yielded specimens of a large-bodied sucker species known as the blue sucker (*Cycleptus elongatus*), which is endangered in the state of New Mexico. The blue sucker remains from Ponsipa represent the furthest known northern extent of this unique species in the Rio Grande drainage. Chapter 3 is, therefore, dedicated to the analysis of ichthyofaunal remains from Ponsipa and other sites located in the Northern Rio Grande.

A secondary goal of this thesis is to provide a large faunal dataset from the Tewa Basin during the Coalition and Classic Periods. While at present the regional animal procurement strategies cannot be comprehensively tested between the Northern Rio Grande and Mesa Verde areas, the Ponsipa fauna provides one more source of data. In line with this goal, chapter 2 is dedicated to explaining the faunal identifications made at Ponsipa in a systematic, or descriptive, paleontology, which is a form of quality control that is commonly utilized in paleontological research.

Fig. 1. Google Earth image of the Northern Rio Grande region.



San Juan Chronology	Rio Grande Chronology
Pueblo I (AD 750 – 900)	Developmental (AD 600 – 1200)
Pueblo II (AD 900 – 1150)	
Pueblo III (AD 1150 – 1300)	Coalition (AD 1200 – 1325)
	Classic (AD 1325 – 1600)

Fig. 2. San Juan Chronology (developed by Kidder, 1927) compared to the Rio Grande Chronology (developed by Wendorf, 1954).

Fig. 3. The view of the Rio Ojo Caliente from Ponsipa.

Fig. 4. Atop the grass dominated alluvial bench where Ponsipa is located. This picture was taken towards the east of the site, and the camera is pointed westward.

Fig. 5. Looking towards the west of Ponsipa. US-285 and the Rio Ojo Caliente are below. The domination of juniper on the landscape is demonstrated with some pinyon in the background.

Fig. 6. Under a Rio Grande cottonwood (*Populus wislizeni*) looking towards another cottonwood on the desiccated Rio Ojo Caliente.

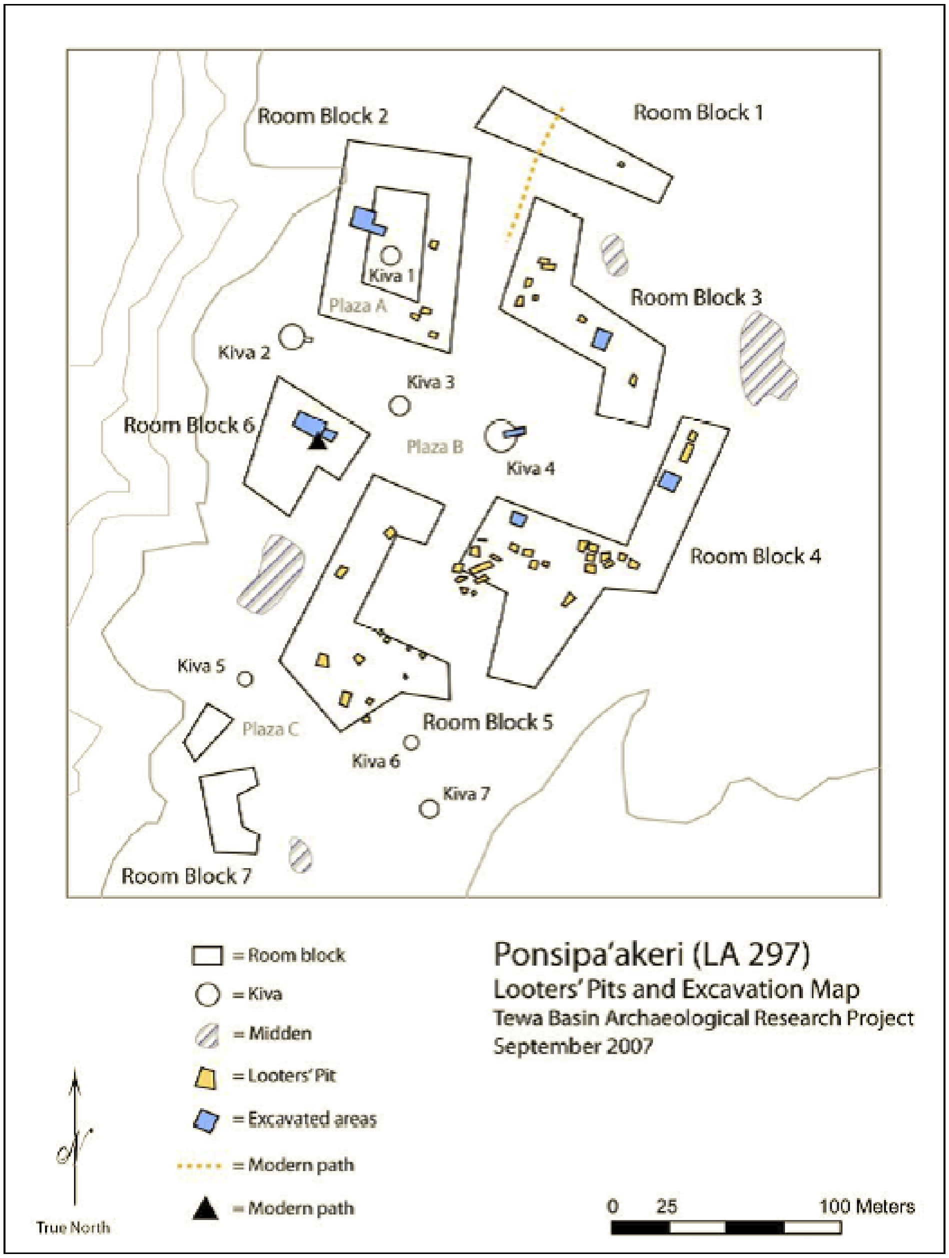


Fig. 7. Excavation of Ponsipa
Note: Figure from Duwe (2011)

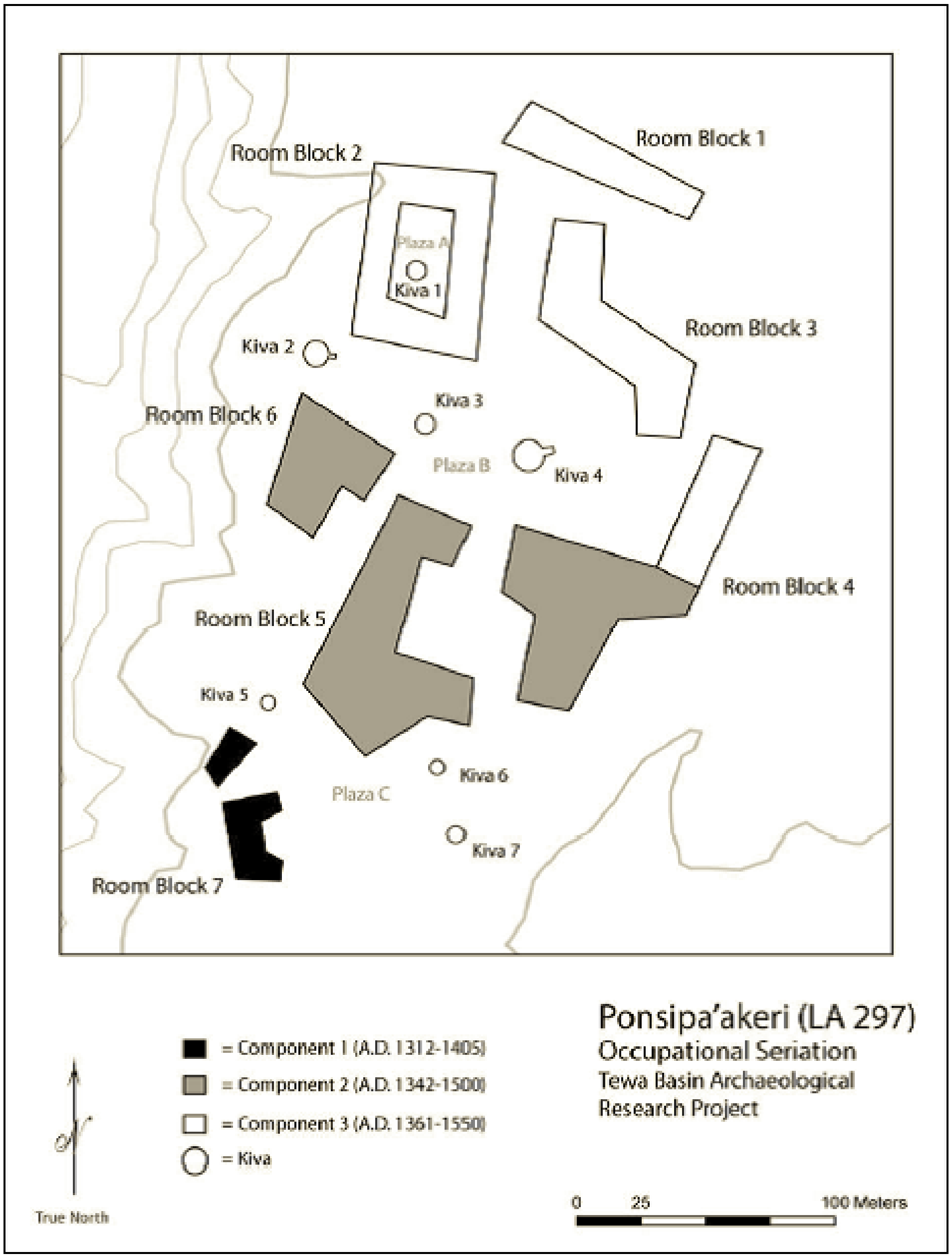


Fig. 8. Components of occupation from Ponsipa
Note: Figure from Duwe (2011)

CHAPTER 2

SYSTEMATIC PALEONTOLOGY

Introduction

Descriptive terminology is a cornerstone of paleontological research, and is used to differentiate anatomical features of fossils and subfossils to assign specimens into taxonomic units (Raup and Stanley, 1978). A “systematic paleontology” is the section of paleontological reports intended to describe anatomical features of bone, antler, horn, and shell specimens used for taxonomic identification (Lyman, 2011). In this systematic paleontology, the criteria used to identify animal remains from Ponsipa are explicated. Information regarding modern comparative collections, manuals and keys, specific diagnostic criteria, and biogeography are used on a case-by-case basis to support identifications of bones and bone fragments to Linnaean taxa. Reporting these criteria using a systematic paleontology is one way to improve data quality in zooarchaeological faunal analysis (Wolverton, 2013).

The primary comparative collection utilized for the analysis of faunal remains from Ponsipa is housed at the Laboratory of Zooarchaeology at the University of North Texas (UNT). When comparative specimens were unavailable in this collection for distinction of closely related, or morphologically similar, specimens it is clearly stated in the systematic paleontology. In many cases, with or without adequate comparative materials, broad-level identifications are more appropriate because all of the specimens were identified based on their own diagnostic criteria and many were fragmented and, thus, lacked morphological features. Specimens that possessed diagnostic features but could not be identified with the UNT collection were taken to the Vertebrate Paleontology Laboratory at the University of Texas.

Many manuals and keys were utilized for the identification of zooarchaeological bone from Ponsipa (For mammals: Adams and Crabtree, 2012; Chavez, 2008; Gilbert, 1980; Hillson, 1996, 2009; Jacobson, 2003; Olsen, 1964; Smart, 2009; for birds: Cohen and Serjeantson, 1996; Gilbert et al., 1985; Hargrave and Emslie, 1979; Olsen, 1979; for the skulls of both birds and mammals: Elbroch, 2006; for fish: Branson, 1962; Mundell, 1975; Olsen, 1968; and to check against human: White et al., 2011). While diagnostic criteria used to separate taxa were made in conjunction with these manuals and keys, some of the criteria explained below were formed with the author's own observations and experiences with the UNT comparative collection.

The 8th edition of the *Manual for the Description of Vertebrate Remains*, developed by Jonathan Driver for Crow Canyon Archaeological Center, was utilized to systematically code the Ponsipa fauna. Jonathan Driver developed this manual for the description of vertebrate faunas in southwestern Colorado, and not for the Northern Rio Grande region of New Mexico. Some of the identifications used in the manual are outdated because their systematic designations have changed. If there is an updated systematic designation for a taxon, it is noted within the remarks. Two deviations from the identifications codified in the manual were made, and they relate to the fish and macaw specimens identified from Ponsipa (these are described below).

Throughout this systematic paleontology, Bailey (1931) is referenced to provide information on the biogeography of mammal species in the state of New Mexico, and Bailey (1928) is utilized for avian species. These books are unique because the authors utilize multiple historical and cultural sources to provide information on native taxa in New Mexico, along with their extensive firsthand experience. Henderson and Harrington's (1914) *Ethnozoology of the Tewa Indians* is, however, most relied upon to provide information on historical vertebrate biogeography. The use of this volume is warranted because it provides a point of reference, or a baseline, for the taxa one could reasonably expect to find at Tewa sites.

Systematic Paleontology

Class Mammalia (mammals)

Order Artiodactyla (artiodactyls)

Identified specimen: 1 tooth fragment

(total NISP = 1)

Remarks: Selenodont teeth are those where tooth cusps have joined into mesiodistally oriented folds (Hillson, 2009).The crescent-shape and folding patterns of selenodont teeth are unique and, therefore, diagnostic. The only order in the Northern Rio Grande that has selenodontic teeth is Artiodactyla . Body size could not be inferred because this specimen was a small buccal fragment that did not include parts of the occlusal surface or root. This specimen could belong to a number of different genera that span medium and large body sizes including *Antilocapra*, *Odocoileus*, and *Cervus*.

Family Antilocapridae (pronghorns)

Antilocapra americana (pronghorn)

Identified specimens: 1 mandible, 1 permanent premolar, 1 atlas, 1 sternebra, 1 humerus, 1 innominate, 1 femur, 2 tibiae, 2 astragali, 2 metatarsi, 1 proximal phalanx, 1 medial phalanx

(total NISP = 15)

Remarks: Pronghorn specimens were identified using one complete comparative specimen from the UNT collection and criteria from Lawrence (1951). The current largest contiguous distribution of pronghorn in New Mexico is relegated to the arid plains located in the eastern portion of the state (Byers, 2003). There are, however, small populations sporadically located throughout New Mexico, of which some are located in the Northern Rio Grande region. Henderson and Harrington (1914:15) documented an older member of San Ildefonso Pueblo who recalled hunting pronghorn on the Pajarito Plateau.

