Cultural control and agency: a quantitative analysis of Mazama sp. and Odocoileus sp. osteological remains from Mayapán, Yucatan, Mexico

Vivian S. James
University at Albany, State University of New York, vsjames@tds.net

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Cultural Control and Agency: A Quantitative Analysis of *Mazama* sp. and *Odocoileus* sp.
Osteological Remains from Mayapán, Yucatán, México

by

Vivian S. James

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Cultural Control and Agency: A Quantitative Analysis of

*Mazama* sp. and *Odocoileus* sp. Osteological Remains from

Mayapán, Yucatán, México

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Abstract

Mayan management of deer populations at Mayapán in the Yucatán, México has been suggested by historical texts, iconography, and archaeological investigation. Therefore, the main research question of this thesis is: Was deer management or husbandry practiced at Mayapán? Two Cervidae species are identified in the Mayapán faunal assemblage, *Odocoileus virginianus* (white-tailed deer) and *Mazama americana* (brocket deer). It is likely that *Mazama pandora* (Yucatan brocket deer) is also present and possibly another *Odocoileus* subspecies. Consequently, the second research question of this thesis is: How many deer species or subspecies were present in Postclassic Period Mayapán? There is a considerable non-overlapping size difference between living specimens of *Odocoileus* sp., which is 90-105 cm tall and 134-206 cm long, and *Mazama* sp., which is 69-71 cm tall and 70-130 cm long, which may be reflected in skeletal anatomy. This study tests the hypothesis that *Odocoileus* sp. and *Mazama* sp. are metrically distinguishable. Data from previous faunal investigations was combined with metrical and statistical analyses of osteological faunal remains from Mayapán to determine the presence of a third deer species or subspecies and support claims that management or husbandry was practiced at Mayapán.
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Introduction

Tantalizing indirect evidence from epigraphic and historical textual sources has suggested to researchers for decades that some form of “cultural control” over deer may have been practiced by the ancient Maya (Tozzer and Allen 1910; Pohl 1981; Hecker 1982:217; Carr 1996; Seler 2008[2004]; Franco 2011 [1954]). More recent studies based on material evidence from Mayan archaeological sites, particularly Mayapán, have provided support for this hypothesis (Teeter and Chase 2004; Masson and Peraza 2008; Russell 2008; Gazdik 2010). The Maya made extensive use of deer for subsistence, but also employed them as a resource in economic, ritual, and social systems (Pohl 1981; Pohl and Feldman 1982; Hamblin 1984; Emery 2001:559-561, 2003; Carr and Fradkin 2008; Masson 2009; Pollock and Ray 2009 [1957]; Masson and Peraza 2010; Sharpe 2011). The impact of Cervidae biological factors is rarely considered in existing paradigms that tend to focus on anthropogenic agency, with some important exceptions, but is a potential confound in a factor for any model of human-faunal relations (Pohl 1985a:3-6; Emery 2004; Brown and Emery 2008). This study quantifies Cervidae bones recovered from Mayapán by the Proyecto Económico de Mayapán (PEMY) to determine if there is osteological evidence to support the hypothesis that the Maya engaged in husbandry practices of deer during the Postclassic Period.
Theoretical Considerations

**Agency and Practice**

The concept of agency has been applied in many different ways by archaeologists (Pauketat 2001:79; Dornan 2002:308-315). Defined simply by Giddens as “action” in opposition to structure, which is conceived of as “institutions,” agency is better thought of as a capability or capacity for action within and by social structures requisite for practice, which is more properly used to indicate the application of agency and has its own theoretical background (Bourdieu 1977 [1972]:80; Giddens 1979:55, 65-66; Dornan 2002:304-308; Joyce and Lopiparo 2005:365; Ortner 2006:5). Dornan’s summary of agency theory as presented through Giddens’ structuration theory is sufficient to explain the strengths and weaknesses of the theory for archaeological applications (Giddens 1979:69-73; Dornan 2002:307-308). Agency, as Giddens considered it, is specifically useful in archaeology as an attempt to understand past behavior in temporal and spatial reality (Giddens 1979:2-3, 54-55, 64, 70; Joyce and Lopiparo 2005:370, 372). Practice theory examines how agency translates potentiality into action and how the production and reproduction of human individual and social experience creates the world, which Pauketat transformed into “historical processualism” (Bourdieu 1977 [1972]:79, 82-83, 85-87, 91, 163-164, 167; Giddens 1979:5, 7, 64, 69; Pauketat 2001:73-74, 79-80, 83-88; Joyce and Lopiparo 2005:366; Ortner 2006:16-18). Giddens’ agency theory is tied to Bourdieu’s practice theory in that both consider the effects of conscious and unconscious thought on human behavior within societal structures and the two theories are often

It is important to note here that both Bourdieu and Giddens viewed agency and practice as “a distinctly human phenomenon” (Giddens 1979:79; Pauketat 2001:80; Dornan 2002:319; Ortner 2006:2, 16-17). The issue involves intentionality (Dornan 2002:306, 311-313, 316, 318-325; Joyce and Lopiparo 2005:366-369, 372; Ortner 2006:134-136). Intentionality, which is thought to be inoperative in agency, and “reflexive self-regulation” are considered limited to human cognition in structuration theory (Giddens 1979:56-59, 79; Dornan 2002:308). Moving into the twenty-first century, agency has been extended beyond the realm of humanity. A study examining the taphonomy of shells recovered at coastal archaeological sites argued that agentic animals may be responsible for shell “accumulations” (Erlandson and Moss 2001:422, 424-426). Critical of this study, Lyman (2002) acknowledged nonhuman agency in his review of Erlandson and Moss (Lyman 2002:361-364). Moss and Erlandson’s 2002 reply stated unequivocably that “we humans are also ‘animal agents’” in defense of their argument for the distinguishement of human from nonhuman taphonomic agents (Moss and Erlandson 2002:367-368). A few years later, Brown and Emery assigned agency to the “animate forest” in a study of Mayan ceremonial caves and shrines in Guatemala that are related to hunting rituals (Brown and Emery 2008:300-333). More pertinent to this paper
than the idea of an agentic environment is that:

“Prey species are also active participants in the hunt and possess a purposeful and thoughtful agency. Hunters know that if the network of ritual obligations has been met then animals will voluntarily present themselves to be caught. Females, males, young or old might allow themselves to be killed in an act of self-sacrifice and any of these individuals would be taken” (Brown and Emery 2008:312).

Additionally, dogs were considered members of the hunting party and are included in all of the preparatory rites as well as the hunt itself (Brown and Emery 2008:312-313).

Nonhuman mammals have been integral actors within human institutions, particularly the structures of domestication and subsistence, capable of independent thought and action; therefore, the concepts of agency and practice should be extended into the nonhuman world.

**Domestication and Cultural Control**

Domestication is a symbiotic process involving agency functioning in an evolutionary framework (Rindos 1980:752; Hecker 1982:218, 220; Zeder 2012:227-228). The process of domestication is a continuum, which can be accessed at any point through the range of co-evolution between plants and animals, including humans, as is illustrated by Zeder’s (2012) “Multiple Axes of Domestication” model (Rindos 1980:753; 756-758; Zeder 2012:229). It is useful to divide the wide range of domestication practices into archaeologically visible sets of changes to discuss the evidence available for domestication in any specific population (Zeder 2012:228-230). Asymmetrical agency is demonstrated by the development of specific human practices that begin the process and become increasingly supportive of domestication, such as live capturing instead of killing potential domesticates, which are often evidenced archaeologically by structures that
function to restrict the movement of potential domesticates and shifting agricultural patterns to provide fodder in addition to plants intended for human consumption (Zeder 2010[2003]:163; 2012:228-229). The domestication spectrum is characterized by mutual interspecies dependence as the domesticated animals are biologically changed through human selection for desired traits and lose the ability to survive in the wild while humans become increasingly reliant on the domesticates as food resources (Zeder 2012:228-230). Some level of agency is retained in that feralization remains possible throughout the continuum (Zeder 2012:228-229). Defining domestication considering the distribution of biological natural selection and human cultural practice interactions has been problematic because it is difficult to determine the exact point at which interspecies dependence has been achieved.

Having discussed the definitional difficulties related to the term “domestication,” Hecker (1982) found that the concept of “cultural control” was more helpful in evaluating the relationship between humans and nonhuman mammals earlier in the spectrum of domestication processes (Hecker 1982:217-222). Hecker further established four criteria, of which at least two should be met, by which cultural control might be visible in the archaeological record. The first of these criteria is that of human agency or intention to physically control a nonhuman population, its reproduction, or the demographic profile of the population. The second criteria is that this control be exercised relatively permanently, resulting in the condition that humans must arrange for the needs of the nonhuman mammals, such as food and shelter, to be met. The third criteria is that a population, rather than an individual animal, is involved. The fourth criteria is that the
cultural control of the animal population by humans intentionally results in greater access
to the animals as exploitable resources. These criteria of incipient domestication practices
may be visible archaeologically as structures built for the care, maintenance, and physical
control of the animals such as pens or fences as well as faunal evidence of the age and
sex profiles of the species population. The model specifically excludes individual pets or
small groups of animals kept briefly for use in sacrificial rituals, but includes deliberate
culling of specific ages and/or sexes of a prey population by hunters (Hecker 1982:219-
220). Archaeologically distinguishable human agency and practices early in the
domestication process, before morphological changes are detectable or become
permanent, are the foundation of the cultural control model.

The possibility of achieving domestication is dependent on characteristics of the
population under consideration for domestication related to social organization,
reproduction and family relations, interspecies interaction, as well as biological needs for
food, water, and safety (Hecker 1982:222; Zeder 2012:231). Some of the behavioral traits
that foster domestication include: large social groups with a hierarchical and patriarchal
social organization, action-oriented rather than embodied sexual signals, generalized food
requirements, a wide environmental niche, and the ability of the animal species to
habituate to humans (Zeder 2012:231-237). Agentic relationships between humans and
the animals that have either been domesticated or that humans have attempted to exercise
cultural control over follow three “pathways” according to Zeder: 1) commensality, in
which the nonhuman mammal is the primary actor, self-habituating to human landscapes;
2) a human agency based “prey pathway” in which previously hunted animals become
managed mainly for subsistence, or sometimes for secondary products such as milk or eggs, and were later potentially domesticated; and 3) a “directed pathway” similar to the prey pathway in which the animals exploited by humans for secondary products such as labor, result in a more balanced agency as both the needs of both humans and nonhuman mammals are met (Zeder 2012:239-250). The concept of agency and agent roles within the domestication process will be returned to later as it relates specifically to the question of deer management by the Maya in the Yucatan during the Postclassic Period.
Iconographic Evidence

Iconographic evidence for the social control and agency of deer is found in a variety of codices and edifice adornments (Tozzer and Allen 1910:283-284). The three codices from the Mayan area are: the Dresden Codex, the Tro-Cortesianus Codex, and the Peresianus Codex, all of which have been deposited in European repositories (Tozzer and Allen 1910:283). Other Mayan texts initially existed at Contact, but they were destroyed by the Franciscans during the Auto de Fé at Maní in 1562 (Gates 1978 [1937]:iii). The *Tro-Cortesianus*, also known as the *Codex Madrid*, includes a section that Tozzer and Allen (1910) have described as scenes of hunting to obtain deer for the purpose of capturing deer alive to ritually sacrifice (Tozzer and Allen 1910:293, 348-351; Pohl 1981:524; Carr 1996:252-254; Masson and Peraza 2010:8).

A number of artistic conventions, including the representation of antlers, have assisted researchers in identifying various animals in the codices (Tozzer and Allen 1910:285, 348; Seler 2008 [2004]:122).

“The characteristics of deer drawings are the long head and ears, the prominently elevated tail with the hair bristling from its posterior side (the characteristic position of the tail when the deer is running), the hoofs, and less often the presence of incisors in the lower jaw only and of a curious oblong mark at each end of the eye, possibly representing the large tear gland” (Tozzer and Allen 1910:348).

It is thought that the hunting scenes represent pit traps and yanking snares (Tozzer and Allen 1910:293, 348-349; Franco 2011 [1957]:521-523). Franco (2011 [1957]) identified twenty scenes of trapped deer and four types of traps pictured in the *Codex Madrid*: yanking snares, deadfall traps, pit traps, and net snares (Thomas 1882:97, 131; Seler 2008
The only other animals depicted trapped in “snares” similarly to the deer are turkey and peccary, which are also thought to have been managed faunal species (Franco 2011 [1957]:521). There is ethnographic evidence that the Tzutujils, a Mayan community near Lake Atitlán in Guatemala, use a baited yanking snare to capture birds, but a far more elaborate version is thought to be required to capture deer with a yanking snare (Orellana 1973:127, 137-139; Franco 2011 [1957]:521-523). Franco determined that “deadfalls” were only used to capture armadillos and that nets were possibly used to capture birds with pit traps ostensibly used for deer, although his description of “pitfalls” would more likely result in the death of the animal rather than its capture (Franco 2011 [1957]:523).

An image on page 92 of the Codex Madrid (Figure 1), has been interpreted as a stylized picture of a deer caught in a pit trap (Tozzer and Allen 1910: 347-348, see also plate 30, figure 2; Seler 2008 [2004]:118; Franco 2011 [1957]:522-523). Tozzer and Allen determined the animal pictured on page 92a is Mazama pandora based on an earlier analysis of the antler feature, without ruling out Odocoileus (Tozzer and Allen 1910:347). Further, they identified an unusual triangular area in the lower center of the glyph as a “stake,” on which the deer is “impaled” in the pit (Tozzer and Allen 1910:348). A staked pitfall trap would likely result in death, as mentioned above, rather than the capture of a live deer for future ritual sacrifice. The positioning of the deer looking upwards with its front legs raised is similar to another image from the Codex Madrid (Figure 2) that was described by Pohl as a representation of a “splayed stag” and which she found similar to a scene in the Borgia Codex (Pohl 1981:518; Seler 2008
Yet another splayed deer pictured in the Madrid Codex (Figure 3) illustrates a successful hunter carrying a dead deer on his back, which is immediately followed by an image picturing the splayed deer cut in half with a vulture coming out of the deer’s upper trunk. The splayed posture in this last image could be interpreted as a visual representation of an animal offering itself to be killed by the hunter, an act associated symbolically with the hunt. This concept can then be extended to the image on page 92a in which the splayed deer is pictured inside of a vessel. Tozzer and Allen explain that
images of items presented in bowls or vessels is typical of the manner in which offerings are represented in the Mayan codices (Tozzer and Allen 1910:289; Masson and Peraza 2010:35).

The raised front legs of the deer pictured in the image on page 92a of the *Madrid Codex* suggests that rather than a representation of a deer trapped in a pit as it has been interpreted, the image illustrates a deer that has offered itself for ritual sacrifice or as food when considered in light of the ethnographic evidence regarding the Mayan understanding that agentic animals offer themselves to the hunter (Brown and Emery 2008:312; Seler 2008 [2004]:123). The pictured triangular area is likely a stylized upraised tail that Tozzer and Allen state is typical of Mayan glyphs representing deer as it would be difficult to illustrate bristling hair in a two-dimensional drawing of the posterior, rather than the profile, of the animal (Tozzer and Allen 1910:348). Thus, the image from page 92a of the *Madrid Codex* can be conceived of as evidence for the
agency of animals within Mayan structures and systems. These considerations provide an opportunity to re-examine the historical textual sources considering the constraints imposed on potential domestication models by the evolutionary adaptations of *Cervidae* biology.
Deer as a Natural Resource

Multiple lines of evidence have been used to demonstrate the importance of *Cervidae*, particularly *Odocoileus virginianus*, as a primary resource in Mayan subsistence systems (Carr 1996:252, 254; Reitz and Wing 2008:251-253, 257; Pollock and Ray 2009 [1957]:541; Sharpe 2011:31). Typically the most ubiquitous species represented in Mayan faunal assemblages, the contextual distribution of *Cervidae* within archaeological sites indicates assymetrical access to this important faunal resource, although this varies between sites (Carr 1985:126, 128-129; Pohl 1985b:111; Pohl 1985c:141; Carr 1996:254-255; Emery 2003:498-499, 502, 505, 507, 509-512; 2008:630; Reitz and Wing 2008:278, 280-281; Pollock and Ray 2009 [1957]:541, 549; Gazdik 2010:14; Masson and Peraza 2010:4, 6, 13, 20-22, 40; Sharpe 2011:34, 82, 85-87, 90, 106, 177, 180-182, 185). Both primary and secondary products of *Cervidae* were used locally and included in regional trade networks, as is evident at Cozumel where remains of deer bone tools and antlers have been recovered from archaeological sites on the island despite the fact that deer was not a dietary staple on the island (Hamblin 1984:176, 181, 183-184; Carr 1985:129, 131; Pohl 1985b:110-111; Carr 1996:255; Masson and Peraza 2008:180-181; 2010:37; Reitz and Wing 2008:275-278; Masson 2009: xiv; Pollock and Ray 2009 [1957]:544-545, 549; Gazdik 2010:16-17; Sharpe 2011:32, 106). The ideological importance of deer is supported by comparisons of distribution across social status contexts as well as evidence for the use of deer in sacrificial and feasting rituals (Tozzer and Allen 1910:289, 349; Tozzer 1966 [1941]:110, 114-115, 146, 163; Pohl 1981:515-517, 520-521, 523-526; Carr
Additionally, mortuary evidence supports the ideological symbolism of deer in the Mayan cosmology through grave goods that are interpreted as something other than subsistence-related (i.e., food provisioning of the dead) because the faunal remains were not placed in a food container and were not from a portion of the animal that is normally consumed as food (Masson and Peraza 2010:27-28, 38). The extensive research into the use of deer as a natural resource by the Maya arguably establishes *Cervidae* as one of the most exploited faunal taxa in Mesoamerica.
Taxonomy and Biology of Cervidae