Though Antilocapridae is one of the more basal families in the infraorder Pecora (Matthee et al., 2001), *A. americana* post-cranial skeletal morphology can be remarkably similar to *Ovis* and *Odocoileus*. There are, however, some elements that can be differentiated among these three genera, which represent three different families. The atlas of the pronghorn is more mediolaterally compressed. The ‘wings’ of the element do not laterally bulge outwards (as in *Odocoileus* spp.) or posteriorly taper inwards (as in *Ovis* spp.), but they remain fairly straight in shape. The internal condyle of the distal humerus is dramatically larger than the external condyle in *Odocoileus* spp., and more proportional in *Ovis* spp. The distal end of the humerus of *A. americana* is intermediate in shape. The proximal articular surface of the metatarsus of *A. americana* forms a unique point on the posterior side of the element. This projection originates more medially than in *Ovis* spp. and is almost absent in *Odocoileus* spp. On the astragalus of *A. americana*, the medial salient of the proximal trochlea is pronounced, and the lateral salient is not pronounced. This is the reverse among members of *Odocoileus* spp., and in *Ovis* spp. both salients are pronounced. The proximal articular surface of the first phalanx of *Odocoileus* spp. is characterized by a large surface on the posterior side that articulates with the sesamoid. This surface is absent in *Ovis* spp., and is intermediate in *A. americana*.

Family Bovidae (cloven-hooved, horned mammals)

Ovis spp. (sheep)

Identified specimen: 1 medial phalanx

(total NISP = 1)

Remarks: This specimen most likely belongs to *Ovis Canadensis*, but domestic sheep, specifically the Churra, were brought to New Mexico by Oñate in 1598. Henderson and Harrington (1914:15) note that "[v]ery few of the Tewa own sheep, and the flocks consists of a few animals only." Though it seems that some Northern Rio Grande Puebloans did not herd sheep (Dunmire, 2013:13), a conservative approach was adopted for the identification of this phalanx on the off chance that it could have originated from a domestic sheep.

This medial phalanx was identified using criteria from Lawrence (1951:25). *Ovis* and *Antilocarpa* second phalanges are similar in morphology and are easily separated from *Odocoileus* specimens by the shape of the proximal articular surface. The dorsal margin of the articular surface extends past the ventral margin in both *Ovis* and *Antilocapra* and does the reverse in *Odocoileus*. *Ovis* and *Antilocapra* specimens are not so easily separated. However, the mediolateral width of the proximal articular surface is more equal in length to its dorsoventral length. That is, the proximal articular surface is more rounded in *Ovis* and more compressed in *Odocoileus* and *Antilocapra*. These criteria hold up in reference to modern comparative specimens, and are the basis for the identification of this specimen to the genus *Ovis*.

Family Cervidae (cervids)

Identified specimens: 6 antler fragments

(total NISP = 6)

Remarks: Specimens here could represent either *Odocoileus virginianus*, *O. hemionus*, or *Cervus elaphus* because they are the only species that grow antlers in this geographic area. Antlers are commonly used as tools by Native American peoples, and three of the specimens exhibit signs of human modification. Some characteristics that distinguish antler fragments from other bone fragments are the presence of densely packed trabecular bone coupled with a thick cortex.

Odocoileus spp. (deer)

Identified specimens: 1 permanent premolar, 3 permanent molars, 1 atlas, 1 axis, 2 scapulae, 1 humerus, 2 radii, 2 ulnae, 1 carpal, 7 innominates, 3 femora, 4 tibiae, 2 calcaneae, 3 astragali, 1 metatarsus, 5 proximal phalanges, 8 medial phalanges, 8 terminal phalanges

(total NISP = 55)

Remarks: The primary diagnostic criteria used to separate specimens in this category derive from Lawrence (1951). Comparative specimens from the UNT Laboratory of Zooarchaeology used to differentiate *Odocoileus* spp. consist of two skeletally complete *O. virginianus* specimens, one skeletally complete *A. americana* specimen, and one partially complete *O. aries* specimen. It is possible that mule deer (*O. hemionus*) and white-tailed deer (*O. virginianus*) are represented in this assemblage. Though there is some overlap in their distribution, *O. hemionus* is adapted to more xeric and rocky habitats (Mackie et al., 2003), which characterize the Northern Rio Grande. It is, therefore, likely that *O. hemionus* is the most commonly represented species of artiodactyl in the Ponsipa assemblage. Many of the diagnostic criteria utilized to differentiate *Odocoileus* sp., *Ovis* sp. and *A. americana* have been detailed above. However, some diagnostic criteria that separate *Odocoileus* spp. include: the presence of a deep notch below the acetabulum; a deep muscle scar on the lateral side of the distal femur; a more rounded glenoid fossa that, in profile, slopes less dramatically; and a lob-shaped sustentaculum.

Non-standard descriptions for artiodactyls

Medium Artiodactyl (deer sized)

Identified specimens: 2 cranial fragments, 1 premaxilla, 1 zygomatic, 1 bulla, 1 petrosa, 3 occipital condyles, 1 basioccipital, 8 mandibles, 4 permanent incisors, 4 permanent premolars, 3 permanent molars, 10 tooth fragments, 2 axes, 10 cervical vertebrae, 10 thoracic vertebrae, 6 lumbar vertebrae, 2 vertebrae, 1 sternebra, 3 ribs, 7 scapulae, 7 humeri, 4 radii, 5 ulnae, 9 carpals, 6 metacarpi, 18 innominates, 19 femora, 15 tibiae, 2 fibulae, 4 calcanei, 1 astragalus, 13 tarsals, 15 metatarsi, 12 metapodials, 1 lateral metatarsus, 15 proximal phalanges, 4 medial phalanges, 11 terminal phalanges

(total NISP = 241)

Remarks: The specimens identified as medium artiodactyl most likely belong to the genus *Odocoileus* because this was the most abundant artiodactyl genus-level identification at Ponsipa. The different species that are endemic to the Northern Rio Grande included in this body size category (*Odocoileus*, *Antilocapra*, and *Ovis*) can be difficult to separate. The specimens represented in this category where either too damaged to give a confident identification below order/body size level or they consist of elements like vertebrae that considerably overlap in morphology among congeners.

Large artiodactyl (wapiti sized)

Identified specimens: 2 radii

(total NISP = 2)

Remarks: These two robust radii were culturally modified and were moderately weathered (roughly Behrensmeyer's [1978] Level 3). These modifications made it difficult to assess diagnostic criteria. It is possible that these two radii belong to either *Bos* spp. or *Cervus elaphus*. These specimens were taken to the Vertebrate Paleontology Lab at the University of Texas and compared more favorably in size and general shape to *Cervus elaphus*.

Order Carnivora (carnivores)

Family Canidae (dogs, wolves)

Canis spp. (dog, wolf, coyote)

Identified specimens: 1 zygomatic, 1 mandible, 1 permanent canine, 1 atlas, 2 axes, 1 humerus, 1 radius, 5 femora, 6 tibiae, 1 calcaneus

(total NISP = 20)

Remarks: The domestic dog (*Canis familiaris*), coyote (*Canis latrans*), and gray wolf (*Canis lupus*) were all present in northern New Mexico during the occupation of Ponsipa. Though today the gray wolf is absent in the region, Henderson and Harrington (1914:29) note that their Tewa informants regarded the gray wolf as present, though scarce, and the authors reference Bailey (1907, 1908) who reported the occurrence of gray wolves in the Taos Mountains.

Identification of *Canis* spp. to species was not warranted for three reasons: 1) there is considerable overlap in skeletal morphology among dogs, coyotes, and wolves, 2) hybridization among the three species can occur, and 3) many of the specimens were fragmented or incomplete, which reduced the presence of diagnostic characteristics. These specimens were, however, larger than *Vulpes* spp. and *Urocyon* spp., the genera that represent North American foxes.

Though there is ample evidence that the domestic dog was utilized as a pet animal and beast of burden in the greater American Southwest (see Henderson and Harrington, 1914:25-28 and references therein), there is also evidence from Arroyo Hondo Pueblo that domestic dogs were used as a food resource (Lang and Harris, 1984:89). If the majority of specimens at Ponsipa represent domestic dogs, which is likely, it is unclear how they were utilized. What is clear, however, is that many of the specimens at Ponsipa were worked. The proximal and distal ends of long bones show evidence that they were broken using a groove-and-snap technique, which is commonly used to make tools or ornaments out of the diaphyses of long bones. Olsen (1979) notes that *Canis* spp. bones were sometimes used for the manufacture of tubular beads and small sewing awls at Grasshopper Pueblo, a Mogollon site located in east central Arizona.

Family Felidae (cats)

Puma concolor (mountain lion)

Identified specimens: 1 scapula, 1 radius, 1 calcaneus

(total NISP = 3)

Remarks: The representation of mountain lion in the Ponsipa assemblage was surprising because the species tends to be elusive and somewhat rare on the landscape, but its presence is not unprecedented in the region. Henderson and Harrington (1914:30) note the existence of a Tewa shrine on the Pajarito Plateau that they refer to as "Stone Lions Shrine," and that the Tewa refer to as "where the two mountain lions crouch." Bailey (1931), understood the presence of mountain lion to be most common in the Jemez Mountains, and in the Taos and Pecos River Mountains. Today, the historic North American distribution of *P. concolor* has been decreased by approximately two thirds (Pierce and Bleich, 2003). The mountain lion is, however, widely distributed in the western portion of the United States and is present in multiple biomes in the state of New Mexico (Frey and Yates, 1996).

It is possible that the mountain lion was a food resource for the occupants of Ponsipa, but taphonomic signatures, such as butchering marks, are absent from these specimens. The proximal end of the radius specimen does show signs of carnivore damage, and both the proximal and distal ends of the calcaneus specimen were unfused.

Lynx spp. (lynx, bobcat)

Identified specimens: 1 humerus, 1 tibia

(total NISP = 2)

Remarks: Lynx (*Lynx canadensis*) are uncommon in this area, therefore, these specimens probably belong to bobcat (*Lynx rufus*). However, the dispersal distances of *L. canadensis* are extensive (Anderson and Lovallo, 2003), and there is reason to believe that the historic distribution of lynx could have included the mountains of north-central New Mexico (Frey, 2006). Therefore, it is possible that the occupants of Ponsipa hunted *L. canadensis*. It is interesting to note that the Tewa language does not differentiate between bobcat and lynx (Henderson and Harrington, 1914:29), and that the pelts of bobcats were utilized for the collars of katsina masks at multiple Rio Grande pueblos (Clark, 2007).

The specimens were not identified to species for four reasons, 1) the sympatric distribution of these two species, as noted above, 2) postcranial skeletal elements among these two species are difficult to tell apart, 3) the specimens were incomplete, and 4) there is not a lynx comparative specimen in the UNT collection.

Family Mustelidae (weasels)

Taxidea taxus (American badger)

Identified specimen: 1 permanent molar

(total NISP = 1)

Remarks: The badger is widely distributed throughout the state of New Mexico. Bailey (1931:343) notes, "The badgers are generally distributed over the whole of New Mexico without much regard to climate or physiographic features, except as these modify the abundances of their food supply." In regards to their behavior, Bailey (1931:343) states, "The badgers are pugnacious little animals with as much confidence in their fighting powers as the skunks have in their weapon of defense." According to Henderson and Harrington (1914:24), their Tewa informants admired the fighting prowess of the badger and recounted a story where "… a badger caught one of them by the trousers and held on until it was dragged a long distance to the river and into the water."

Hillson (2009:56) differentiates the teeth of mustelids into different body size categories, and *Taxidea taxus* is the only large-sized mustelid in the Northern Rio Grande. This particular specimen was an upper right molar (M1) and its unique triangular shape, cusp pattern, size, and comparison with two modern specimens were used to warrant its identification to the species level.

Non-standard descriptions for carnivores

Small carnivore (smaller than fox)

Identified specimens: 2 femora

(total NISP = 2)

Remarks: Only the distal ends of these femora were present, which was not enough for a confident identification past this body size category. The distal end of the femur generally fuses before the proximal end in carnivores, as evidenced by Sumner-Smith (1966) and Clark (1997). Since the distal ends are represented by these specimens it is possible they could belong to juveniles. Thus, it is possible that the specimens are not fully developed, and, because of this, a more general order/body size level identification was justified.

Medium carnivore (fox-size or larger)

Identified specimens: 1 cranial fragment, 1 permanent canine, 1 cervical vertebra, 1 lumbar vertebra

(total NISP = 4)

Remarks: The specimens represented in this taxonomic/body size category were either too fragmented (the cranial and canine specimens) or the morphology of the skeletal element was too conserved across related species (the vertebrae) to designate a more specific taxonomic identification.

Large carnivore (wolf-size or larger)

Identified specimen: 1 innominate

(total NISP = 1)

Remarks: This specimen was from an acetabulum fragment and compared more favorably to mountain lion. However, a more precise identification was not assigned because this fragment was devoid of any other diagnostic characteristics. It is likely this specimen belonged to either the family Canidae or Felidae.

Order Lagomorpha (hares, rabbits, and pikas)

Identified specimens: 6 cranial fragments, 2 premaxillae, 1 maxilla, 1 frontal, 6 zygomatics, 5 temporals, 4 parietals, 2 paroccipitals, 1 bulla, 1 squamosal, 20 mandibles, 8 permanent incisors, 1 deciduous incisor, 19 permanent premolars, 16 permanent molars, 5 atlases, 4 cervical vertebrae, 11 thoracic vertebrae, 50 lumbar vertebrae, 1 sternebra, 18 scapulae, 14 humeri, 17 radii, 18 ulnae, 4 metacarpals, 37 innominates, 32 femora, 35 tibiofibulae, 1 fibula, 3 calcanei, 2 tarsals, 69 metatarsi, 2 metapodials, 6 proximal phalanges, 1 medial phalanx

(total NISP = 423)

Remarks: It is likely that most of the specimens represented in this category could be identified more specifically to the family Leporidae. However, the UNT collection does not have a pika (*Ochotona princeps*) reference specimen, and the Northern Rio Grande region, specifically the higher elevations of the Sangre de Cristo Mountains, is where the distribution of this species is focused within the state (Frey and Yates, 1996). The specimens identified to Lagomorpha were either too fragmented or their morphology too conserved across allied species to justify a more specific taxonomic identification.

The potential to confuse the postcranial remains of jackrabbits with cottontails (and vice versa) is considerable because the main characteristic that is used to tell jackrabbits from cottontails is size. When ontogenetic, geographic, and sexual differences in body size are taken into account, differentiating between these two genera becomes more difficult. It is assumed in this report that differences in size can be used to distinguish the genera, and the specimens that were allotted to *Lepus* or *Sylvilagus* were complete enough to gauge body size.

Family Leporidae (jackrabbits and cottontails)

Lepus spp. (jackrabbit or hare)

Identified specimens: 1 cranial fragment, 2 maxillae, 1 zygomatic, 2 parietals, 2 bullae, 1 occipital condyle, 8 mandibles, 5 premolars, 1 molar, 3 atlases, 1 sternebra, 7 scapulae, 10 humeri, 10 radii, 12 ulnae, 12 innominates, 9 femora, 22 tibiofibulae, 6 calcanei, 1 astragalus, 1 tarsal, 14 metatarsi, 1 metapodial

(total NISP = 132)

Remarks: In New Mexico, among the members of the genus *Lepus*, the black-tailed jackrabbit (*Lepus californicus*) is the most common (Flinders and Chapman, 2003). The white-tailed jackrabbit (*L. towsendii*) also occurs in a small north-central portion of the state, and the furthest southern extent of the snowshoe hare (*Lepus americanus*) occurs in the Sangre de Cristo Mountains (Frey and Malaney, 2006). The specimens here were assigned to *Lepus* based off of their large size.

Sylvilagus spp. (cottontails)

Identified specimens: 5 cranial fragments, 4 premaxillae, 9 maxillae, 1 temporal, 1 basioccipital, 1 bulla, 48 mandibles, 2 incisors, 1 unknown incisor, 2 premolars, 1 unknown premolar, 4 molars, 2 atlases, 2 axes, 3 sacra, 19 scapulae, 35 humeri, 28 radii, 20 ulnae, 2 metacarpi, 25 innominates, 30 femora, 30 tibiae, 13 calcanei, 2 astragali, 20 metatarsi

(total NISP = 310)

Remarks: It is possible that three cottontail species were procured by the inhabitants of Ponsipa: the eastern cottontail (*Sylvilagus floridanus*), Nuttall's cottontail (*S. nuttallii*), and the desert cottontail (*S. audubonii*). These species can generally be told apart based off of cranial characteristics (see Hall, 1951; Nelson, 1909). Specimens here were assigned to the genus level because no intact lagomorph skulls were identified from the assemblage.

Order Rodentia (rodents)

Identified specimens: 2 cranial fragments, 1 nasal, 1 maxilla, 1 lacrimal, 3 parietals, 2 basioccipitals, 3 squamosals, 1 occipital condyle, 5 mandibles, 6 permanent incisors, 1 unknown incisor, 1 permanent premolar, 1 permanent molar, 1 humerus, 2 innominates, 5 femora, 1 tibia

(total NISP = 37)

Remarks: Many of the specimens represented in this category were too small and fragmented to assign to more specific taxa. Rodent teeth can usually be designated to a non-standard description of large or small rodent, but, because of the presence of an intrusive rodent nest (see Woodrat and Small-mammal remarks for more details), the majority of these teeth represented juveniles at unknown age classes and confident body size designations could not be made.

Family Castoridae (beavers)

Castor Canadensis (North American beaver)

Identified specimens: 4 mandibles, 1 scapula, 1 innominate, 2 femora, 1 tibia

(total NISP = 9)

Remarks: The bones from the skeleton of *Castor canadensis* are very recognizable. Beavers have stout skeletal elements that include many prominent features, such as the humerus that has a massive lateral supracondyloid ridge and deltoid tuberosity (see Gilbert, 1980; Olsen, 1964). At Ponsipa, beavers were probably utilized as a food resource, though there are no signs of butchery on these specimens. Harrington and Henderson (1914:21) state, “The beaver was hunted and eaten by the Tewa, and its use as food is said by them to have no ill effect.”

Family Erethizontidae (New World porcupines)

Erethizon dorsatum (North American porcupine)

Identified specimens: 1 maxilla, 1 premolar, 1 humerus, 1 tibia

(total NISP = 4)

Remarks: The range of *E. dorsatum* in North America is extensive, and it encompasses Utah, Colorado, and New Mexico (Roze and Ilse, 2003). The right fragment of the maxilla was the first *E. dorsatum* specimen encountered at Ponsipa, and it included the premolar (P4) and the first molar (M1). The teeth of the porcupine are diagnostic in that the crowns of the cheek teeth are low, the general shape of each tooth is like a rounded rectangle, and the infoldings do not subside with increased wear (Hillson, 2009:98). The postcranial elements are also unique in that they are like *Castor canadensis* in size, but are more elongate and lack many of the chunky protuberances present on beaver skeletal elements.

Family Geomyidae (pocket gophers)

Thomomys spp. (smooth-toothed pocket gophers)

Identified specimens: 7 cranial fragments, 2 premaxillae, 1 zygomatic, 27 mandibles, 1 premolar, 1 scapula, 6 humeri, 2 ulnae, 1 metacarpus, 3 innominates, 10 femora, 2 tibiae

(total NISP = 63)

Remarks: There are two different species of pocket gopher in the region today: Botta’s pocket gopher (*Thomomys bottae*) and the northern pocket gopher (*Thomomys talpoides*). Identification past the genus level was not attempted because of the overlap in skeletal morphology among these species. Considering the fossorial nature of the pocket gopher, it is possible that the individuals present at Ponsipa are intrusive. Although, it is also possible that pocket gophers were utilized as a food resource, as at Arroyo Hondo (Lang and Harris, 1984:21).

The pocket gopher skeleton is heavily built and, in this sense, is like a miniaturized version of the beaver. The humerus of geomyids, like beavers, has a prominent deltoid tuberosity (Olsen, 1964). The skull has a thick, laterally oriented zygomatic arch where the zygomatic plate is steep, and the premaxilla has small incisive foramina. The mandible is bulky and its angular process laterally protrudes (see Elbroch, 2006:295-302). The cheek teeth are also unique in shape, with the premolars forming a figure-eight and the molars forming ovals (Hillson, 2009:98).

Family Heteromyidae (pocket mice, kangaroo rats, kangaroo mice)

Identified specimens: 2 mandibles, 1 innominate, 8 femora, 2 tibiae

(total NISP = 13)

Remarks: It is possible that all the specimens in this category belong to *Dipodomys ordii*. A more conservative family level identification was given to these specimens because they were fragmented in such a way that prevented a confident estimation of size. Also, the UNT collection does not have a kangaroo mouse specimen and overlap in skeletal morphology, especially between difference age classes, could not be assessed.

Dipodomys ordii (Ord’s kangaroo rat)

Identified specimens: 1 bulla, 1 innominate, 4 femora, 4 tibiae

(total NISP = 10)

Remarks: The specimens designated as *D. ordii* were complete enough to confidently gauge size and to assess diagnostic features. The skull of the kangaroo rat is unique in that the anterior portion of the skull is slim and the posterior portion is distended (Elbroch, 2006:315-317). The bulla specimen was, therefore, easily identified. The postcranial specimens are also diagnostic in that they are elongate but have salient features. For instance, the third trochanter on the femur is discrete, unlike its subtle form in *Neotoma* and *Sigmodon*. The tibia of *D. ordii* is slender and straight with the fibula fusing more proximally as compared to *Sigmodon* and *Neotoma*.

Family Muridae (Deer mice, voles, etc.)

Identified specimens: 3 cranial fragments, 1 premaxilla, 7 maxillae, 1 frontal, 1 zygomatic, 2 squamosals, 1 basisphenoid, 11 mandibles, 2 incisors, 1 unknown incisor, 7 permanent molars, 1 atlas, 1 sternebra, 3 clavicles, 6 scapulae, 9 humeri, 9 radii, 8 ulnae, 14 innominates, 18 femora, 2 patella, 27 tibiae, 2 fibulae, 4 calcanei, 3 astragali, 6 tarsals, 26 metatarsi, 1 metapodial, 7 proximal phalanges, 1 medial phalanx

(total NISP = 185)

Remarks: The evolutionary history of murids is convoluted, and, here, it is important to note that specimens designated to this classification could belong to either families Muridae (commonly referred to as Old World rats, mice, and allies) or Cricetidae (commonly referred to as New World rats, mice, and allies). This is in following the vertebrate identification manual used for Crow Canyon Archaeological Center. A more accurate classification for these specimens might be the superfamily Muroidea (for more information see Musser and Carleton, 2005).

The specimens in this category were complete enough to assess general body size and minor diagnostic characteristics. This allowed the specimens to be differentiated from members of the suborders Sciuromorpha (squirrels and allies), Hystricomorpha (porcupines and allies), and Castorimorpha (beavers, pocket gophers, kangaroo rats, and kangaroo mice), but it did not allow for a more specific identification.

Neotoma spp. (woodrats)

Identified specimens: 7 cranial fragments, 2 facial fragments, 1 maxilla, 2 temporals, 3 bullae, 19 mandibles, 1 incisor, 6 molars, 2 clavicles, 7 scapulae, 13 humeri, 5 radii, 10 ulnae, 13 innominates, 21 femora, 18 tibiae

(total NISP = 130)

Remarks: *Neotoma* is the most abundant rodent identification made to the genus level at Ponsipa. It seems there was an intrusive woodrat nest in the assemblage, which consisted of almost 600 specimens. The presence of a nest was evidenced by a high degree of skeletal completeness in microfaunal specimens from levels seven and eight of excavation unit 79-1 (PD 66 FS 2 and PD 67 FS 1). There was also a higher proportion of unfused elements compared to fused elements of specimens from these two contexts. Many specimens belonging to this nest were identified above as small-mammal, to the family Muridae (though the woodrat belongs to the family Cricetidae, see remarks above), or to Rodentia because the majority of specimens were unfused, diagnostic characteristics were absent, and identification by association was avoided. On this basis, the microfaunal specimens from PD 66 and 67m should be excluded from any future analysis of animal procurement and subsistence at Ponsipa.

The woodrat is somewhat similar in size and general skeletal morphology to the cotton rat (*Sigmodon hispidus*). Therefore, these taxa can be difficult to tell apart. They, however, can easily be told apart by tooth morphology and some cranial and postcranial characteristics. *Sigmodon* spp. have an S-shaped occlusal pattern on their teeth and *Neotoma*'s are more V-shaped (see Hillson, 2009:78). The skull of the woodrat does not have protruding anterior maxillary extensions, as in *Sigmodon*, and the mandible has a more narrow condyloid process (Elbroch, 2003:334-339). Postcranially, it is more difficult to distinguish between the two. However, in *Neotoma*, the deltoid tuberosity of the humerus projects more gradually; the radius and ulna are straight in shape, with the ulna having a small olecranon; the tibia is straight in shape and the medioproximal part of the diaphysis is wide; and the femur is generally larger with an indistinct intertrochanteric crest (see Olsen, 1964).

Rodent gnawing is the most abundant non-human related taphonomic signature at Ponsipa (Fig. 10), and was extensive on some elements (Fig. 10). It is likely that woodrats were the taphonomic agents because of their abundance at the site.

Peromyscus spp. (deer mice)

Identified specimens: 4 cranial fragments, 19 mandibles, 1 scapula, 1 humeri, 2 innominates, 4 femora, 2 tibiae

(total NISP = 33)

Remarks: Bailey (1931) explains that there are ten members of the genus *Peromyscus* in the State of New Mexico, while Henderson and Harrington (1914:20) note the presence of three species of deer mice around the Pajarito Plateau. Specifically, they remark on the presence of the tawny deer mouse (*P. perfulvus*), the white-footed mouse (*P. leucopus*), and the pinyon mouse (*P. truei*). The white-footed mouse is associated with open habitats while the tawny deer mouse occupies areas of dense forest and the pinyon mouse is found around rocky substrates (Bailey, 1931).

Specimens of the Ponsipa fauna that were assigned to this category were done so using nine comparative specimens from the UNT collection. Identification past the genus level was not attempted because overlap in skeletal morphology among these congeners is significant.

Sigmodon spp. (cotton rats)

Identified specimens: 1 cranial fragment, 1 zygomatic, 1 mandible, 1 humerus

(total NISP = 4)

Remarks: The remains of *Sigmodon* identified from Ponsipa likely belong to *S. hispidus* because their current southern extent is bounded by the Rio Grande in the southwestern United States (Carrol et al., 2005). The skull of the cotton rat can be differentiated by the anterior maxillary extensions, and by the mandible, which has a stubby condyloid process (Elbroch, 2006:332-333). Postcranially, the humerus has a pronounced deltoid tuberosity; the radius and ulna are curved, with the ulna having a large olecranon; the tibia is also curved; and the femur has a well-defined intertrochanteric crest.

Family Sciuridae (squirrels)

Identified specimens: 5 mandibles, 2 scapulae, 7 humeri, 2 radii, 4 ulnae, 4 femora, 5 tibiae

(total NISP = 29)

Remarks: Large ground squirrels (*Spermophilus* spp.) and prairie dogs (*Cynomys* spp.) are difficult to separate. In regards to the rock squirrel, Henderson and Harrington (1914:22) state, “The Tewa eat the flesh but do not use the skin.” One sciurid specimen in the Ponsipa assemblage was burned white. It is possible that squirrels were utilized as a food resource at Ponsipa, though the evidence is meager.

Cynomys spp. (prairie dogs)

Identified specimens: 1 maxilla, 1 mandible, 1 humerus, 1 innominate, 3 tibiae

(total NISP = 7)

Remarks: The specimens identified as *Cynomys* spp. were complete enough to gauge diagnostic characteristics. The maxilla is characterized by well-developed maxillary processes and the notch between the condyloid and angular process is deep and more V-shaped, like a narrow parabola, compared to the rock squirrel (*Spermophilus variegatus*) (Elbroch, 2006:283-284). The distal humerus has a slender piece of bone that makes up the anterior portion of entepicondylar foramen and the lateral supracondyloid ridge is restricted. Finally, on the distal end of the tibia the medial malleolus extends farther down.

Subfamily Xerinae (Holarctic ground squirrels)

Tribe Marmotini (ground squirrels)

Identified specimens: 1 maxilla, 4 mandibles, 4 humeri, 6 femora, 1 tibia

(total NISP = 16)

Remarks: The specimens in this category were small-bodied ground squirrels, and the identification given to them through the Crow Canyon manual was simply: Ground Squirrels. These specimens could belong to the genus *Ammospermophilus* (antelope squirrels) or to *Spermophilus* (common ground squirrels). A more specific identification could not be defended because the skeletal morphology is undoubtedly similar between the two genera and the UNT collection does not have antelope squirrel comparative specimens.

Non-standard descriptions for rodents

Large Rodent (rodent larger than woodrat)

Identified specimens: 2 permanent incisors, 3 sternebra

(total NISP = 5)

Remarks: These hypsodontic teeth were large permanent tooth fragments that clearly showed the characteristic folding patterns of rodent teeth. The sternebra specimens, on the other hand, are not easily identifiable because they lack diagnostic characteristics but compare favorably to the microfauna in the UNT collection.