Taxonomical Considerations

There are four species of *Cervidae* in Mexico, two of which – *Odocoileus virginianus* (white-tailed deer) and *Mazama americana* (red brocket deer) – are commonly found in the Yucatan, although multiple subspecies have been reported (Gaumer 1917:68-85; Smith 1991:1-2; Carr 1996:251, 257-258; Emery 2004:19; Mandujano 2004:211-212, 216, 220; Heffelfinger 2011:23). The morphological differences between the subspecies, other than size, are considered to be minor and most have been subsumed under either *Odocoileus virginianus* or *Mazama americana* in official taxonomical lists, including *Odocoileus thomasi* mentioned by Tozzer and Allen in their discussion of Mayan pictorial representations of deer (Tozzer and Allen 1910:348; Wilson and Reeder 2005:652-671; Seler 2008 [2004]:112; Heffelfinger 2011:4-5, 23). An important exception to this is *Mazama pandora*, the Yucatan brown brocket deer or gray brocket deer, which is considered a separate species from *Mazama americana*, the red brocket deer, based on historical reports and cranial morphological and metrical differences in addition to characteristics such as pelage color and breeding behavior that are useful in biology, but are not discernable zooarchaeologically (Medellín, et al. 1998:1-13; Reyna-Hurtado and Tanner 2005:676; Masson and Peraza 2010:12). *Odocoileus* sp. is determined from *Mazama* sp. zooarchaeologically aided by skeletal size differences because *Odocoileus* sp. is about four times the size of *Mazama* sp. (Olsen 1982:9, 49-52, 54-57, 59-60, 62, 67, 71, 76, 80, 85, 89). Subsequently, both *Mazama americana* and
Mazama pandora are listed in the Integrated Taxonomic Information System (ITIS) as separate individual species under the genus Mazama (Rafinesque 1817) while Odocoileus (Rafinesque 1832) is divided into two species: Odocoileus hemionus (mule deer), the range of which is limited to the California and Sonora Biotic Provinces in northern Mexico, and Odocoileus virginianus, which is ubiquitous nearly everywhere in North America (ITIS 1777; 1817; 1832; 1901; Goldman and Moore 1945:350, 352; Gilbert 1990:149). The question Carr (1996) raised regarding Gaumer’s (1917) descriptions of Mexican Cervidae is satisfied by an understanding of his Cariacus virginianus as Odocoileus virginianus, Cariacus toltecus as Mazama americana, and Cariacus pandora as subsumed under Cariacus rufinus as synononomous with Mazama pandora (Gaumer 1917:68-85; Carr 1996:257-258; Medellín, et al. 1998:1).

Cervidae Osteology

Deer morphology is affected by local geographic factors such as latitude and landscape, but characteristics of local communities are highly predictable (Purdue 1983:1207; Reitz and Wing 2008:63-65; Densmore 2009:1; Ditchkoff 2011:43-44). Osteological metrics of Cervidae remains from Mesoamerican sites have not yet provided conclusive evidence for domestication and it is likely that the Maya practiced some form of cultural control earlier in the continuum of domestication processes, such as management or husbandry (Emery 2004:31). Biomass is exponentially related to bone size, which could indicate sexual dimorphism in some species, but the determination of sex from long bone measurements has not been demonstrated for Cervidae and Carr has stated that any differences in the osteological measurements of deer long bones that could
be attributable to sexual dimorphism would be “slight” (Scott 1990:301-334; Carr 1996:257; Emery 2004:20-21). Another potential confounding factor for interpreting osteological evidence is that food availability for a local deer population is generally unknown for archaeological sites, but scarcity may reduce animal size (Emery 2004:31; Sykes, et al. 2011). Therefore, environmental reconstruction has been and continues to be a major area of research in Mesoamerica (Emery 2004:30-32).

Known to be sympatric species, both Mazama americana and Mazama pandora occupy the tropical rainforest environment of the southern Yucatan (Medellín, et al. 1998:11). An examination of cranial osteology demonstrated that Mazama pandora has a larger auditory bulla than that of Mazama americana, which is thought to be an evolutionary adaptation to the drier and more open environment of the northern Yucatan (Mandujano and Rico-Gray 1991:176-177; Medellín, et al. 1998:11-12). This has implications for identifying the Cervidae remains from Mayapán, which are currently thought to be Mazama americana, but may actually be Mazama pandora. It is also possible that both Mazama species are represented in the faunal assemblage recovered from Mayapán in addition to one or more Odocoileus species. Few cranial elements of Cervidae have been recovered from Mayapán as well as from Piedras Negras and Aguateca and it would be useful if the two Mazama species can be identified from appendicular element characteristics (Masson and Peraza 2008:176-177, 180-181; Sharpe 2011:103, 183-184).
Deer in Distress

Distress is a series of biological reactions to excessive or extended stress (Spraker 1993:481-482). Cervidae species, in particular, have distress responses that are not conducive to domestication strategies (Zeder 2012:231-232). Diminished reproduction in captivity is documented for most animal species while less evident in the Mesoamerican zooarchaeological literature are the effects of capture myopathy, the deterioration of skeletal muscle that is caused by overexertion and stress in response to capture, four types of which will be discussed here (Spraker 1993:482; Ditchkoff 2011:65). Capture shock syndrome is characterized by low blood pressure and hypoxia the result of which is insufficient nutrition and cellular decay, causing death within six hours of capture (Spraker 1993:486-487). Ataxic myoglobinuric syndrome is an insufficient recovery from capture shock and which some animals survive, but death is likely within a few days of capture (Spraker 1993:483, 487). Ruptured muscle syndrome presents within a few days of capture and is characterized by muscular necrosis that results in death a few weeks after capture if not arrested (Spraker 1993:483-484, 487). Animals that have been captive for a day or more that experience a second episode of distress sometimes die immediately of a heart attack, which is known as delayed-peracute syndrome (Spraker 1993:484, 487-488). A number of preventative measures have been developed to avoid capture myopathy in modern Artiodactylid populations and there is ethnographic evidence that the ancient Maya had capture practices similar enough to ensure the survival of captured deer (Spraker 1993:488; Beringer, et al. 1996:374; Marilyn A. Masson, personal communication 2013).
Some methods of capture are more successful than others in reducing the number of deaths from capture myopathy. Beringer and his colleagues (1996) tested modified rocket-nets and clover traps in Missouri, the latter method of which included up to a twenty-four hour delay in processing while the former incorporated immediate processing and release, to determine the effects of each technique on deer mortality rates from capture (Beringer, et al. 1996:374-375). A total of 415 deer were captured, 300 with the rocket-nets, which are capable of capturing up to five deer at a time, and 115 were captured individually in the modified clover traps (Beringer 1996:374, 376). Accidents at the time of capture caused the deaths of eight deer caught with the rocket-nets and six caught with the modified clover traps (Beringer 1996:376, 379). All of the deer caught using the modified clover traps survived their brief captivity, but 23 of the deer caught using the rocket-nets had died from ataxic myoglobinuric syndrome within a month of their capture (Beringer 1996:374, 376, 379). A more recent study tested not only clover traps and rocket-nets, but also dart guns and Stephenson box traps in New York (Haulton, et al. 2001:255). The clover and Stephenson box traps were checked twice daily (Haulton, et al. 2001:257). The Stephenson box traps in which 367 deer were captured, including 159 that were captured multiple times, had an overall 2% mortality rate, but an injury rate of over 35%, most of which were considered serious and some deer were injured multiple times (Haulton, et al. 2001:258). Only 29 deer were captured using clover traps. Six fawns died within two weeks of their capture and more than 3% of the deer captured using this method received some type of serious injury (Haulton, et al. 2001:258-259). The mortality rate of deer trapped with rocket-nets was almost 5% with
approximately 2% receiving serious injuries during the trapping process while darting resulted in only one death out of 51 captures and no injuries other than the penetration opening (Haulton, et al. 2001:259). These examples demonstrate that the methods by which Cervidae are captured affect the survival rates of the captured deer and therefore, should be considered when analyzing the epigraphical, historical, and ethnological evidence related to Mayan techniques of capture that are implicated in Cervidae management paradigms.

An Ethnology of Deer

Deer behavior is often discussed as though deer have no agency and make no choices. The Mayan worldview, particularly in ideological conceptions of sacrifice, differs from this considerably as was discussed above (Brown and Emery 2008:302, 304, 310, 312). A 2005 study related to modern conservation issues is a refreshing examination of the options of deer and other ungulates in choosing different environmental landscapes in response to human hunting practices (Reyna-Hurtado and Tanner 2005:676). The study tracked ungulates in the Calakmul Biosphere Reserve, where hunting is not permitted (“protected areas”), and three additional forested zones in which hunting is allowed in order to determine if human predation affected ungulate distribution (Reyna-Hurtado and Tanner 2005:676-678). Reyna-Hurtado and Tanner found that Mazama americana and Mazama pandora preferred drier forest areas in the protected Calakmul Biosphere Reserve, but wet forest where hunting is permitted because humans prefer to hunt in the more hospitable dry forest areas (Reyna-Hurtado and Tanner 2005:680-682). Odocoileus virginianus prefer the same environment as the Mazama species; they thrive in areas
protected from hunters, flourish in ecotonal landscapes between forested areas and meadows or fields irrespective of protection, and avoid the humid tropical subperennial forest that is heavily affected by hunting – gravitating toward optimal forest settings to meet requirements for shelter, food and water, and safe areas in which to mate and protect their offspring (Linares 1976:344, 347; Mandujano and Rico-Gray 1991:179; Reyna-Hurtado and Tanner 2005:677-682; Emery 2008:628). Modern Mayan hunters in the Yucatán are aware that deer proliferate in certain environments and vegetation zones and the Tixcacaltuyub have linguistic terms that categorize deer by presence or absence of antlers, age, size, and color, but not sex (Mandujano and Rico-Gray 1991:179-181). The Mayan worldview regarding the agency of deer may have been affirmed in ancient times by correlations of thriving deer populations in optimal environmental settings and specific patterns of Cervidae behavior and biology are reflected in historical descriptions of Mayan faunal exploitation.
Historical Textual Sources