Non-standard descriptions for mammals

Small mammal (jackrabbit size or smaller)

Identified specimens: 1 cranial fragment, 1 nasal, 2 premaxillae, 3 maxillae, 1 zygomatic, 2 parietals, 1 temporal, 2 bullae, 5 mandibles, 14 incisors, 3 unknown tooth fragments, 6 atlases, 4 axes, 34 cervical vertebrae, 43 thoracic vertebrae, 79 lumbar vertebrae, 4 sacra, 21 caudal vertebrae, 57 vertebrae, 1 sternebra, 255 ribs, 7 scapulae, 8 humeri, 11 radii, 2 ulnae, 7 metacarpi, 25 innominates, 20 femora, 1 patella, 22 tibiae, 2 fibulae, 1 calcaneus, 1 astragali, 20 metatarsi, 35 metapodials, 28 proximal phalanges, 7 medial phalanges, 1 terminal phalanx, 9 foot phalanges

(total NISP = 746)

Remarks: Many of these specimens originate from what seems to be an intrusive woodrat nest, and, of the specimens assigned to this category, many were unfused epiphyses and diaphysis that lacked diagnostic characteristics. Because identification by association was avoided, these juvenile specimens could have represented multiple orders in the class Mammalia. Due to their size it is likely they either belonged to the orders Rodentia or Lagomorpha, which were common at Ponsipa. Thus, this conservative identification was chosen often. All other bones represented in this category were too fragmented to receive a confident identification past this body size level.

Medium mammal (deer size or smaller)

Identified specimens: 3 cranial fragments, 6 unknown tooth fragments, 4 thoracic vertebrae, 2 lumbar vertebrae, 2 caudal vertebrae, 6 vertebrae, 65 ribs, 4 scapulae, 1 humerus, 2 radius, 4 ulnae, 6 innominates, 6 femora, 5 tibiae, 2 ossified costal cartilage fragments

(total NISP = 118)

Remarks: The majority of specimens in this category are fragments of skeletal elements that are difficult to identify in skeletons of most taxa, such as vertebrae and ribs (Olsen, 1961). Other specimens that are classified as medium mammal were too fragmented to warrant any further taxonomic identification.

Large mammal (larger than deer)

Identified specimens: 3 ribs

(total NISP = 3)

Remarks: These ribs are represented by two shaft fragments and one dorsal fragment. When compared with the UNT collection, they were larger than deer ribs but smaller than bison ribs. In other words, these ribs were elk-sized.

Class Aves (birds)

Order Anseriformes (waterfowl)

Identified specimens: 1 sternum, 1 carpometacarpus, 1 second phalanx

(total NISP = 3)

Remarks: There are two general body size categories among waterfowl that are found in the Northern Rio Grande, where surface feeding ducks constitute a medium body size and geese and swans represent a large body size. The specimens here were fragmented in such a way that a clear estimation of body size could not be determined, but a general order level identification was settled upon with comparison to the waterfowl in the UNT collection.

Family Anatidae (ducks, geese, and swans)

Subfamily Anatinae (ducks)

Tribe Anatini (surface feeding ducks)

Identified specimen: 1 furculum

(total NISP = 1)

Remarks: Duck furcula are unique and can be differentiated from other members of the order Anseriformes, specifically geese and swans, by body size and some basic morphological characteristics (Serjeantson, 2009:73-74). The general morphological features used to distinguish this ventral specimen were the curvature of the furcula and the distinctness of the furcular process. In *Branta* the furculum is more robust, has a distinct furcular process, and is more V-shaped. The surface feeding ducks, however, have a smaller furculum that is more U-shaped with a furcular process that is less projected.

Subfamily Anserinae (geese and swans)

Identified specimen: 1 coracoid

(total NISP = 1)

Remarks: This specimen compared more favorably to the Canada goose (*Branta canadensis*), and it is likely that it belongs to this species because they are common in the area. However, three different geese of three different genera have been reported along the Rio Grande: the snow goose (*Chen caerulescens*), white-fronted goose (*Anser albifrons*), and brant goose (*Branta bernicla*) (Henderson and Harrington, 1914:33). Snow goose, Canada goose, and white-fronted goose reference specimens were utilized for this identification, and the UNT collection does not have a brant goose. Therefore, a subfamily level identification was given to this coracoid specimen. A tribe level identification is probably most accurate, but the Crow Canyon Manual does not utilize the designation Anserini. This coracoid specimen was a proximal fragment, and was distinguished from ducks based off of its robustness and from the presence of a deep scapular facet.

Order Ciconiiformes (herons, egrets, and ibises)

Identified specimen: 1 humerus

(total NISP = 1)

Remarks: This distal humerus fragment was medium size and elongate, and unlike any bird specimen encountered at Ponsipa. Ultimately, it compared best with the snowy egret (*Egretta thula*). Other members of the order Ciconiiformes were used in comparison as well, which included the great blue heron (*Ardea herodias*), the black-crowned night heron (*Nycticorax nycticorax*), and the white ibis (*Eudocimus albus*). One species that could possibly overlap in skeletal morphology with the snowy egret is the American bittern (*Botaurus lentiginosus*), and the UNT comparative collection does not have an American bittern reference specimen. A broader order-level identification was settled upon for two reasons: first, and most important, the fragment was small and did not include much of the diaphysis, and second, the specimen could not be compared with the breadth of ciconiiforms that occur in the region.

Order Columbiformes (pigeons and doves)

Family Columbidae (doves)

Zenaida macroura (mourning dove)

Identified specimens: 1 sternum, 1 coracoid, 2 humeri

(total NISP = 4)

Remarks: Today, mourning doves are abundant in the Northern Rio Grande region (Amy and Cook, 2012), and their historical abundance seems to have changed little (Henderson and Harrington, 1914:35, Bailey, 1928:7). Though Henderson and Harrington (1914:4) doubted its dietary significance, it has been documented as a food item among Puebloan people (Bailey, 1940).

The general shape of mourning dove elements share similar characteristics with some medium-sized parrots. The only medium-sized parrot that has been documented from archaeological sites in the state of New Mexico is the thick-billed parrot (*Rhynchopsitta pachyrhyncha*), though two large-sized parrots have been recorded (see Passeriformes below). Zooarchaeological burials of thick-billed parrots have been reported from Pueblo Bonito (Judd, 1954) and its presence is depicted in kiva murals from Pottery Mound (Vivian, 2007:98), which suggests that parrots were of cultural significance to Ancestral Puebloans in New Mexico. It is, therefore, important to explicitly state the characteristics that distinguish mourning doves from the thick-billed parrot, and vice versa.

Though mourning doves are smaller than thick-billed parrots and can be distinguished in some circumstances based off of this attribute (see Olsen, 1967, 1979:154), it is possible there is overlap in body size between the two species when ontogenetic, geographic, and sexual differences are taken into account. Furthermore, this problem is compounded when dealing with fragments of skeletal elements, which zooarchaeologists often encounter.

The humeri represented at Ponsipa were distinguished from thick-billed parrots based off of the presence of a developed brachial depression on the distal portion of the diaphysis and the presence of a pointed deltoid crest (Olsen, 1979:154). The morphology of the distal portion of the coracoid, where the sterno-coracoidal fossa is, is significantly different among these two species. Though, among mourning doves, it is prone to snapping off because it is so laterally elongated. The distal portion, therefore, might not always be a good way to separate these two taxa. The proximal portion of the coracoid is, however, different in the mourning dove in that the head of the element is more curved in shape, and the procoracoid is more robust. Finally, the sternum element represented at Ponsipa, derived from an anterior fragment, was differentiated from thick-billed parrot by the distinct bulges that occur, right under the manubrium, on the lateral portions of the keel.

Order Falconiformes (vultures, hawks, eagles, and allies)

Identified specimens: 1 radius, 3 ulnae, 1 tibiotarsus, 1 second phalanx, 1 third phalanx (total NISP = 7)

Remarks: Through phylogenetic studies, members of the order Falconiformes have been reassigned to a broader taxonomic group (Hackett et al., 2008). This clade is known as Acciptrimorphae (Jarvis et al., 2014). Like many broad-level identifications at Ponsipa, the specimens in the Falconiformes category were either fragmented in such a way as to preclude a more specific taxonomic designation or the morphology of the element was too conserved among closely related species. Only general morphological characteristics were used to separate these specimens. The main diagnostic features used to distinguish these specimens from other orders of birds were size and the presence of highly developed ridges, which are especially conspicuous on the hindlimb portions. These ridges are characteristic of raptors because they are sites of enhanced muscle and ligament attachment, which assists in prey acquisition. These specimens were separated from the order Strigiformes (owls) by comparison with multiple reference specimens that included great horned owl (*Bubo virginianus*), barn owl (*Tyto alba*), and eastern screech owl (*Megascops asio*) and compared best with either hawks or vultures, which are most abundant at the site. It is also interesting to note that the ulna and radius elements show clear signs of human modification through the groove-and-snap technique.

Family Acciptridae (hawks and eagles)

Buteo spp. (hawks)

Identified specimens: 1 furculum, 1 coracoid, 2 humeri, 2 radii, 3 ulnae, 1 carpometacarpus, 1 femur, 4 tarsometatarsi, 4 proximal phalanges, 3 second phalanges, 3 thirds phalanges, 1 terminal phalanx

(total NISP = 26)

Remarks: The red-tailed hawk (*Buteo jamaicensis*) was one of the most historically abundant hawk species in the region (Henderson and Harrington, 1914:36; Cartron et al., 2010). Additionally, it has been ethnographically documented that the Tewa utilized red-tailed hawk feathers for certain rituals and ceremonies (Bailey, 1928:163), and even removed whole hawk wings for use as fans (Lang and Harris, 1984:131). Thus, it is not surprising that all of the specimens here compared favorably to this ubiquitous raptor.

A genus level identification was settled upon because the UNT collection only had one member of the genus *Buteo*, and it was the red-tailed hawk. In the region, the comparative specimens that are required to identify species in the genus are Swainson’s hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), rough-legged hawk (*Buteo lagopus*), and the zone-tailed hawk (*Buteo albonotatus*). Many of the Ponsipa specimens were complete, and some could even be articulated (Fig. 11). Other specimens showed signs of human modification through localized burning and the groove-and-snap technique (Fig. 11).

Family Cathartidae (New World vultures)

Cathartes aura (turkey vulture)

Identified specimen: 1 ulna

(total NISP = 1)

Remarks: In the early 1900's, the Tewa knew the turkey vulture to be most abundant in the mountains of the Northern Rio Grande region (Henderson and Harrington, 1914:36). Bailey (1928:153) noted that she once saw 20 to 30 turkey vultures circling above in Chama Canyon. Today, in the Northern Rio Grande, they are abundant from March until October (Travis, 1992).

This distal ulna fragment was compared to both turkey vulture and black vulture (*Coragyps atratus*) because, though black vulture is not abundant in the state, it is known to occur (Cartron, 2010). The distal portion of the ulna differs in that the styloid process is more pronounced compared to the black vulture. Also, the wingspan of the turkey vulture is larger, and, as a result, their ulnae are more robust. This ulna specimen also compared in size to the turkey vulture.

One of the more interesting types of bone artifacts from Ponsipa is the bone whistle, and many of the whistle artifacts found at Ponsipa compare favorably in terms of morphology to long bones of the turkey vulture (see Large bird remarks). Burger et al. (2014) noted a similar pattern among the bone whistles from Sapawe, a site that is close to Ponsipa. Ultimately, these specimens were not assigned to turkey vulture because they were highly worked and lacked the distal and proximal ends. Therefore, diagnostic criteria could not be assessed.

Order Galliformes (grouse, turkeys, and quail)

Identified specimens: 1 mandible, 1 sternum, 1 carpometacarpus, 2 tibiotarsi

(total NISP = 5)

Remarks: Specimens were assigned to this category because they could not be distinguished from quails or grouse. The reference specimens used to determine such overlap in skeletal morphology were the dusky grouse (*Dendragapus obscurus*), king quail *(Coturnix chinensis*), Gambel's quail (*Callipepia gambelii*), and the northern bobwhite (*Colinus virginianus*).

Family Phasianidae (pheasants, quail, junglefowl, etc.)

Identified specimens: 2 humeri

(total NISP = 2)

Remarks: Four species of quail are native to New Mexico: Gambel's quail, scaled quail (*Callipepla squamata*), northern bobwhite, and the Montezuma quail (*Cyrtonyx montezumae*). The scaled quail is the most ubiquitous, and it is likely the species represented at Ponsipa (Bailey, 1928:212-228). Large flocks of scaled quail were said to inhabit the Rito de Los Frijoles, which is located in Bandelier National Monument (Henderson and Harrington, 1914:33). Specimens identified to the family Phasianidae compared favorably to reference specimens of the king quail, Gambel's quail, and the northern bobwhite. The identification Phasianidae may not be the most appropriate considering that New World quails are a family in and of themselves (Odontophoridae), but this was the identification used for the Crow Canyon manual.

Meleagris gallopavo (wild turkey)

Identified specimens: 5 cranial fragments, 1 nasal, 2 maxillae, 5 quadrates, 9 mandibles, 1 axis, 3 sternums, 2 furcula, 16 coracoids, 11 scapulae, 14 humeri, 3 radii, 12 ulnae, 14 carpometacarpi, 5 carpals, 2 wing phalanges, 1 innominate, 2 synsacra, 6 femora, 13 tibiotarsi, 4 fibulae, 8 tarsometatarsi, 13 proximal phalanges, 3 second phalanges, 1 terminal phalanx

(total NISP = 157)

Remarks: The turkey is one of the most unique members of the family Phasianidae in the Northern Rio Grande region because it is large. Size was a major characteristic that separated these specimens from other avian specimens found at Ponsipa, but it was not the most important one. Though the turkey is unique among phasianids, there is overlap in skeletal morphology with the sandhill crane (*Grus canadensis*). Therefore, the diagnostic characteristics that were reported by Hargrave and Emslie (1979) were followed closely, and comparisons were made at the Vertebrate Paleontology Lab with multiple *G. canadensis* individuals. An overwhelming majority of the specimens in the large-bird category exhibited similar morphology to the turkey, but the large-bird category was often chosen for two reasons. First, as stated, there is overlap with the sandhill crane, and second, specimens identified as large bird are often included in analyses of turkey exploitation in the American Southwest (Driver, 2002; Badenhorst and Driver, 2009). The conservative designation of large bird also avoids the problem of identification by association.

In regards to avian games species, Henderson and Harrington (1914:4) note that the grouse and turkey were the most important taxa exploited by the Tewa. The authors also remark on an ongoing debate in southwestern archaeology (some 100 years later) concerning the widespread domestication of the turkey and exactly how its primary function changed through time in Puebloan cultures. Undoubtedly, the use of the turkey as a food source increased through time in the Mesa Verde region (Badenhorst and Driver, 2009). After the abandonment of the Mesa Verde area it is likely that the northern Rio Grande became one of the most important areas of turkey domestication (Munro, 2012).