One paragraph from the *Relación de las Cosas de Yucatán*, suggests that the Maya actively managed deer and other animals. This text from the early contact period describes the agency of Mayan women to engage in deer management practices. The original text is reported to have been written by Friar Diego de Landa in 1566 (Gates 1978 [1937]:xiv; Tozzer 1966 [1941]:vii). Although no original copy remains, Landa’s writings or a selection of them were compiled in the seventeenth and eighteenth centuries and deposited in the Biblioteca de la Real Academia de la Historia in Madrid, Spain (Tozzer 1966 [1941]:vii; Gates 1978 [1937]:xiv; Restall and Chuchiak 2002:653-656, 661-663). This original compilation was then used by Brasseur de Bourbourg to publish a French and Spanish anthology titled *Des Choses de Yucatan de Diego de Landa* in 1864, which has been criticized as inaccurate (Bourbourg 1864; Brinton 1887:1-8; Bowditch 1912:i, iii; Tozzer 1966 [1941]:vii-viii; Gates 1978 [1937]:xiv; Restall and Chuchiak 2002:655-656). Bowditch relied on the Bourbourg text in preparing his unpublished manuscript, but later corrected it using a Spanish version of the original published by Rada y Delgado in 1881 (Rada y Delgado 1881:69-114; Brinton 1887:2; Bowditch 1912:i; Tozzer 1966 [1941]:viii, ix; Gates 1978 [1937]:xiv). The Bowditch translation formed the foundation for the much cited scholarly English translation originally published by Tozzer in 1941 (Tozzer 1966 [1941]:ix; Restall and Chuchiak 2002:657-659). An earlier English translation was published by William Gates in 1937 (Tozzer 1966 [1941]:viii; Restall and Chuchiak 2002:656-657, 659).
The Bourbourg and Rada y Delgado transcriptions of the paragraph below are not exactly the same. The minor discrepancies of spacing and punctuation aside, there is one important difference between the two transcriptions. Bourbourg uses the present tense “Crian aves para vender de Castilla, y de las suyas y para comer. Crian paxaros para su recreacion y para las plumas para hazer sus ropas galanas, y crien otros animales domesticos de los quales dan el pecho a los corços, con lo qual los crien tan mansos que no saben irseles al monte jamas, aunque los lleven y traigan por los montes y crien en ellos” Bourbourg 1864:190

“Crian aves para vender de Castilla, y de las suyas y para comer. Crian paxaros para su recreacion, y para las plumas para hazer sus ropas galanas, y crien otros animales domesticos de los quales dan el pecho a los corços con lo qual los crien tan mansos que no saben irse les al monte jamas aunque los lleven y traigan por los montes, y crien en ellos”

Rada y Delgado1881:86

lleven in the last phrase of the paragraph while Rada y Delgado, whose transcription is reported to be more accurate, rendered this word in the present subjunctive tense as lleven. This changes the verb llevar from something that is carried or taken in the present to something that is intended to be carried or taken in the future, an uncompleted rather than a completed action. Note that both versions have transcribed crien, the present subjunctive tense of criar, and curiously used the present tense of tragar, which is traigan, between the two subjunctive verbs. Normally, verbs that come after aunque, which translates to “although” or “even though,” are expressed in a subjunctive tense because the term indicates something less than a concrete action. Present subjunctive, as mentioned, is used to indicate an intended, but incomplete, action. The use of the present tense traigan indicates that both lleven and crien refer to the latter use of the present subjunctive tense and this changes the meaning of the phrase substantially. Instead of referring to an intentional, but incomplete action, the use of a present tense verb between two subjunctive verbs here establishes that the action occurs not only intentionally, but
also continuously or on a continuous basis and therefore, cannot be completed. Only the Gates version attempts to convey this idea in the English by translating aunque as “even when.” Other translation issues will be discussed in the next section, which compares the three English translations by Bowditch, Gates, and Tozzer and introduces additional language translation issues of this single paragraph using Rada y Delgado’s Spanish transcription.

The first thing that is noticeable about the English translations is that each of the authors translated the Spanish differently. The differences between the translations of the initial phrase are minor, a matter of word order. The later phrases, however, vary enough to convey different ideas. I will argue that none of the translations is completely accurate, but it is important to understand how the words chosen by the translators have influenced ideas regarding Mayan cultural control of animals.

“They raise fowls for sale and for food -- both the Castilian and the native breeds. They also raise birds for their own pleasure, and for the feathers from which to make their fine clothes and they raise other domestic animals, and let the deer suck their breasts, by which means they raise them and make them so tame that they never will go into the woods, although they take them and carry them through the woods and raise them there.”

Bowditch 1912:63

“...Spanish and native fowls for sale, and for eating. They raise birds for their pleasure and for the feathers for adornment on their finer clothes; also raising other domestic animals, among these even offering their breast to the deer, which they have so tame that they never run away into the woods, even when they take them there and back, and raise them there.”

Gates 1978 [1937]:55

“...and for food – both the Castilian and the native breeds; they also raise birds for their own pleasure, and for the feathers from which to make their fine clothes and they raise other domestic animals, and let the deer suck their breasts, by which means they raise them and make them so tame that they never go into the woods, although they take them and carry them through the woods and raise them there.”

Tozzer [1966] 1941:127
The first phrase considered is that regarding the uses of birds. Bowditch and Tozzer add the word “also” to their translations, perhaps to improve readability, although the English is clear without the addition. Gates adds “adornment on”, which does not appear in the Spanish, suggesting that the Maya used feathers as decorative elements rather than as the raw material from which fine clothing is made. Later in the text, Landa uses the phrase “y quieren aquella pluma para las labores de sus ropas,” in reference to duck feathers that are attached to clothing as “embroidery” (Rada y Delgado 1881:111; Tozzer 1966 [1941]:201). Thus, it is quite probable that feathers were used both as adornments and clothing materials.

Gates’ translation of su recreacion [sic] as “their pleasure” is more accurate as there is nothing in the Spanish to indicate a reflexive verb. Although “pleasure” as an alternate to “recreation” is a legitimate translation of recreación, it seems an unlikely choice in a section of text describing the economic “industriousness of Maya women” (Pohl and Feldman 1982:304). Additionally, the verbs gustar or placer would be more appropriate to indicate that something is pleasing because in Spanish, pleasure is an act of being pleased, requiring a reflexive verb. An alternative English word that would capture this emotive meaning would be “amusement.” There is another meaning ascribed to recreación, however, that may be more appropriate given the economic context related to fauna, which is “reproduction” or re-creation. This is based on the alternate meaning of the verb recrear “to reproduce,” whereas recreate only means “to entertain oneself” when the reflexive suffix se is used, which is not the case here.
It is unknown why Bowditch, Gates, and Tozzer chose the provocative phrasing they did for the Spanish term *dan el pecho*. The phrase can simply be translated as “they breastfeed.” The literal translation is “they give the breast,” which would account for the translated phrasing, except that none of the translators used literal translations for other Spanish terms, even when the literal translation was more accurate and the phrasing easily understandable in English, as discussed above. Again, the subject matter of the text is economic and nothing in the original Spanish indicates that de Landa was using poetic forms, and thus the considered renderings have chosen terms that provide the reader with an unnecessarily dramatic perspective. Also, Gates’ use of the phrase “of which” for *de los quales* correctly distinguishes the deer categorically from the other animals that de Landa called domesticated (“animales domesticos”). It is not known why de Landa made this distinction, but the context suggests it was because the deer were provisioned differently than other managed animal populations. It is important to note here that Landa states clearly that dogs were the only domesticated animals, defined by him as not causing harm to humans (Rada y Delgado 1881:112; Tozzer 1966 [1941]:203). The Maya make clear distinctions between places where people live and places where people do not live; therefore, Mesoamerican researchers understand the phrase “domesticated animals” to mean tamed animals that were raised in domestic contexts.

The remainder of the paragraph is quite challenging, involving several words that have multiple meanings, including the verb *recrear* that is discussed above, and issues of practice that are difficult to ascertain from the text. The first question of “to raise” versus “to create” that has been more accurately translated phrasally by Bowditch and Tozzer as
“by which means they raise them and make them so tame that” is effective in that the deer are created or made tame because they were breastfed (i.e., raised) by the Mayan women. All of the translators chose “woods” to render the Spanish montes. There are no mountains, the most common use of montes, in the Yucatán, so one of the many alternative meanings is correct (Wagner 1942:2; Goldman and Moore 1945:360). “Countryside” might be a more appropriate choice as it is inclusive of both the forested areas preferred by Mazama sp. and the patchwork agrarian landscapes preferred by Odocoileus sp., which would include wooded areas near the milpas. An essential consideration here is that montes is referring to locations the Maya considered to be outside of domestic contexts.