There is clear evidence for the practice of turkey husbandry at Ponsipa, and it might be one of the clearer cases in the Tewa Basin. In the third component of the site, room 79-2 is an area where turkey penning was initially evidenced by the layers of turkey dung that were excavated (Bugé, 1979:3). Through analysis of the Ponsipa fauna, a female turkey burial in room 79-2 was identified, where the sex of the individual is based on the lack of a spur on the tarsometatarsus. Finally, in the same unit, eggshell and juvenile large bird remains were identified (Fig. 12). Though multiple lines of evidence suggest that the juvenile specimens were from *M. gallopavo*, identification by association was avoided and large bird was an appropriate identification because only body size could be inferred from the specimens, and the UNT collection does not have juvenile turkey comparative specimens.

Subfamily Tetraoninae (grouse)

Identified specimen: 1 tibiotarsus

(total NISP = 1)

Remarks: The dusky grouse (*Dendragapus obscurus*) was historically abundant near the Jemez Moutains, and considered an important food bird for the Tewa (Henderson and Harrington, 1914:34). This one tibiotarsus compared favorably to the dusky grouse (*Dendragapus obscurus*), but a species specific identification was not assigned because the UNT collection does not have a Gunnison sage-grouse (*Centrocercus minimus*) reference specimen or a sharp-tailed grouse (*Typmanuchus phasianellus*) specimen. These two species historically occurred in the northern Rio Grande region, though in limited numbers (Aldrich, 1963; Schroeder et al., 2004).

Order Gruiformes (cranes, rails, and soras)

Family Rallidae (rails and soras)

Identified specimens: 1 humerus, 1 ulna

(total NISP = 2)

Remarks: Two comparative taxa were used to assign these specimens to the family Rallidae: *Porzana carolina* (sora) and *Rallus elegans* (king rail). The only other family of Gruiformes in the region is Gruidae, and the only species of that family that is represented is the sandhill crane (*Grus canadensis*), which is a large bird with robust skeletal morphology. These specimens were not robust and could be separated from Gruidae based on size. The identifications were, however, not taken further because these specimens were not compared to the full suite of rails that exist in the region.

Order Passeriformes (perching birds)

Family Corvidae (jays and crows)

Identified specimens: 2 furcula, 2 coracoids, 1 scapula, 2 humeri, 3 carpometacarpi, 2 tibiotarsi, 1 tarsometatarsi

(total NISP = 13)

Remarks: All of these specimens were raven-sized, but postcranial separation of corvids based upon body size is unreliable (Serjeantson, 2009:76). The UNT collection does not have a magpie, and, therefore, a more conservative identification was settled upon.

Family Icteridae (blackbirds and orioles)

Identified specimen: 1 coracoid

(total NISP = 1)

Remarks: This coracoid specimen compared well with the western meadowlark (*Sturnella neglecta*), based on the pinched neck, the hook-shaped head, and the thin shaft of the element. A number of icterids occur in the region and it was somewhat difficult to distinguish this specimen from other members in the family, such as the Bullock’s oriole (*Icterus bullockii*) and the great-tailed grackle (*Quiscalus mexicanus*).

Family Psittacidae (parrots)

Ara spp.

Identified specimens: 1 sternum, 1 furculum

(total NISP = 2)

Remarks: Henderson and Harrington (1914:45), state that macaws were highly prized for their feathers by the Tewa and that a macaw, at the time, was kept in a cage at Santa Domingo Pueblo. Both military macaw (*Ara militaris*) and scarlet macaw (*Ara macao*) are known to have occurred in Ancestral Puebloan sites in New Mexico (Judd, 1954; Olsen, 1967; Lang and Harris, 1984). These specimens were taken to the University of Texas Vertebrate Paleontology Laboratory, but the collection only included a military macaw. The general shape of the coracoidal groove on the sternum and the robust V-shape of the furculum were similar to the military macaw, but the morphology of the foramina that occurs in the middle of the coracoidal groove and the shape of the furcular process were not. A scarlet macaw burial was reported from Arroyo Hondo, which is one of the largest zooarchaeological datasets in the region. It is possible that these specimens belonged to a scarlet macaw. The sternum fragment compared favorably with a digital scan of a hyacinth macaw (*Anodorhynchus hyacinthinus*) sternum (from www.aves3d.org), though it is unlikely that this specimen is from a hyacinth macaw. These two specimens were coded as passeriformes because the Crow Canyon manual does not have designations for these large-bodied parrots.

Family Turdidae (thrushes)

Identified specimens: 1 coracoid, 1 humerus, 1 carpometacarpus

(total NISP = 3)

Remarks: Specimens assigned to Turdidae compared favorably to Swainson’s thrush (*Catharus ustulatus*) and to the American robin (*Turdus migratorious*).

Non-standard descriptions for birds

Small bird (robin size and smaller)

Identified specimens: 1 mandible, 1 sternum, 1 scapula, 3 humeri, 1 ulna, 1 carpometacarpi, 1 tibiotarsus, 3 tarsometatarsi

(total NISP = 12)

Remarks: These specimens were too fragmented and too small to confidently identify them past a general body size designation. It is likely they belong to the order Passeriformes, considering it is the most diverse order of small birds, and it is unlikely they represent food items due to their small size.

Medium bird (mallard size and smaller)

Identified specimens: 2 mandibles, 3 cervical vertebrae, 1 vertebrae, 1 rib, 3 sternums, 2 scapulae, 2 humeri, 2 radii, 3 ulnae, 2 carpometacarpi, 1 innominate, 2 tibiotarsi, 1 second phalanx, 1 third phalanx

(total NISP = 26)

Remarks: Specimens here could represent multiple species of birds, and they could not be distinguished further because the elements are too similar in morphology among species or they are too fragmented.

Large bird (larger than mallard)

Identified specimens: 6 cranial fragments, 1 sphenoid, 1 zygomatic, 1 occipital condyle, 3 quadrates, 14 mandibles, 2 atlases, 75 cervical vertebrae, 4 thoracic vertebrae, 13 caudal vertebrae, 14 vertebrae, 1 pygostyle, 54 ribs, 7 sternal ribs, 11 sternums, 2 furcula, 13 coracoids, 12 scapulae, 18 humeri, 19 radii, 21 ulnae, 5 carpals, 1 carpometacarpus, 2 wing phalanges, 5 innominates, 9 synsacra, 14 femora, 16 tibiotarsi, 4 fibulae, 1 tarsal, 36 tarsometatarsi, 22 proximal phalanges, 7 second phalanges, 10 third phalanges, 6 terminal phalanges, 45 foot phalanges, 15 ossified tendons

(total NISP = 490)

Remarks: It is often assumed that large-bird remains in the American Southwest are from turkey (Driver, 2002). However, the sandhill crane and turkey can sometimes be difficult to tell apart (see *Meleagris gallopavo* remarks above). Therefore, many specimens were conservatively identified to this category.

Four bone whistles, identified as large bird, were recovered from the second component of the site (Fig. 13), and three of the four whistles compare favorably to the turkey vulture. Bone whistles and flutes were manufactured from a range of large birds, such as eagles and turkeys, and sometimes mammals (Judd, 1954; Payne, 1991). Their use seems to be multifunctional, but is primarily associated with either turkey sound imitation or as a musical instrument (Payne, 1991). In the American Southwest, the Northern Rio Grande region has the highest abundance of bone flutes and whistles (Brown, 1964:71), and it is interesting to note that, in the literature, theories as to why this might be have not been posited.

Superclass Osteichthyes (bony fishes)

Class Actinopterygii (ray-finned fishes)

Identified specimens: 2 cranial fragments, 1 presphenoid, 63 vertebrae, 1 caudal vertebra, 11 ribs

(total NISP = 78)

Remarks: Although the identification assigned to these specimens is ‘Pisces, this informal category is too broad. Osteichthyes is more appropriate because this term refers to bony fishes in general. Furthermore, the class designation Actinopterygii is more accurate because no sarcopterygians (lobe-finned fishes) are known to have occurred in the Rio Grande drainage during this time period. Neopterygians (such as gar and carp) and chondrosteins (such as sturgeon) are the two subclasses that make up the Actinopterygii, and both have been historically and prehistorically reported in the region (Gehlbach and Miller, 1961; Snow, 2002).

In regards to the dietary significance of fish among the Tewa, Henderson and Harrington (1914:3) write, "There were undoubtedly fish in all the important streams, but they could not have been numerous enough to have played a large part in sustaining the number of people who lived in the region, even if the latter were no more numerous than at the time of the Spanish conquest." Snow (2002) challenged this long held perspective about the low dietary utility of fish in the region by calling upon extensive ethnographic evidence. She explains that mass seining events took place, which could last for days until everyone in the village had enough to eat. The utility of fish is an exciting area for future zooarchaeological research in the Northern Rio Grande region.

Order Cypriniformes (carps, minnows, and suckers)

Family Catostomidae (suckers)

Identified specimens: 3 cleithra, 1 parasphenoid, 2 scapulars, 2 basipterygia, 1 tripus, 2 first vertebrae, 2 second vertebrae, 1 third vertebra, 1 neural complex, 1 ultimate vertebra, 2 dorsal spines, 2 suspensorial pleural ribs

(total NISP = 20)

Remarks: Every specimen assigned to this taxon compared favorably to the blue sucker (*Cycleptus elongatus*). The specimens, however, derived from elements that are usually conserved among congeners, such as ribs and vertebrae, or that were fragmented and less identifiable.

Cycleptus elongatus (blue sucker)

Identified specimens: 1 maxilla, 1 hyomandibula, 2 cleithra, 1 parasphenoid, 1 urohyal, 1 operculum, 2 basipterygia, 1 pharyngeal

(total NISP = 10)

Remarks: There is current evidence suggesting that the blue suckers present in the state of New Mexico represents their own species (Bessert, 2006). Taxonomic designation of the specimens from Ponsipa may be changed to *Cycleptus speratus* in the near future as suggested by Bessert (2006).

Branson (1962) and Gehlbach and Miller (1961) provide the osteological criteria for identifying blue sucker at Ponsipa. In the fauna, it is possible that blue sucker skeletal elements could be confused with the river carpsucker (*Carpiodes carpio*), which belongs to the subfamily Ictiobinae. The UNT collection does not have a river carpsucker comparative specimen, but it does have a smallmouth buffalo (*Ictiobus bubalus*). The smallmouth buffalo is present in the Middle Rio Grande, and belongs to the same subfamily as the river carpsucker. The skeletal elements between these closely related species are similar, and the general characteristics used to distinguish the smallmouth buffalo from the blue sucker, which belongs to a separate subfamily (Cycleptinae), appear to conserve across the two ictiobines. The smallmouth buffalo is used as a proxy for the river carpsucker for the purposes of the identifications made at Ponsipa. Also, two comparative blue sucker specimens from the Vertebrate Paleontology Laboratory at the University of Texas were utilized to confirm identifications.

The backward oriented wings of the urohyal are diagnostic in *C. elongatus* (see Smith 1992:786). The Ictiobinae urohyal have lateral wings that are fuller and more laterally oriented. The blue sucker's pharyngeal arch and teeth are robust, and compared to the river carpsucker the pharyngeal arch is thin and the teeth are fine. The opercle of the blue sucker has a rounded posterior angle and anterior margin, while the ictiobines have a sharp posterior angle and a flat to concave anterior margin. *C. elongatus* has an internal process of the maxillary that is dorsoventrally oriented, while it is mediolaterally oriented in the ictiobines. The cleithra of blue sucker have a pinched dorsal narrow strut and a much more robust body; the cleithra of ictiobines are narrow and have a dorsal narrow strut that gradually tapers to a point. The symplectic facet of the hyomandibular is much wider in *C. elongatus*, and is longer and narrower in the ictiobines. The alar process of the parasphenoid in the blue sucker is oriented downwards and the midpart of the parasphenoid body has prongs. Finally, the symphyseal articulation of the basipterygium in *C. elongatus* is dorsoventrally oriented while it is mediolaterally oriented in the Ictiobinae.

Oviparous Animal

Identified specimens: >5 eggshell fragments

(total NISP = 5)

Remarks: There were more than five shell fragments identified from Ponsipa (25 might be more accurate). But many were very small and fragile. Handling these specimens, even to count, was problematic, causing fragmentation. PD 136 FS 3 had the smallest fragments that likely constituted a larger egg specimen when it was first excavated. That particular provenience produced roughly 20 eggshell specimens that were less than 5 mm in length. Thus, each occurrence of eggshell in a new context was treated as a single specimen. Though this method underrepresents the abundance of eggshell specimens, it reduced handling time and the chance of unnecessarily creating more specimens through accidental fragmentation.

These fragments came from both components of the site. The oviparous identification was given because these specimens could possibly represent either reptile or bird shell fragments. It is, however, unlikely that these shell fragments originate from reptile because there were no reptile remains identified at Ponsipa. Some of the fragments were excavated from room 79-2, where there is clear evidence for turkey husbandry. In all likelihood these fragments derive from turkey.

Summary

The Ponsipa fauna could be used for a variety of site level, subregional, and regional zooarchaeological analyses, if more information regarding provenience becomes available. Currently it contributes to a growing regional zooarchaeological database, which is important because regional analyses have recently received a significant amount of attention in the Northern Rio Grande due to the second phase of the Village Ecodynamics Project. This project was initiated in 2009, is ongoing, and focuses on a large area in southwestern Colorado, in addition to the Northern Rio Grande region of New Mexico. Researchers associated with the Village Ecodynamics Project have utilized diverse sources of information and new techniques to model past population sizes, demographics, agricultural productivity, violence, social networks, and, though to a lesser extent, hunting efficiency (see for starters Arakawa et al., 2011; Bocinsky and Kohler, 2014; Kohler and Reese, 2014; Kohler and Varien, 2012, Kohler et al., 2010; Kohler et al., 2014; Ortman, 2012, 2014). In the future, it is possible that the Ponsipa fauna can contribute to a fuller understanding of animal subsistence strategies in the Village Ecodynamics Project study areas.

While some utility of the Ponsipa fauna is set aside for the future, this does not detract from its current utility. The rest of this thesis focuses on the zooarchaeology and biogeography of the blue sucker and its relation to the conservation of the species. The blue sucker is an endangered fish in the state of New Mexico because their populations have been greatly reduced due to modern anthropogenic impacts.

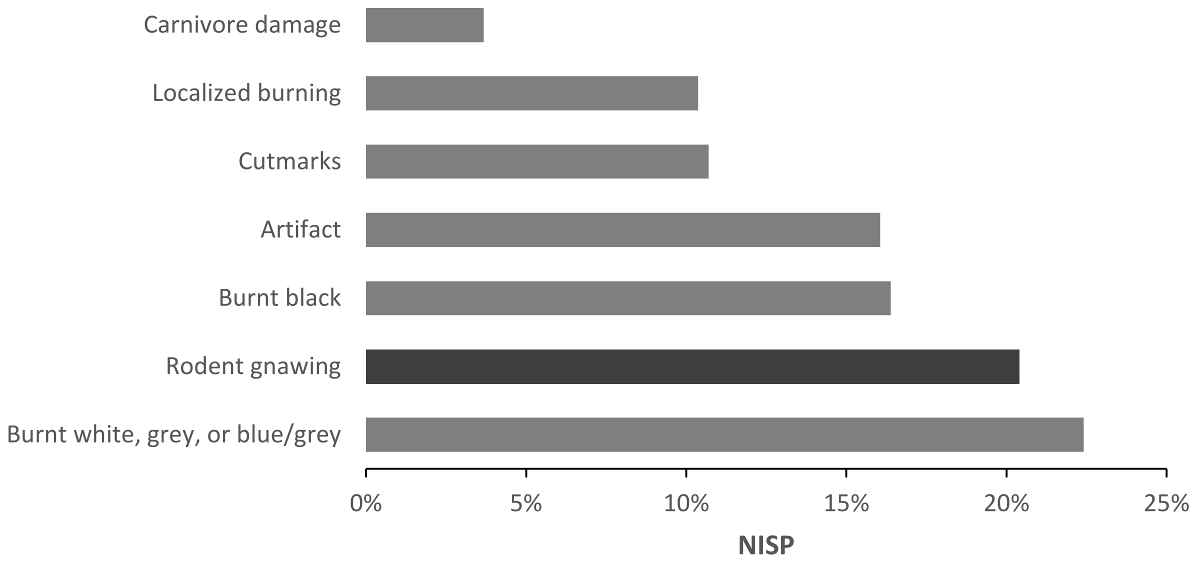


Fig. 9. Abundance of modifications at Ponsipa among identified specimens. Approximately 8% of the identified assemblage had at least one modification type recorded. Rodent gnawing is the second most abundant, and it is the most abundant non-human related modification type.

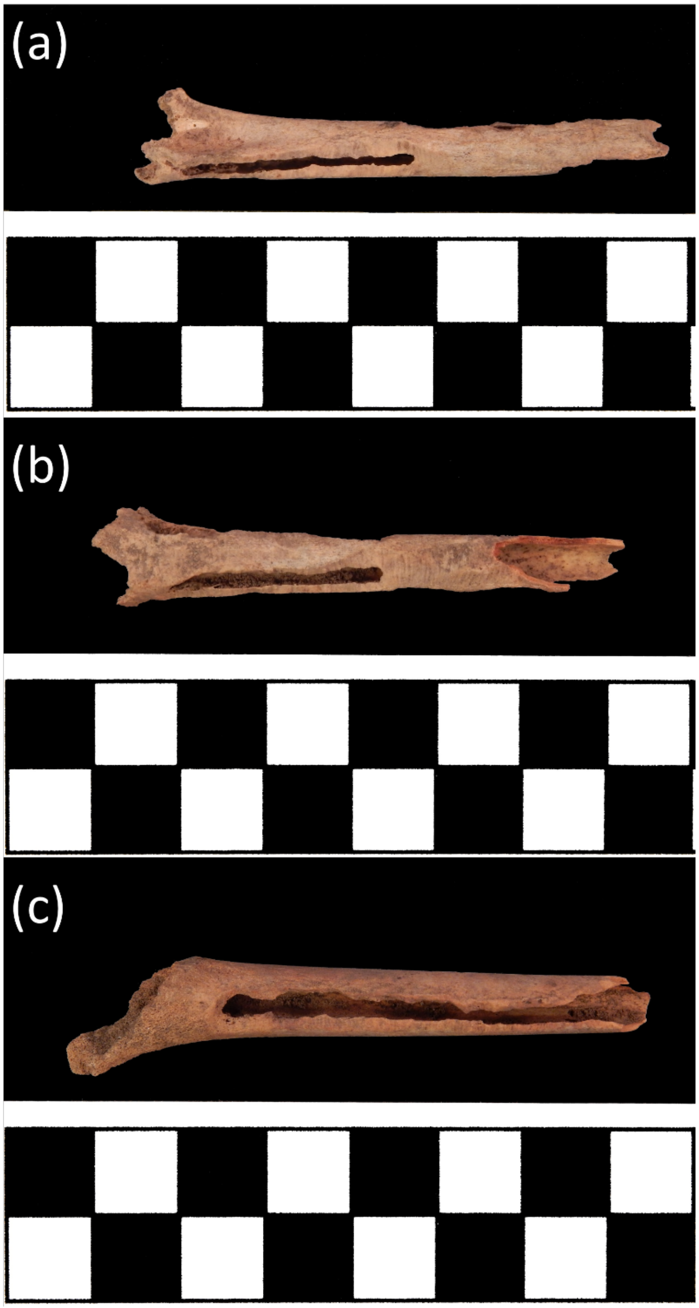


Fig. 10. Examples of extensive rodent damage at Ponsipa on various lagomorph long bones.

Fig. 11. Semi-articulated *Buteo* spp. lower leg and foot. The proximal portion of the tarsometatarsus fragment possessed indications of localized burning, and was broken using the groove-and-snap technique.

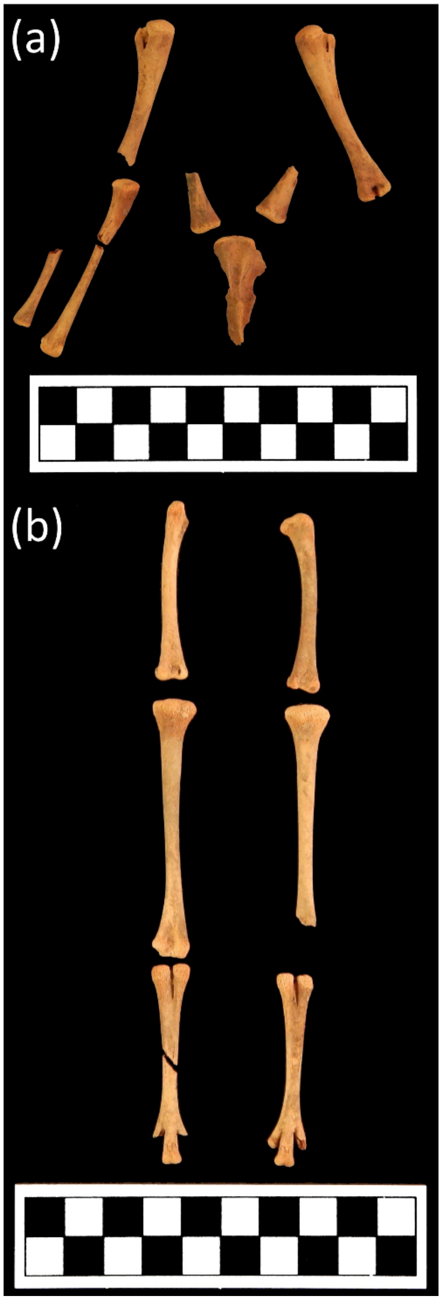


Fig. 12. Juvenile large bird remains (probably turkey) from Ponsipa, which likely belong to a single poult.

Fig. 13. Bone whistles from Ponispa. The first three seem to derive from turkey vulture (from left to right).

CHAPTER 3

THE PROTOHISTORIC PRESENCE OF BLUE SUCKER (*Cycleptus elongatus*) IN THE UPPER RIO GRANDE

Introduction

The family Catostomidae is diverse and consists of more than 76 species that exist in numerous habitat types across North America. As such, the life-history strategies of individual catostomid species are variable. Mixed with diverse life-history strategies and differing anthropogenic land use practices occurring in catostomid habitats, the conservation and management of suckers poses a unique geographic challenge (Cooke et al., 2005). One way to increase the effectiveness of catostomid conservation is to utilize diverse sources of information on a species- and region-specific basis. One source of information that is rarely utilized in catostomid conservation efforts is the zooarchaeological record, which consists of nonhuman subfossils that were associated with past human activities. The zooarchaeological record in the service of wildlife management and conservation biology has come to be known as applied zooarchaeology (Lyman, 1996). Applied zooarchaeological practitioners have provided important information regarding the past distribution of a suite of threatened and endangered taxa (see Grayson, 1987; Lyman, 1991; Lyman and Cannon, 2004; Wolverton and Lyman, 2012).

A geographic area where the zooarchaeological record might prove to be useful to catostomid conservation is New Mexico, where archaeological sites are numerous and the preservation of faunal remains is good. The blue sucker (*Cycleptus elongatus*) has experienced a dramatic decrease in its historic range due to habitat loss and degradation that is related to agricultural and urban development (Sublette et al., 1990; Zymonas and Propst, 2007), and was labeled as endangered in the state of New Mexico on May 21, 1976. Its current distribution in the state is in the Pecos River, and the most stable populations are found in the Lower Pecos within a 10 km stretch between Brantley Dam and Avalon Dam (Propst, 1999). In 1961, Gehlbach and Miller reported the presence of two blue sucker skeletal specimens from Rainbow House (site number: LA 217), which is an archaeological site located in Bandelier National Monument that was occupied from approximately A.D. 1400 to 1600. The authors suggested that, in the past, the blue sucker occurred farther north than previously thought, and that temperature and flow in the Rio Grande were more stable. However, Gehlbach and Miller's (1961) account is not fully accepted by conservation biologists and wildlife managers, perhaps on the basis of small sample size or an incomplete understanding of the nature of the zooarchaeological record. Propst (1999:52) asserts that "[a]lthough archaeological evidence from Native American ruins indicates the blue sucker inhabited the Rio Grande in New Mexico… no specimens exist to confirm its historic occurrence there."

According to the New Mexico Wildlife Conservation Act of 1974, the New Mexico Department of Game and Fish has the obligation to ensure that native ichthyofaunal distributions remain "natural" (Rinne, 1995:25; Rinne and Platania, 1995:168). On this basis, in the Rio Grande, significant attention has been given to the conservation of the cutthroat trout (*Oncorhynchus clarki virginalis*) and the Rio Grande silvery minnow (*Hybognathus amarus*). One reason for concentrated conservation strategies of these species is that their current ranges are dwindling when they were historically recorded to be ubiquitous (Cope and Yarrow, 1875). However, little consideration has been given to relevant zooarchaeological information regarding the pre-impoundment distribution of the blue sucker, which suggests that its range extended farther north in the Rio Grande. If the blue sucker did occur farther north than what is currently accepted, then native ichthyofaunal distributions are, unsurprisingly, not in a “natural” state in the Upper Rio Grande, the extent of habitat loss for this species is dramatically larger than currently accepted, the identification of relict populations in the Rio Grande is worthwhile, and restoration of this species in the Rio Grande might be defensible given certain parameters are met.

To underscore that the blue sucker was present in the Upper Rio Grande, the archaeological literature is reviewed to show that more than two blue sucker skeletal specimens (identifiable bones or fragments of bone) were identified at Rainbow House. In addition, blue sucker remains have been identified from three other archaeological sites in the area. In particular, there is new zooarchaeological evidence from Ponsipa’akeri (LA 297; hereafter Ponsipa), a site occupied ca. A.D. 1300 to 1600 that is located directly east of the Rio Ojo Caliente in the Upper Rio Grande drainage. Ponsipa has yielded over 100 actinopterygian specimens, of which 20 have been identified to the family Catostomidae and ten have been identified to *C. elongatus*.

Background

It is important to understand general life-history strategies of the blue sucker to more fully understand factors that limit its dispersal, and it is also important to understand the existing body of archaeological evidence that suggests the blue sucker occurred in the Upper Rio Grande. There are multiple lines of evidence that indicate the blue sucker was present in the region prior to and at the beginning of the historic time period.

Blue Sucker Life-History and Distribution

As in many desert fishes, the blue sucker has a periodic life-history strategy, which is characterized by increased generation times, higher age at sexual maturity, increased body size, high fecundity, and low juvenile survivorship (Winemiller and Rose, 1992). The blue sucker is a large-bodied benthopelagic fish that prefers warm water with higher water velocities. The common total length of blue suckers is around 66 cm (Hugg, 1996). Blue suckers prefer deep river channels, pools with moderate current, and deep lakes (Sublette et al., 1990). *C. elongatus* is a relatively long-lived fish that commonly lives up to 13 years (Hugg, 1996). Though some issues related to the accuracy of ageing methods do exist, ages as high as 22 years have been reported (Labay et al., 2011). Moss et al. (1983) noted that the common age of sexual maturity was three years old, but also noted that females mature faster than males and are consistently heavier and longer. Blue sucker primarily feed on midge and caddisfly larvae, with detritus and algae also supplementing their diet (Sublette *et al.*, 1990). In the fall, Walburg et al. (1971) found that algae comprised a substantial part of the diet for blue suckers when water temperature ranged from 9-17 °C.

C. elongatus is a non-guarding annual spring spawner (April – June) that can migrate hundreds of kilometers upstream (Mettee and Shepard, 1997). Moss et al. (1983), found that blue suckers spawn in deep riffles that have coarse substrate with a water temperature around 20-23 °C. Neely et al. (2010) found that in the middle Missouri River blue suckers heavily rely on different habitat types between spring and summer seasons. Particularly preceding spawning, blue suckers chose to occupy habitats with reduced water velocity as a way to reduce the energetic costs of reproduction. Post spawning, it seems that blue sucker occupied habitats with an increased amount of food sources. Adams et al. (2006) found that juvenile blue suckers were more commonly affiliated with off-channel habitats than with main channel habitats in the Mississippi River, and that they frequently fed on invertebrates associated with vegetated islands. This suggests that secondary production is crucial for the survival of juvenile blue suckers.

Blue suckers are widely distributed throughout the interior of North America, and largely occur in the Mississippi Basin with only small populations in the Rio Grande Basin. It is unclear how past populations entered into the Rio Grande Basin, but hypotheses include lateral and coastal migration (Bessert, 2006). Despite their large range sizes, blue suckers are currently experiencing reduction in their distribution (Burr and Mayden, 1999). The cause of this reduction is often attributed to impoundments that hinder spawning migrations as well as runoff that increases stream contaminants (Bessert, 2006).

Within the Rio Grande Basin during the historic period, blue sucker occurred in the Pecos River from around the Carlsbad area to the Texas/New Mexico border (Propst, 1999). Blue suckers also inhabit lower portions of the Black River (Cowley and Sublette, 1987; Zymonas and Propst, 2007). Zymonas and Propst (2007) found that range size of blue sucker in the Pecos from 2001 to 2006 dramatically reduced due to massive fish kills caused by golden algae blooms.