Agency is marked differently in Spanish in comparison to English. It is here indicated by the reflexive se attached to the infinitive verb ir, which means “to go.” The context, including the negative verb phrase no saben, which indicates not having knowledge, clarifies that the phrase is stating that the tame deer do not go [by themselves] into the countryside without humans because they are tame and are habituated to human behavioral expectations. The translation by Gates of the final phrases is more accurate in that it includes both a going to and a returning from the countryside, which is indicative of an intentionally maintained physical control or management of deer. All three translators chose “raise” in translation of crien, a verb that is in the subjunctive present tense as discussed above; this requires a translation of “would raise in them [the countryside or forests]” to be clear. An alternative reading is “would breed in them [the countryside or forests].” There is not enough context to determine if the going to and
returning from the countryside was a daily or occasional occurrence in order that the deer might procure food for themselves or if it was an annual trip for the purpose of allowing the deer to reproduce. The lack of the reflexive se here seems to indicate that the former case was more likely and explains the choice of “raise” by the translators, although criar is sometimes used without the reflexive to mean “breed.” The same lack of reflexion related to the verb criar, however, also indicates the deer were not feeding or raising themselves while in the countryside. This leaves open the question of which practice the ancient Mayan women were engaging in when taking the deer back and forth to the countryside. Also called into question is the interpretation of the codex images that depict deer tied to trees as having been caught in snares or traps. It is possible that the deer are depicted as tethered to prevent them from wandering if they are left in the woods for feeding or breeding. Given the limitations of historic texts on the subject, the specifics of such management practices cannot be known, but archaeological evidence concerning Cervidae diets during the Postclassic Period may reveal whether the trips to the forest were for provisioning or reproduction.
Archaeological Evidence

Formative and Classic Period Archaeological Evidence

Animal exploitation during the Formative Period in the Maya area is characterized as a hunting based strategy. Deer hunting at Cuello in Belize might have involved extensive planning (Hammond 1991:239). One report from Cuello, however, seems to indicate a shift from deer as the primary subsistence resource to smaller mammals such as *Dasypus novemcinctus* (armadillo) and *Kinosternum* sp. (mud turtle) throughout the Formative Period, but it is thought that deer remained an important game animal at Cuello continuing into the Classic Period (Carr 1985:129, 131; Hammond 1991:238, 247; Wing and Scudder 1991:85, 88-94, 97, 146-148; Fradkin and Carr 2003:36-38, 40-41). In fact, *Kinosternum* sp. is so well represented at Cuello that it is thought to have been a managed wetland faunal resource, although there is no evidence that any *Cervidae* species were managed (Hammond 1991:239; Fradkin and Carr 2003:40-41; Masson 2004:119; Carr and Fradkin 2008:146, 149). Turtles were also a major source of meat protein at Preclassic Period K’axob and Colha, which was found to differ from the Terminal Classic Period site of Northern River Lagoon that was heavily reliant on fish (Masson 2004:119, 122). The possibility of turtle management suggests that the Maya were engaging in subsistence practices to increase food resource reliability and sustainability in the Formative and Classic Periods.

A study of faunal remains recovered from other excavations at Cuello describes an agricultural environment that was conducive to a “garden hunting” procurement strategy.
as does the evidence from Preclassic Period Cerros (Linares 1976:344-345, 347-348; Carr 1996:258-259; Carr and Fradkin 2008:145, 147, 151; Emery 2008:628). Hunting strategies that take advantage of the ecotonal environment between forest and *milpa* in order to procure deer have also been ethnographically documented (Mandujano and Rico-Gray 1991:178, 181). Forest clearing for *milpas* would have provided more opportunities for garden hunting in addition to feeding larger polities like Colha. Faunal evidence for the possibility of Classic Period deforestation is seen in the absence of tapir and it has been suggested that the Terminal Classic Period appearance of tapir in Northern Belize indicates a return of forest environments (Masson 2004:121). Colha also seems to have had more access to deer and other terrestrial mammals than K’axob, thought to be related to its higher status in the Preclassic Period sociopolitical structure (Masson 2004:121).

Generally, animal exploitation in the Yucatan peninsula during the Classic and Postclassic Periods is characterized by reliance on local faunal resources supplemented at larger sites like Mayapán by regionally available fauna that may have been traded between sites (Götz 2008:164-167; Masson and Peraza 2008:172; Sharpe 2011:84-85, 102-103, 105-106, 169, 175-176).

Studies of some Classic Period fauna have provided evidence that the Maya were managing deer populations. The age profile of deer remains recovered from Caracol in Belize reveals that the number of subadult deer increased throughout the Classic Period, although it is not clear whether selective hunting or culling practices explain the phenomenon (Teeter and Chase 2004:165-166). Antler fragments were recovered *in situ* from one of the structures at Seibal in Guatemala, which has been identified as an animal
pen that may have been used to contain deer (Pohl and Feldman 1982:299; Pohl 1985c:140). Studies at the Classic Period sites of Altar de Sacrificios and Macanche in Guatemala also report high proportions of subadult deer, which indicates that game management may have been a regional adaptation, rather than one localized to the Yucatan peninsula (Masson and Peraza 2008:180). Although the evidence is limited, it seems likely that the shift from generalized hunting procurement strategies to selective hunting practices, including possible deer management, may have begun during the Classic Period (Masson and Peraza 2008:180).

**Evidence from Postclassic Period Mayapán**

Evidence for the management of deer has been accumulating at the Postclassic archaeological site of Mayapán (Masson and Peraza 2010:37). Masson and Peraza (2008) argued that deer management was one of several faunal procurement strategies practiced at Mayapán (Masson and Peraza 2008:170, 181; Gazdik 2010:4, 16). The age structure profile of *Odocoileus* sp. specimens from the monumental core of Mayapán was similar to that of dogs, known to have been domesticated by the Maya prior to the Postclassic Period, with full-sized subadult proportions ranging from around 14% to just over 42% of various unfused long bone epiphyses to those that were fused (Masson and Peraza 2008:178-179). The proportion of unfused *Odocoileus* sp. long bone epiphyses was similarly high in the sample recovered from domestic houselots located outside of the monumental center (Masson and Peraza 2008:177-179). Another study found a much higher proportion (over 60%) of unfused elements in the houselots, although the small sample size (n = 18) may have skewed the results, while the larger sample (n = 165) from
the monumental center excavations found a similar proportion of unfused to fused elements to those reported by Masson and Peraza (Gazdik 2010:32). Gazdik (2010) concluded that residents of Mayapán likely selectively hunted full-size subadult deer; sex was not determinable for the sample (Gazdik 2010:13, 15-16, 18-19). The presence in a faunal assemblage of a large proportion of subadults that have attained their full adult size supports optimization theories that predict maximum food value for the least amount of energy or economic expenditure (Masson and Peraza 2008:172-173, 179; Reitz and Wing 2008:253-255). It is thought that most of the white-tailed deer specimens examined by Masson and Peraza were around 2.5-3.5 years of age based on the age of epiphyseal fusion (Masson and Peraza 2008:177). Specifically, the age structure of white-tailed deer at Mayapán varies considerably from that expected for white-tailed deer in a setting devoid of significant human manipulation (Masson and Peraza 2008:179).

Structures thought to be animal pens have been frequently mapped at Mayapán (Pohl and Feldman 1982:301; Masson and Peraza 2008:180; Russell 2008:693-705; Gazdik 2010:15). Enclosures in both internal residential areas and outside of Mayapán’s wall may have housed deer or turkeys (Russell 2008:694, 696, 698, 701-702; Gazdik 2010:13). One pen was located in a ritual context (Russell 2008:699-700, 704-705). Another pen (Group 14P-4) contained a small enclosed structure that may have been used to store fodder; it had a limestone slab “bench” that would have been too high for peccaries (Tayassu sp.) to reach and Russell suggests this feature functioned as a deer “feeding station” (Russell 2008:696). The Group 14P-4 pen structure was not located near a residence, lending support to the idea that it was built intentionally to corral game.
(Russell 2008:695-696). This suggestion is further supported by ethnographic analogies, in which similar pens were constructed and a limited control of modern deer is observed (Turner 1985:203; Emery 2004:31; Russell 2008:697-698; Gazdik 2010:9-10). The architectural evidence as well as the high proportion of subadult *Cervidae* remains excavated at Mayapán have provided evidence that the Maya managed deer populations.
Methodological Considerations

Osteological Measurement

Clear definitions of anatomical directions and measurement terms are necessary for any study to be useful comparatively as well as providing the basis for understanding what is being measured. The directional terms standardized by von den Driesch (1976) are followed in this study, with one exception that is explained below. *Odocoileus virginianus* and other deer ambulate upon four legs. Thus, in this study the term “dorsal” means towards the spine or sky while “ventral” means towards the stomach or ground. The term “cranial” denotes the direction towards the head and the term “caudal” denotes the direction towards the tail. Towards the trunk of the animal’s body is indicated by the term “proximal” while away from the trunk of the animal’s body is indicated by the term “distal.” The median plane bisects both the cranium and the tail; therefore, the side of a bone closer toward the median plane is the “medial” side and the side of a bone further away from the median plane is the “lateral” side. Use of the term “dorsal” to denote both up towards the spine and the front of the lower leg bones is ambiguous; for clarity, the term “cranial” will be used here to indicate the front of the leg bones and the term “caudal” to indicate the rear of the leg bones, in keeping with the definitions of these terms as described above and in addition to the application of these terms in regards to “the scapula, humerus, pelvis, and femur” (von den Driesch 1976:14-16).