Archaeological Presence of Blue Sucker in New Mexico

Gehlbach and Miller (1961) reported the presence of a blue sucker urohyal bone and an incomplete Weberian apparatus from Rainbow House (LA 217), which is an archaeological site located within Bandelier National Monument that was occupied ca. A.D. 1400 to 1600 (Kohler, 2004). In regards to the identifiability of the urohyal bone, Gehlbach and Miller (1961:5) state that "[w]ith its broad, strongly developed wings directed obliquely backward and originating at the anteroventral end of the bone, the urohyal is unlike that of any other genus of North American sucker and this establishes without question its pertinence to the monotypic genus *Cycleptus*." Concerning the relative date the blue sucker remains were deposited at the site, Gehlbach and Miller (1961) specify that the "bones were associated with Kidder's Glaze IV pottery which dates them between about 1550 and 1600 A.D." The historic period in the northern

Rio Grande region is generally regarded as starting around A.D. 1540 with Francisco Vázquez de Coronado's entrada (Barrett, 2002).

Excavations at Rainbow House started in 1948 and were led by Fredrick C.V. Worman. The project ended in 1950 when Worman left his position at Adams State College (Kohler, 2004). Sixteen years later, Caywood (1966) compiled a site report in which he mentioned the blue sucker remains identified by Gehlbach and Miller. Caywood explained that five more blue sucker specimens were recovered from Kiva 1 at Rainbow House. The specimens were identified by Miller and consisted of four basipterygia and one lateral ethmoid.

Sublette *et al.* (1990) noted the possibility that blue sucker remains were recovered from the Cochiti Dam Archaeological Salvage Project that date prior to the 1800s. This assertion was corroborated by Snow (2002). In one of the few publications detailing how fishes were utilized in the region at this time, Snow (2002) reports three sites from the Northern Rio Grande from which *C. elongatus* specimens were identified by W.J. Koster, the former curator of fishes at the University of New Mexico, in 1983. The three archaeological sites that are unmentioned in the conservation literature are Palace of the Governors (LA 4451) that was occupied from A.D. 1605 to 1692, Alfred Herrera (LA 6455) occupied around A.D. 600 to 1600 , and LA 70 which was occupied from A.D. 1300 to 1600.

Blue suckers appear to have been more ubiquitous in the Upper Rio Grande than once thought (Fig. 14). There is, however, another previously unidentified fauna from the Northern Rio Grande region that has yielded a substantial amount of ichthyofaunal specimens from the site of Ponsipa, which is located along the eastside of the Rio Ojo Caliente. The site is approximately 15 km away from the confluence of the Rio Ojo Caliente and Rio Chama, and is located about 53 km northeast from Rainbow House. Duwe (2011) explains that Ponsipa included three occupational components, and that the peak population at the site was around 1,350 people. The site was excavated in 1910 by Sylvanus Morley and from 1979 to 1981 by David Bugé, who was the field instructor of the Occidental College archaeological field school. The faunal remains that yielded sucker specimens come from Bugé's excavation, and most of the remains derive from deposits late in the sequence. Ponsipa is nearly 435 km away from where blue suckers are currently found in any abundance within the state, below the Brantley Dam (Zymonas and Propst, 2007).

Methods

There are two ways to add to the current understanding of the distribution of blue suckers in the Upper Rio Grande prior to and at the beginning of the historic period, either a new written record would need to be found that details the former presence of blue sucker, or more paleozoological/ zooarchaeological remains of the blue sucker need to be identified. Here, we provide new data on blue sucker remains from Ponsipa.

The taxonomic level to which faunal remains can be identified is contingent upon a variety of factors. Some taphonomic (preservation) processes have the potential to greatly affect the identifiability of zooarchaeological remains. Taphonomy refers to processes that influence bone destruction and preservation after deposition and burial into paleontological or archaeological sediments (Lyman, 1994). Processes such as carnivore gnawing and digestion (e.g., from domestic dogs at these villages), weathering, or burning during cooking can render faunal remains fragmented and unidentifiable. The taxonomic specificity of identifications also varies with the experience of the zooarchaeologist; more experienced zooarchaeologists tend to be more conservative in their identifications (Driver 1992; Lyman 2002, 2011). The academic tradition a zooarchaeologist is trained in, the comparative collection they utilize, the manual or coding system they use, rules that they set, and the keys and guides they rely on also influence the taxonomic specificity with which identifications are made (Driver 1992, 2011).

The Ponsipa fauna was analyzed using two comparative collections—one from the University of North Texas, Laboratory of Zooarchaeology and one from the Vertebrate Paleontology Laboratory located at the University of Texas. The main key used for blue suckers comes from Branson (1962), though others sources were used (Eastman, 1977, 1980; Gehlbach and Miller, 1961; Nelson, 1948, 1949; Olsen, 1968).

For Ponsipa, five rules for identification that are derived from Driver (1992; Wolverton 2013) were followed: 1) identify each specimen on its own merits, 2) set the universe, 3) set diagnostic criteria, 4) anticipate difficult-to-separate taxa, and 5) write a systematic paleontology. The first rule relates to the problem of "identification by association," which is a tendency to identify skeletal specimens based on other specimens found from the same deposit. If one identifies each specimen based off of its own characteristics, then more reliable and precise identifications can be produced. Setting the universe requires the zooarchaeologist to create a list of taxa that are thought to have occurred within one's study region during a time period. Setting diagnostic criteria forces the analyst to recognize what features of a skeletal element are taxonomically specific, and anticipating difficult-to-separate taxa, requires the faunal analyst to understand when more general identifications should be given to a specimen based on the overlap in skeletal morphology of closely related taxa. Writing a systematic paleontology requires the faunal analyst to report, on a taxa-specific basis, how skeletal elements were identified.

Each bone and bone fragment from Ponsipa received individual attention to avoid identification by association. Current understanding of catostomid species in the region is based on Sublette et al. (1990). There are four potential candidates for sucker species in the Upper Rio Grande: the blue sucker, the Rio Grande sucker (*Catostomus plebius*), the white sucker (*Catostomus commersonii*), and the river carpsucker (*Carpiodes carpio*). Diagnostic criteria are reported the results section (see below); however, taxa that might be difficult to separate from the blue sucker must be anticipated. The Rio Grande sucker is a small-bodied fish with a maximum total length at 20 cm. Based on body size characteristics skeletal remains of the Rio Grande sucker can be distinguished from the blue sucker. The white sucker is also a large-bodied sucker and might potentially be difficult to separate from the blue sucker, but this species was introduced in the Rio Grande in the mid to late 19th century. Therefore, the white sucker was not present in the Upper Rio Grande during the late prehistoric/early historic periods. The river carpsucker is, however, a relatively large-bodied catostomid belonging to the subfamily Ictiobinae that is native to the Upper Rio Grande and might potentially be difficult to separate from the blue sucker. Diagnostic characteristics that set blue sucker skeletal remains apart from those of river carpsucker are described below.

Results

Fish specimens are common at Ponsipa (Fig. 15), and ten blue sucker specimens were identified that represent eight different skeletal elements. For some elements it was not possible to make direct comparisons to river carpsucker because this species is not represented in reference collections or representative photos are not commonly published for all skeletal elements. Instead, skeletons of the closely related smallmouth buffalo (*Ictiobus bubalus*) which is in the same subfamily Ictiobinae (Smith, 1992) were used to rule out the presence of carpsucker. This was appropriate because the general characteristics used to separate *C. elongatus* from the members of the subfamily Ictiobinae are conserved in carpsucker and smallmouth buffalo. General osteological characteristics and terminology utilized below derive from Rojo (1991).

Smith (1992) utilized the urohyal to construct phylogenies of members of the family Catostomidae and from his analysis it is clear that cycleptines are widely divergent. As Gehlbach and Miller (1961) noted, the backward oriented wings of the urohyal are diagnostic in *C. elongatus* (Fig. 16a). The Ictiobinae urohyal has lateral wings that are fuller (Fig. 17a). The pharyngeal arch and teeth of *C. elongatus* are robust (Fig. 16b), and compared to the river carpsucker/smallmouth buffalo the pharyngeal arch is slender and the teeth are fine (Fig. 17b). The opercle of the blue sucker has a rounded posterior angle and dorsal edge, while the ictiobines have a sharp posterior angle and a flat to concave dorsal edge (Figs 16c and 17c). The caudal process of the maxilla is dorsoventrally oriented in *C. elongatus*, while it is twisted in the ictiobines (Figs 16d and 17d). The cleithra of blue suckers have a pinched dorsal narrow strut and a more robust body, the cleithra of ictiobines are narrow and have a dorsal narrow strut that gradually tapers to a point (Figs 16e and 17e). The alar process of the parasphenoid in the blue sucker is oriented downwards and the midpart of the parasphenoid body has prongs, while these features are absent in the ictiobines (Figs 16f and 17f). The symplectic facet of the hyomandibular is much wider in *C. elongatus*, and is longer and narrower in the ictiobines (Figs 16g and 17g). Finally, the posterior process of the basipterygium in *C. elongatus* is dorsoventrally oriented while it is mediolaterally oriented in the Ictiobinae (Figs 16h and 17h).

Discussion

It is clear that the pre-impoundment distribution of the blue sucker was more extensive in the state of New Mexico at the start of the historic period than it is today, which may relate to installation of impoundments on the Rio Grande. The extent of spawning migration is a key attribute of the blue sucker’s periodic life-history strategy. Though the blue sucker is adapted to periods of discontinuity from intermittent flow that sometimes characterizes the Rio Grande, it is also adapted to rapidly take advantage of the re-establishment of continuity and increased flow in river systems. For the blue sucker the fragmentation of its habitat caused by impoundments creates permanent discontinuity and severely disrupts migration and spawning. One way to promote increased habitat connectivity for this species, and potential reestablishment of past range is through the construction of fishways. Cooke et al. (2005) note that relatively little work has been done understanding how suckers utilize fishways. The construction and monitoring of fishways in the lower Pecos might be a good way to assess the feasibility of reconnecting past habitat and thus, possibly, restoring blue sucker in the Rio Grande.

In addition, it is possible that relict populations exist in the Rio Grande that have not been found during contemporary fish surveys. If relict populations are encountered, it is clear that they should be targeted for conservation. The Comprehensive Wildlife Conservation Strategy for the state of New Mexico (New Mexico Department of Game and Fish, 2006) has no clear management plan for this species, and labels its monitoring as “periodic”. For any new sampling and more effective management to be done, a clear conservation strategy is required.

Finally, the taxonomic status of the blue sucker in the Rio Grande is in question. Bessert (2006) found that Rio Grande blue suckers form a unique clade among other populations of *C. elongatus* and *C. meridionalis*. This clade seems to have diverged almost ten million years ago. These data may lead to the formal taxonomic description of a new species of cycleptine in the Rio Grande. If this does occur, Rio Grande blue sucker would be a prime candidate for federal listing as an endangered species, and its conservation in the state of New Mexico is warranted.

Conclusion

It has been fifty-four years since Gehlbach and Miller published their novel paper on applied ichthyoarchaeology in the American Southwest, and, since then, very little has been done in the state of New Mexico concerning blue sucker conservation. With increased sample size from Rainbow House, reporting of remains from three additional archaeological sites, and new data from Ponsipa, it is clear that the extent of the blue sucker's pre-impoundment distribution included the Upper Rio Grande. Range decline in this species has been dramatic, and should the Rio Grande blue sucker be formally described as a species, it could be considered federally endangered. This analysis adds to a growing body of research highlighting the value of zooarchaeological data for biological conservation (e.g., Peacock et al,, 2012; Randklev et al., 2010; papers in Wolverton and Lyman, 2012). The Northern Rio Grande region has recently received renewed archaeological attention (see Ortman, 2012; Vierra, 2013 and references therein), and it is possible that with new zooarchaeological data, protohistoric distribution of the blue sucker will continue to be better understood.

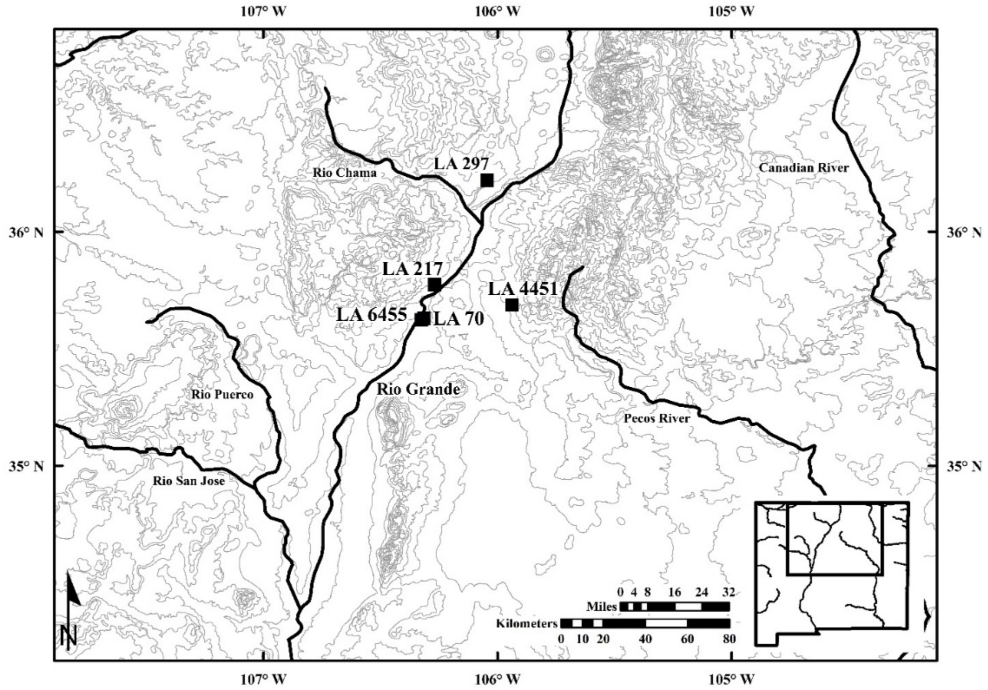


Fig. 14. Five archaeological sites where blue suckers have been identified in the Northern Rio Grande region.

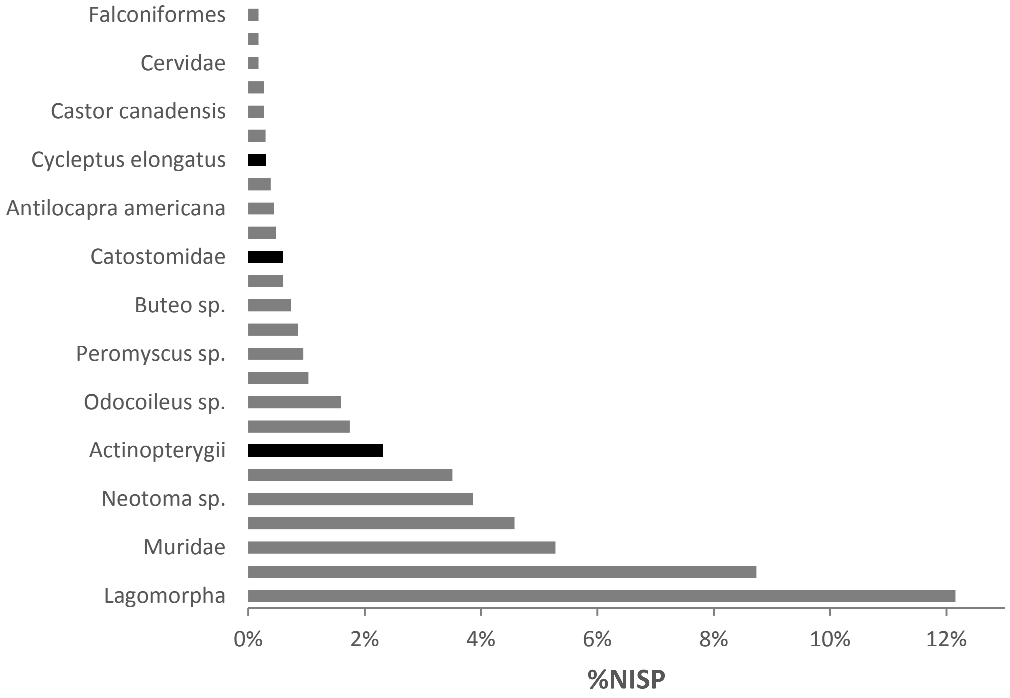


Fig. 15. Top 25 standard taxonomic descriptions at Ponsipa. Actinopterygii ranked number 7, Catostomidae ranked number 15, and *Cycleptus elongatus* ranked number 19.

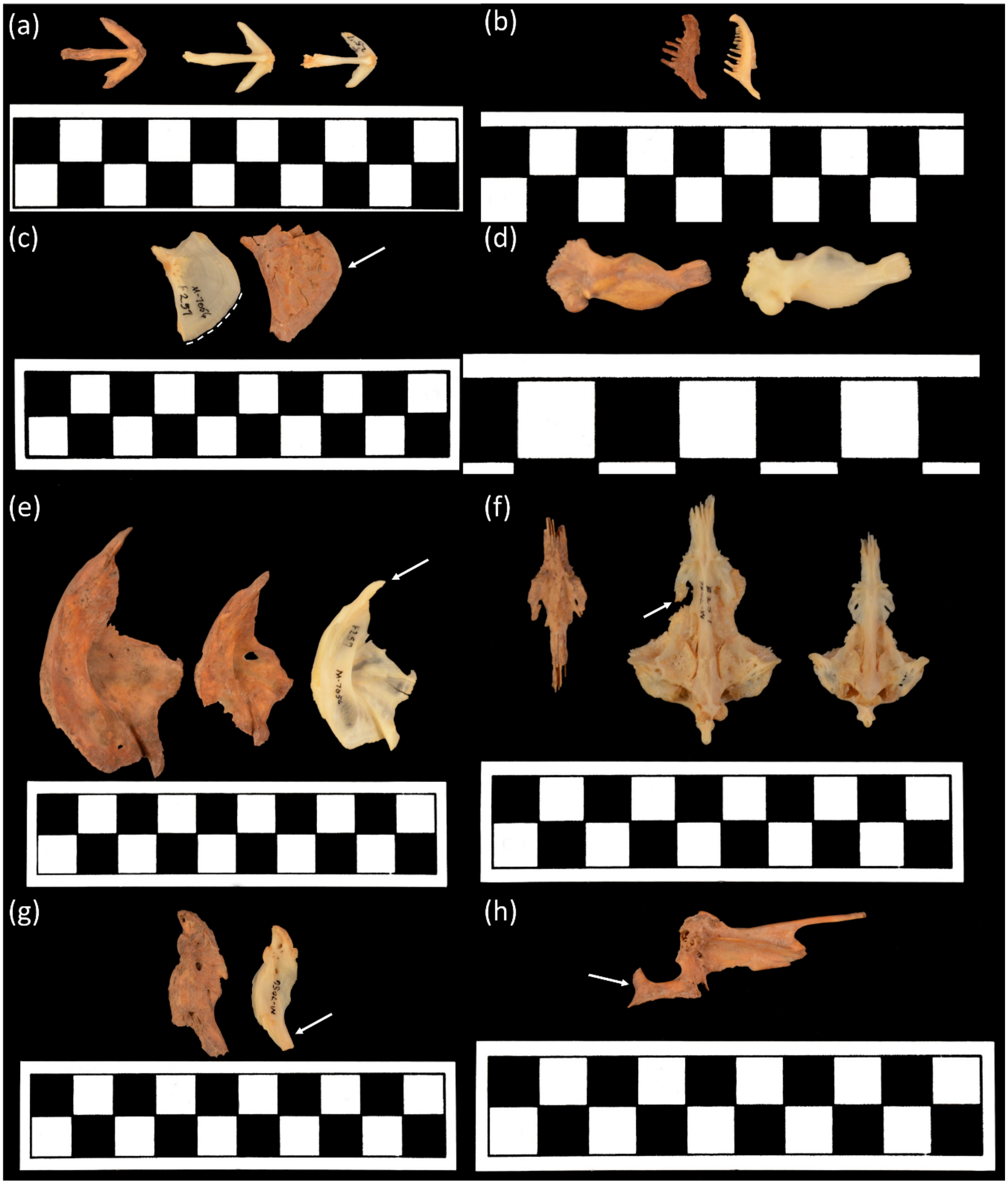


Fig. 16. Archaeological blue sucker specimens from Ponsipa compared to modern blue sucker comparative specimens. A) one archaeological urohyal compared to two comparative specimens, B) left pharyngeal arch, C) right opercle with arrow pointing to posterior angle and the dotted line showing the shape of the dorsal edge, D) right maxilla with arrow pointing to caudal process, E) two archaeological and one comparative right cleithra with arrow pointing to dorsal narrow strut, F) one archaeological and two comparative parasphenoids with arrow pointing to alar process, G) left hyomandibular with arrow pointing to the symplectic facet, and H) left basipterygium with arrow pointing to posterior process.

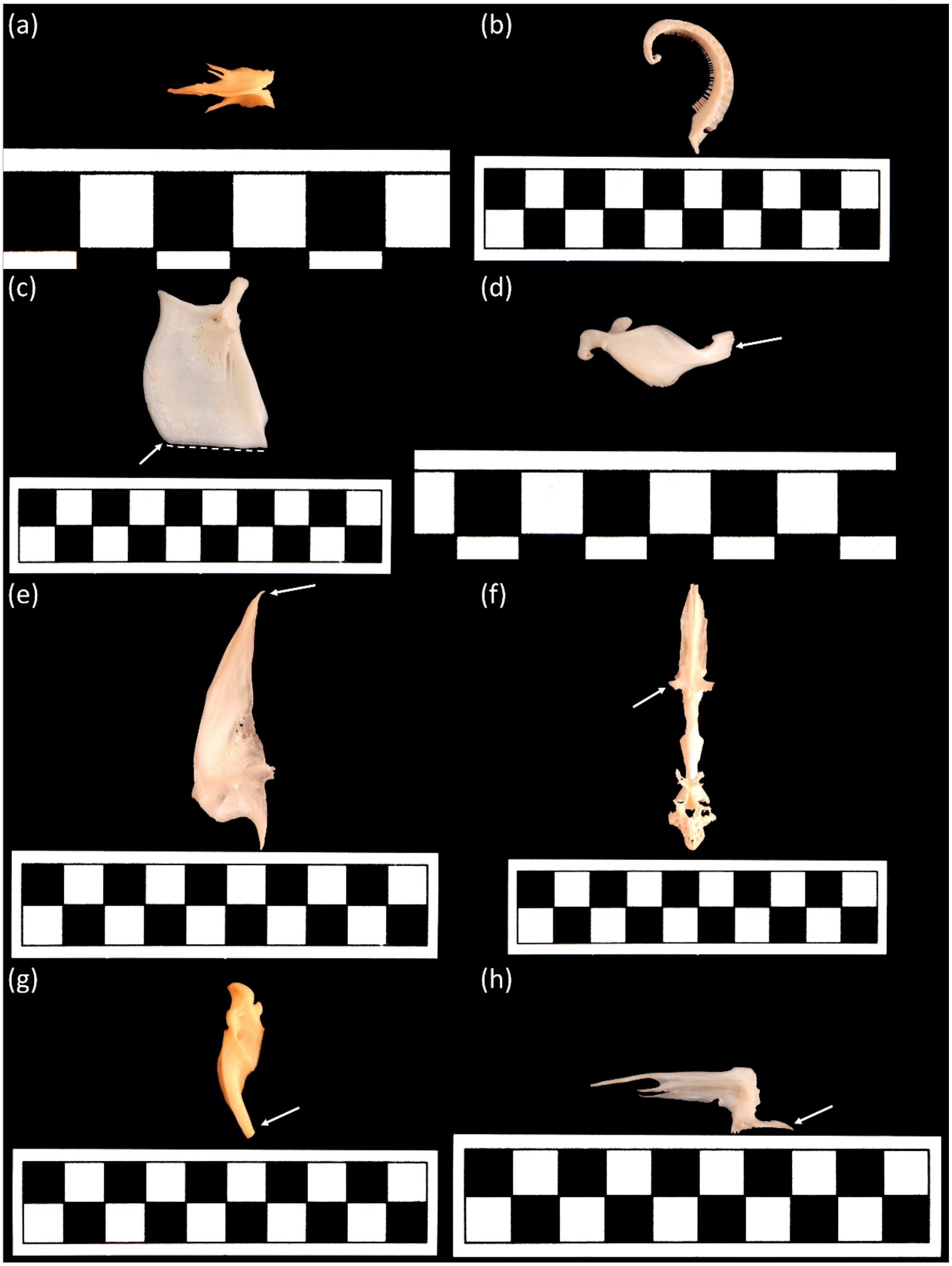


Fig. 17. Comparative smallmouth buffalo specimens. A) urohyal, B) left pharyngeal arch, C) left opercle with arrow pointing to posterior angle and the dotted line showing the shape of the dorsal edge, D) right maxilla with arrow pointing to caudal process, E) right cleithrum with arrow pointing to the dorsal narrow strut, F) parasphenoid with arrow pointing to alar process, G) left hyomandibular with arrow pointing to the symplectic facet, and H) right basipterygium with arrow pointing to posterior process.

APPENDIX

FAUNAL REMAINS FROM PONSIPA

	NUMBER OF IDENTIFED SPECIMENS	
	Count	**Percent**
MAMMALS		
Artiodactyls		
(Artiodactyla)	1	0.03
Pronghorn		
(*Antilocapra americana*)	15	0.43
Sheep		
(*Ovis* spp.)	1	0.03
Deer family		
(Cervidae)	6	0.17
Deer		
(*Odocoileus* spp.)	55	1.57
Medium artiodactyl		
(Deer size artiodactyl)	241	6.88
Large artiodactyl		
(Elk/bison size artiodactyl)	2	0.06
Dog, wolf, coyote		
(*Canis* spp.)	20	0.57
Mountain lion		
(*Felis concolor)*	3	0.09
Lynx/bobcat		
(*Lynx* spp.)	2	0.06
Badger		
(*Taxidea taxus*)	1	0.03
Small carnivore		
(Carnivore smaller than fox)	2	0.06
Medium carnivore		
(Fox size or larger carnivore)	4	0.11
Large carnivore		
(Wolf size or larger carnivore)	1	0.03
Rabbits and hares		
(Lagomorpha)	423	12.08
Jackrabbit or hare		
(*Lepus* spp.)	132	3.77
Cottontail		
(*Sylvilagus* spp.)	310	8.85
Rodents		
(Rodentia)	37	1.06
Beaver		
(*Castor canadensis*)	9	0.26

Porcupine (*Erethizon dorsatum*)	4	0.11
Smooth-toothed pocket gopher (*Thomomys* spp.)	63	1.80
Pocket mice, kangaroo rats (Heteromyidae)	13	0.37
Ord's kangaroo rat (*Dipodomys ordii*)	10	0.29
Deer mice, voles etc. (Muridae)	185	5.28
Woodrat (*Neotoma* spp.)	130	3.71
Mice (*Peromyscus* spp.)	33	0.94
Cotton Rats (*Sigmodon* spp.)	4	0.11
Squirrels (Sciuridae)	29	0.83
Prairie dog (*Cynomys* spp.)	7	0.20
Ground squirrels (Holarctic ground squirrels)	16	0.46
Large rodent (Rodent larger than wood rat)	5	0.14
Small mammal (Jackrabbit size or smaller)	746	21.31
Medium mammal (Deer size or smaller)	118	3.37
Large mammal (Larger than deer)	3	0.09
BIRDS		
Waterfowl (Anseriformes)	3	0.09
Surface feeding ducks (Anatini)	1	0.03
Geese and swans (Anserinae)	1	0.03
Herons etc. (Ciconiiformes)	1	0.03
Mourning Dove (*Zenaida macroura*)	4	0.11

Vultures, hawks, eagles (Falconiformes)	7	0.20
Hawks (Buteo spp.)	26	0.74
Turkey Vulture (*Cathartes aura*)	1	0.03
Grouse etc. (Galliformes)	5	0.14
Pheasants, quail, junglefowl, etc. (Phasianidae)	2	0.06
Turkey (*Meleagris gallopavo*)	156	4.46
Grouse (Tetraoninae)	1	0.03
Rails (Rallidae)	2	0.06
Jays and crows (Corvidae)	13	0.37
Blackbirds and orioles (Icteridae)	1	0.03
Neotropical macaws (*Ara* spp.)	2	0.06
Thrushes, robins etc. (Turdidae)	3	0.09
Small birds (Robin size and smaller)	12	0.34
Medium birds (Mallard size and smaller)	26	0.74
Large birds (Birds larger than mallard)	490	14.00
FISHES		
Ray-finned fishes (Actinopterygii)	78	2.23
Suckers (Catostomidae)	20	0.57
Blue sucker (*Cycleptus elongatus*)	10	0.29
OTHER		
Egg laying animal (Oviparous animal)	5	0.14

TOTAL	3501
UNIDENTIFIED	2859
TOTAL NUMBER OF SPECIMENS	6360

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