Measurements are typically taken using slide gauge calipers, curved calipers, or an osteological board and are recorded in millimeters (von den Driesch 1976:8-9). Multiple
measurements of any specific faunal specimen are considered to be better than a single measurement as multidimensional data allows for more accurate analysis (von den Driesch 1976:1; Reitz and Wing 2008:179). Osteological remains that have been exposed to fire cannot always be accurately measured, as experiments have demonstrated that the original bone size can be reduced by an average of five percent and the original bone weight reduced by an average of fifty percent in thermally impacted bones (von den Driesch 1976:3-4; Reitz and Wing 2008:180). The measurement of subadult bones, identified by unfused epiphyses or osteological porosity, is merited for special purpose studies, “justified in the case of exceptional size,” or for the purpose of ascertaining specimen age (von den Driesch 1976:4). Late fusing epiphyses are better indicators of adult specimens, although they are less well-preserved in the archaeological record than early fusing epiphyses (von den Driesch 1976:5). Long bones of hooved animals tend to preserve well and are relatively easy to measure, but the value of those measurements in indicating the overall size of individual animals can vary (von den Driesch 1976:6-7). Another measurement concern is that the points on long bones that are used in maximal measurements are not necessarily on the same plane and it is suggested that maximal length be measured in “projection” to relocate the measurement points on the same plane, but to measure maximum breadth on the “diagonal” (von den Driesch 1976:65).

**Ageing Archaeological Faunal Remains**

Dental material provides the most accurate measure of age, but good samples are often unavailable in archaeological faunal assemblages (Carden and Hayden 2002:227, 235; O’Connor 2002:1; Emery 2004:21; Reitz and Wing 2008:174-178, 195-196).
Alternatively, epiphyseal fusion rates have been used to provide a reasonably accurate age at death for animals from bones that are more frequently recovered (Purdue 1983:1207, 1209-1212; Carden and Hayden 2002:227-234; Reitz and Wing 2008:70-73, 173-174 193-196). Earlier fusing long bones in *Odocoileus virginianus* demonstrate less variability in fusion age than those that fuse later in life (Purdue 1983:1210). The proximal radius, distal humerus, and distal ulna of females tend to fuse slightly earlier than those of males, but only by a few months (Purdue 1983:1210-1211). More importantly, Purdue (1983) found no geographical or nutritional effects on epiphyseal fusion rates in *Odocoileus virginianus*, increasing the reliability of comparable age structure data across populations, independent of environmental factors (Purdue 1983:1211-1212).

The age structure of *Cervidae* remains recovered from archaeological sites can reveal procurement strategies and the effects of other human practices. A striking change in the demography of faunal remains, for instance, may indicate a shift from primarily hunting procurement strategies towards husbandry or other practices like those of incipient domestication (Emery 2004:31). Predator population reduction, whether intended to protect local human populations or to procure primary and/or secondary faunal products, results in increased *Cervidae* and other prey populations (Pohl 1985c:137; Carr 1996:256). Cultural control, especially husbandry, is indicated by an age profile that includes more full-size subadults represented in the faunal assemblage versus the proportion of full-size subadults that would normally be present in a species population (Carr 1996:256). A similar age structure can also indicate preferential hunting strategies.
(Carr 1996:256-257; Emery 2004:21; Masson and Peraza 2008:180). Carr’s (1996) analysis of the effects on deer age structure from an increasing human population predicts two alternative impacts on a simultaneously decreasing Cervidae population: First, either juvenile deer represent a larger proportion of a sample, implying overhunting and fewer prey animals living to normal life expectancy. Second, a decrease in the number of overall deer bones coupled with a selective age profile of primarily mature deer and few juveniles might indicate a conservation strategy (Carr 1996:259-260; Emery 2004:20). Thus, determining the age structure for Cervidae remains from Mayapán is important for clarifying details of possible hunting practices as well as management strategies such as husbandry or other means of cultural control.
Methodology

The specimens included in this study were selected from faunal materials recovered from Mayapán as part of the Proyecto Económico de Mayapán. Currently on loan to Marilyn Masson from the Instituto Nacional de Antropología e Historia in Mexico, these specimens are presently located in the zooarchaeology laboratory on the campus of the University at Albany, State University of New York, in the United States. Most of the specimens had been excavated during the 2008 and 2009 field season, although some were recovered during earlier excavations. The sample of Cervidae specimens examined in this study can be characterized as a convenient, but purposive cluster sample (Bernard 2006:157, 189, 191-192). A total of 310 bone specimens were examined and 103 were determined to be measurable (i.e., included the points of measurement necessary to measure the maximum breadth of an element).

This study used greatest breadth measurements to characterize and compare metrical data obtained from Cervidae long bones recovered at the archaeological site of Mayapán in Yucatan, Mexico (Appendix A). The total number of bones measured was 103; eleven of these were complete specimens in which both distal and proximal measurements were taken. Fifty-two of the bones included only the distal end while an additional forty represented only the proximal end of the bone. Specific bone elements and the number of measured specimens are detailed in Table 1. A measurement of the greatest breadth of the distal end (Bd) was obtained from 62 of the bones and a measurement of the greatest breadth of the proximal end (Bp) was obtained from 52 of the bones. A total of 115
measurements of greatest breadth were taken. Greatest length (GL) was determined for four of the long bones. Depth measurements were taken at axes perpendicular to the maximum breadth measurement when possible, but were determined to not add any additional information and were not considered in this study. Finally, the sample sizes for greatest length measurements was considered too small to be useful and were also excluded from this study (See von den Driesch 1976:65-66, 76-77, 79-81, 84-87, 92-93; see also Densmore 2009:7; and Vukićević, et al. 2012:78 for additional diagrams of the described measurements). Directly comparable measurements of *Odocoileus* and *Mazama* long bones with known demographic information and geographical contexts were not found, which would have shed light on the osteological variation inherent in

<table>
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<th>Taxa</th>
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<th>Unfused</th>
<th>Portion</th>
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<td>2</td>
<td>distal</td>
<td>femur</td>
</tr>
<tr>
<td><em>Odocoileus</em> sp.</td>
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<td>distal</td>
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<tr>
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<td>2</td>
<td>distal</td>
<td>tibia</td>
</tr>
<tr>
<td><em>Mazama</em> sp.</td>
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<td>proximal</td>
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<td><em>Odocoileus</em> sp.</td>
<td>11</td>
<td>5</td>
<td>proximal</td>
<td>tibia</td>
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these two genera, and results should be viewed with caution. All of the measurements except for GL were taken using a Neiko 0-150 mm digital caliper that is accurate to within 0.02 millimeters. Measures of GL were taken using a Neiko 0-300 mm digital caliper, also accurate to within 0.02 millimeters. Two or more photographs of each specimen displaying various perspectives were taken with a scale for future reference.

The state of epiphyseal fusion was noted for each specimen and this was used to classify ages for the specimens as juvenile (unfused and much smaller than the adult mean size), subadult (unfused or partially fused, but comparable to the adult mean size), and adult (completely fused). The sample included one *Odocoileus* sp. juvenile, two *Mazama* sp. full-size subadults, fourteen *Odocoileus* sp. full-size subadults, 55 *Mazama* sp. adults, and 31 *Odocoileus* sp. adults. Care was taken that individual complete bones were only counted once and for these, the later fusing epiphysis was used to construct the age structure profile of the sample. The amount of epiphyseal fusion was compared to lists detailing the approximate ages of *Cervidae* at which each of the long bone epiphyseal ends fuse that have been published by Purdue and summarized by Reitz and Wing (Purdue 1983:1210; Reitz and Wing 2008:72 Table 3.5). It was thus possible to determine the approximate age at death for each of the specimens with a reasonable amount of accuracy. Age proportions were computed as an indication of the diversity of the sample and to determine if the proportion of adults to subadults might reveal whether a conservation strategy was practiced at Mayapán. The age structure is further interpreted using Wing and Scudder's (1991) definition of subadults as those reliably aged at less than thirty months (Wing and Scudder 1991:96 note to Table 4.15).
Descriptive statistical analysis of the measurement data was conducted to characterize the result. The means and standard deviations of the epiphyseal width measurements for each bone type were computed for both *Mazama* sp. and *Odocoileus* sp. specimens. These calculations were used to determine the range of Bd and Bp measurements for each bone element by species and individual specimen measurements were graphed and examined for patterns. Each element was examined for size outliers, defined as measurements that were more than two standard deviations from the mean, which were then reinspected and remeasured for accuracy. Analysis of statistical results was undertaken inclusive of subadults as well as exclusively for adult individuals. Additionally, a series of complete metapodials that are of strikingly different size were examined separately to better characterize the visually observed size variation. Proportional analysis was incorporated to characterize and visualize the age diversity of the sample, but a paucity of comparable data limits this study to interspecies and intrasite inferences. The following section describes the results of the measurement analysis.
Results

Range and Central Tendency Analysis Results

Bone size ranges for *Mazama* sp. and *Odocoileus* sp. did not overlap, even when subadults were included. This is important because it was thought that juvenile or subadult *Odocoileus* sp. specimens might confound the ability to identify adult *Mazama* sp. specimens. Generally, the interspecies interval was almost one half centimeter up to just over one centimeter, discriminating *Mazama* sp. specimens from those of *Odocoileus* sp.; even when subadults were included, the interspecies interval for every bone element was at least three millimeters. There were significant size differences within each species when measurements were plotted in 2 mm intervals. Table 2 illustrates the ranges and the interspecies intervals between measurement ranges for each adult element by taxa while Table 3 includes subadults in order to examine the potential skew caused by their inclusion.

The following discussion regarding the distribution of maximum breadth measurements excludes subadults. Because the interspecies interval was never less than three millimeters, it was thought that classificatory categories of two millimeters would accurately represent the measurement data. Measurements of femoral Bd fell into five separate size groups. Femoral head maximum breadth and Bd of the distal humerus only separated the two species from one another in bimodal distributions, as did the Bp metatarsal measurement and the Bd measurement of the tibia. It is likely that the bimodal
Table 2: Ranges and Means of Maximum Epiphyseal Breadth Measurements per Bone Element of and Interspecies Intervals between Mazama sp. and Odocoileus sp. Excluding Subadults

<table>
<thead>
<tr>
<th>Bone</th>
<th>Portion</th>
<th>Taxa</th>
<th>Interspecies Interval (mm)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Mazama sp.</td>
<td>Odocoileus sp.</td>
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<tr>
<td></td>
<td></td>
<td>Range (mm)</td>
<td>χ</td>
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<td>15.53-19.91</td>
<td>17.48</td>
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<td>humerus</td>
<td>distal</td>
<td>21.14-26.15</td>
<td>24.43</td>
</tr>
<tr>
<td>tibia</td>
<td>distal</td>
<td>20.25-23.65</td>
<td>21.76</td>
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<tr>
<td>metacarpal</td>
<td>distal</td>
<td>16.24-17.83</td>
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<td>metatarsal</td>
<td>distal</td>
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<td>18.23</td>
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<td>30.86</td>
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<td>tibia</td>
<td>proximal</td>
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<tr>
<td>femoral heads</td>
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<td>15.94-17.60</td>
<td>16.41</td>
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Table 3: Ranges and Means of Maximum Epiphyseal Breadth Measurements per Bone Element of and Interspecies Intervals between Mazama sp. and Odocoileus sp. Including Subadults

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<tr>
<th>Bone</th>
<th>Portion</th>
<th>Taxa</th>
<th>Interspecies Interval (mm)</th>
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<tr>
<td></td>
<td></td>
<td>Mazama sp.</td>
<td>Odocoileus sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range (mm)</td>
<td>χ</td>
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<td>metacarpal</td>
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<td>15.34-18.14</td>
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<tr>
<td>humerus</td>
<td>distal</td>
<td>21.14-26.15</td>
<td>24.43</td>
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<tr>
<td>tibia</td>
<td>distal</td>
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<tr>
<td>metacarpal</td>
<td>distal</td>
<td>16.24-17.83</td>
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<td>femoral heads</td>
<td>proximal</td>
<td>15.94-17.60</td>
<td>16.41</td>
</tr>
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distributions of the femoral head and distal humerus maximum breadth measurements were affected by the small sample size. The sampled metacarpal Bd and Bp, the Bp measurement of the tibia, and also the metatarsal Bd measurements, however, resulted in trimodal distributions. The measurement distributions are illustrated in Appendix B and an interpretation of the range and interval data is offered in the “Discussion” Section below.

The measures of central tendency were helpful in characterizing and understanding the effect of subadults within the sample and may provide comparative data for other studies so are included here. The distal femora of Mazama sp. had a mean of 30.86 that surprisingly rose to 31.72 when subadults were included, while the standard deviation reduced from 2.70 to 2.50. The mean for greatest width of the femoral head for Mazama sp. was 16.41 with a standard deviation of 0.80. The eleven Mazama sp. distal humeri were all adult specimens and had mean breadths of 24.43 with a standard deviation of 1.52. Likewise, the Mazama sp. metapodials, the proximal portions fusing on birth and the distal ends completely fusing by 29 months, included only fused specimens. Distal and proximal metacarpals had means of 17.14 with a standard deviation of 0.66 and 16.75 with a standard deviation of 1.04, respectively. The metatarsals showed a reverse pattern with more deviation in the earlier fusing proximal portion (17.48 with a standard deviation of 1.33) than the later fusing distal end (18.23 with a standard deviation of 0.68). The distal tibiae of Mazama sp. had a mean of 21.76 with a standard deviation of 1.01. Finally, the proximal tibiae of Mazama sp., one of the last epiphyseal surfaces to fuse, had a mean of 35.99 with a standard deviation of 2.10, the deviation of which is
comparable to that of the distal femur, which is also late fusing. The central tendency results of the maximum breadth of *Odocoileus* sp. long bones are presented separately so that any differences between the species are clear.

The femurs from the *Odocoileus* sp. population, like that of the *Mazama* sp., represented several subadults. The results of subadult inclusion were more expected than those of *Mazama* sp. as the mean for distal femora shrank from 47.87 with a standard deviation of 5.49 to 46.17 with a standard deviation of 5.24 when subadults were included and from 23.44 with a standard deviation of 0.63 to 22.33 with a standard deviation of 2.16 for the maximum breadth of the femoral head. Only two adult *Odocoileus* sp. distal humeri were found to be measurable in the sample and these averaged to 38.12 with a standard deviation of 1.16. The one subadult represented in the *Odocoileus* sp. metacarpal sample is a complete element with a fused proximal end and an unfused distal end. The adult distal metacarpals had a mean of 27.67 with a standard deviation of 3.29 that was skewed to a mean of 26.44 with a standard deviation of 3.65 and the mean of adult proximal metacarpals (26.77 with a standard deviation of 3.50) was also skewed to 25.79 with a standard deviation of 3.75 because the small sample size was affected by the single subadult bone in this case. The two adult *Odocoileus* sp. distal metatarsals averaged 25.57, with a high standard deviation of 4.84. The mean of the four adult *Odocoileus* sp. proximal metatarsals displayed less variation at 24.61 with a standard deviation of 1.02. The mean for *Odocoileus* sp. distal tibiae was 32.83 with a standard deviation of 1.51 and only slightly reduced to 32.57 with a standard deviation of 1.44 when two full-size subadults were included. This was similar to the effect on the late
fusing proximal tibiae, the mean of which reduced slightly from 49.51 with a standard
deviation of 3.19 to 48.44 with a standard deviation of 2.95 when the measurements for
maximum breadth of five adult individuals were combined with those of six subadult
*Odocoileus* sp. specimens. Thus, not only are the means of *Odocoileus* sp. larger than
those of *Mazama* sp., the standard deviations are also larger.

**Age Structure Profile Results**

There were very few unfused *Mazama* sp. specimens in comparison to *Odocoileus* sp.
in the sample and the number of specimens in each fusion category is illustrated in Table
4. While overall juvenile and subadult specimens make up about 14% of the entire
sample and less than 2% of the bones identified as *Mazama* sp., they account for 28% of

<table>
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</table>
| *Odocoileus*| unfused| juvenile | 1  | 1.75%
| *Mazama*    | unfused| subadults| 2  | 1.75%
| *Odocoileus*| unfused| subadults| 14 | 10.53%
| *Mazama*    | fused  | adults   | 55 | 54.39%
| *Odocoileus*| fused  | adults   | 31 | 31.58%
| **Totals**  |        |          | 103| 100.00%|

the *Odocoileus* sp. faunal remains as is illustrated in Figures 4, 5, and 6. When the age
structure was divided first by taxa and then into age categories following Reitz and Wing
2008, the diversity of the population structure became apparent (Reitz and Wing 2008:72
Table 3.5). The age category 0 is based on proximal metapodials, which are fused at birth
or shortly afterward and should be reviewed with caution as it is not possible to
determine age from this bone portion. It would be best to view this as an unknown age category. When the proximal metapodials were removed from consideration, a very clear picture emerged of the difference between the age structure of *Mazama* sp. and the age structure of *Odocoileus* sp. at Mayapán (Figure 6). The *Mazama* sp. remains in the sample, after correcting for specimens that cannot be accurately aged (i.e., those in age category 0), are dominated by bones that fuse under thirty months of age (80%, n=37) (Figures 7 and 8). The *Odocoileus* sp. sample after correction, on the other hand, shows that 41% of the sample population (n=17) is represented by bones that fuse after thirty months (Figures 9 and 10). Both samples, however, are composed primarily of bones that fuse at over twenty months of age and that likely represent deer that were adults or approaching full-size. When the long bones of subadults with unfused epiphyses were considered, 78.57% were the same size as adults with fully fused epiphyses.

![Age Structure of Mazama sp. in Sample](image)

**Figure 4:** Age Structure of *Mazama* sp. at Mayapán by Fusion Category
Figure 5: Age Structure of *Odocoileus* sp. at Mayapán by Fusion Category

Figure 6: Age Structure of *Cervidae* at Mayapán by Fusion Category
Figure 7: Number of *Mazama* sp. Specimens per Age Category in Mayapán Sample

Figure 8: *Mazama* sp. Age Diversity in Mayapán Sample
Particularly interesting after the age correction is the result that nearly a quarter of the Mazama sp. sample was of bones that fuse at less than twenty months of age compared to only 5% of the Odocoileus sp. sample (Figures 11 and 12). This unexpected result and its implications are discussed below along with the results from the other analyses.

Figure 9: Number of Odocoileus sp. Specimens per Age Category in Mayapán Sample

Figure 10: Odocoileus sp. Age Diversity in Mayapán Sample
Figure 11: Minimal Age of *Mazama* sp. Elements Based on Epiphyseal Fusion

Figure 12: Minimal Age of *Odocoileus* sp. Based on Epiphyseal Fusion
Discussion

This study was undertaken to determine if there was osteological evidence to support previous claims that some sort of cultural control of deer was practiced at the Postclassic Mayan site of Mayapán. All of the previous studies, including one that was based on metrical evidence, examined *Odocoileus* sp. specimens only while this study included both *Odocoileus* sp. and *Mazama* sp. specimens. Thus, this study was able to determine what differences, if any, existed in how the two types of deer were treated at Mayapán. Previous researchers have consistently noticed that some bones in the assemblage do not fit the average sizes of the majority of deer bones in the sample. It has generally been assumed that *Odocoileus virginianus* and *Mazama americana* are the only deer species present in the Yucatan region, but the unusually sized specimens, smaller than white-tailed deer and larger than brocket deer, have led some researchers to speculate that multiple species might be present (Tozzer and Allen 1910:348; Carr 1996:251, 257-258; Emery 2004:19; Marilyn A. Masson, personal communication 2013).

This study tested the hypothesis that two subspecies of *Mazama* sp. (*M. americana* and *M. pandora*) and at least one, but possibly two subspecies of *Odocoileus* sp. (*O. virginianus* and possibly *O. thomasi*) were present in the Mayapán faunal assemblage. The result of the frequency distribution showed that the maximum breadth measurements of long bones identified as *Mazama* sp. differed from those identified as *Odocoileus* sp. by at least three millimeters, which is a large enough difference that the two genera are reliably identified visually on size alone. Classification categories were placed at two
millimeter intervals in order to reveal intragenus variation, but resulted in the same intergenus distribution as when the classification categories were placed at three millimeter intervals. There was no size overlap between the Mazama sp. and Odocoileus sp. specimens in the sample. Past research questions have focused on subsistence strategies, iconographic interpretation, and husbandry rather than the more biological or paleontological questions of Cervidae intraspecies variation, although taxon identification is one of the most basic zooarchaeological tasks (Emery 2004:19-20). Therefore, the ability to detect inter- or intraspeciation through descriptive statistics improves the ability of researchers to understand faunal evidence.

Bimodal distributions in the greatest breadth of the femoral head and distal tibia remained bimodal even when subadults were considered. All of the multimodal distributions for adult deer retained the same multimodal character when subadults were considered; although the ranges of the maximum breadth of the proximal tibia and distal femur of Odocoileus sp. specimens were slightly lowered by subadult specimens, neither entered into the Mazama sp. range. The multimodal distributions of the maximum breadth of the distal femur and proximal tibia support the hypothesis that two Mazama sp. species are present at Postclassic Mayapán. The histograms also provide quantitative evidence that supports previous claims that deer may have been raised until reaching full-size, which suggests human management of deer at Mayapán in the Postclassic Period.

It has been presumed that the Maya managed, but never domesticated deer, as no genetically-altered domesticate is known. Therefore, evidence of osteological size
differences does not suggest domestication among Mesoamerican *Cervidae* skeletal remains. Deer hunting continued throughout the Postclassic Period and it is possible that selective hunting strategies were used in order to balance an increasing human population and decreasing *Cervidae* populations as Gazdik has suggested (Gazdik 2010:14). The ethnographic study of modern Tz’utujil and Kaqchikel hunters in Guatemala indicates beliefs that deer offered themselves to hunters and this belief is used to explain somewhat even proportions of young versus more mature individuals. However, more young deer are successfully hunted in these cases than would be predicted for a human group concerned with conservation, perhaps as a response to local game shortages (Carr 1996:260; Brown and Emery 2008:319-321).

The age structure profile of *Cervidae* at Mayapán can be explained by Mayan hunting practices were it not for the architectural evidence of animal pens that were suitable for housing deer and the ethnohistorical accounts of tamed and controlled deer that were raised and perhaps bred by Mayan women. The human population of Mayapán during the Postclassic Period is estimated at approximately 17,000 residents, and given the many uses of deer primary and secondary products, it seems unlikely that hunting was the sole method of procurement or that it would have provided enough deer to satisfy the need for this vital subsistence, economic, ritual, and social resource (Russell 2008:487). Therefore, a mixed procurement strategy that included the cultural control of *Cervidae* as has been proposed by Masson and Peraza remains a credible possibility.

The animal pens described by Russell (2008) meet Hecker’s four criteria of cultural control. Walled pens were potentially able to confine a population of tethered deer, or of
free deer if the walls were high enough to prevent jumping. Alternatively, the deer may have been tame enough to prevent flight. Although evidence for provision of food and water for a confined population is undocumented, a longterm relationship between the humans and the deer at Mayapán is inferred from multiple lines of evidence. Finally, the location of pens outside of the city as well as within Mayapán, is suggestive of human intent to manage deer.
Conclusions

Although this study does not provide conclusive evidence regarding the husbandry or management of *Cervidae* at Mayapán, it discusses some of the reasons a purely hunting strategy was likely untenable. Additionally, concepts of agency and practice as well as biological factors were reviewed to clarify interpretations for iconographic evidence and historical texts related to the past relationship between humans and deer in the Mayan region. The age structure profiles for *Mazama* sp. and *Odocoileus* sp. support previous studies of the faunal assemblage from Mayapán in that the age diversity of the two species is different, indicating little evidence for management of *Mazama* sp. while *Odocoileus* sp. may have been both husbanded and hunted, accounting for a larger percentage of adult and full-size subadult specimens. It is possible that some of the specimens identified as *Mazama americana* are *Mazama pandora*, but comparative osteological specimens are needed in order to confirm that visually observable differences are reflected in the skeletal anatomy. This study did not find conclusive osteological evidence of a second *Odocoileus* species, such as *O. thomasi*, at Mayapán. The greatest breadth of *Mazama* sp. and *Odocoileus* sp long bones, however, is sufficiently different to aid in taxa identification. Future studies should consider the possibility that various *Cervidae* species or subspecies inhabited ecological landscapes accessible to precontact Maya towns, perhaps requiring different procurement strategies.

The metric data compiled in this study would be strengthened by additional measurements of *Cervidae* long bones recovered from Mayapán. Complete skeletal
elements would allow evaluation of the association between measurements of greatest length and greatest breadth. Additionally, DNA and isotopic analysis studies of the Mayapán *Cervidae* osteological material should be undertaken to provide additional evidence concerning Mayan management of deer. Finally, it is hoped that the data collected in this study will support future archaeofaunal research in Mesoamerica by providing a baseline characterization of Mayapán deer size variation.
Note

1. The literal translation would be “with it [referring to breastfeeding] which them they raise/create so much tame that they do not know to go themselves to the mountain/country(side)/woodland/scrub never although/even though them they would carry/take/have/bear/run/lead and they bring/bring back to the mountains/country(side)s/woodlands/scrub, and raise/breed in them. Additionally, the phrase *lleven y traigan* can be translated as “they would bother/pester,” although this would be a highly unlikely translation in this context.


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Restall, Matthew, and John F. Chuchiak IV

Reyna-Hurtado, Rafael, and George W. Tanner
Rindos, David

Russell, Bradley W.

Scott, Kathleen M.

Seler, Eduard

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Wagner, Henry R.

Wing, Elizabeth S., and Sylvia J. Scudder

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Appendix A: Long Bone Measurement Diagrams
Figure 13: Measurement of the Greatest Breadth (Bp) of the Proximal Tibia

Figure 14: Measurement of the Greatest Breadth (Bd) of the Distal Tibia
Figure 15: Measurements of the Greatest Breadth (Bd and Bp) of the Metacarpal

Figure 16: Measurements of the Greatest Breadth (Bd and Bp) of the Metatarsal
Figure 17: Measurement of the Greatest Breadth (Bd) of the Distal Humerus

Figure 18: Measurement of the Greatest Breadth of the Femoral Head
Appendix B: Distribution Histograms

Maximum Breadth Measurements of Adult Specimens
Inclusive and Exclusive of Full-Size Adult Specimens of
Mazama sp. and Odocoileus sp. Long Bones from Mayapán, Yucatán, México
Figure 19: Distal Femur Maximum Breadth (Bd) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 20: Distal Femur Maximum Breadth (Bd) of Adult and Full-Size Subadult Cervidae Specimens from Mayapán Sample
Figure 21: Femoral Head Maximum Breadth of Adult Ceridae Specimens from Mayapán Sample
Figure 22: Femoral Head Maximum Breadth of Adult and Full-Size Subadult Cervidae Specimens from Mayapán Sample
Figure 23: Distal Tibia Maximum Breadth (Bd) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 24: Distal Tibia Maximum Breadth (Bd) of Adult and Full-Size Subadult Cervidae Specimens from Mayapán Sample
Figure 25: Proximal Tibia Maximum Breadth (Bp) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 26: Proximal Tibia Maximum Breadth (Bp) of Adult and Full-Size Subadult Cervidae Specimens from Mayapán Sample
Figure 27: Distal Metacarpal Maximum Breadth (Bd) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 28: Distal Metacarpal Maximum Breadth (Bd) of Adult and Full-Size Subadult Cervidae Specimens from Mayapán Sample
Figure 29: Proximal Metacarpal Maximum Breadth (Bp) of Adult Cervidae Specimens from Mayapán Sample
Figure 30: Distal Metatarsal Maximum Breadth (Bd) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 31: Proximal Metatarsal Maximum Breadth (Bp) of Adult *Cervidae* Specimens from Mayapán Sample
Figure 32: Distal Humerus Maximum Breadth (Bd) of Adult *Cervidae* Specimens from Mayapán Sample