THE ZOOARCHAEOLOGY OF THE SAN CRISTOBAL SITE, NICARAGUA

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ABSTRACT

The Zooarchaeology of the San Cristóbal Site, Nicaragua

David Nicholas Rewniak

San Cristóbal is a Pre-Columbian village situated along the southern shore of Nicaragua's Lake Managua. The site is composed of 60 mounds, which served as building platforms for perishable houses, and was excavated between 1977-1979. Faunal remains from the site consist of 17,119 vertebrates and invertebrates from two dated contexts. This study examines and interprets the excavated faunal assemblage from San Cristóbal. It presents a descriptive analysis of the taxa recovered from the site, documenting numbers and overall percentages of animals found at the house mounds, as well as illustrations of faunal use by inhabitants of San Cristóbal. This study is the first of its kind for the Lake Managua region in Pacific Nicaragua. The excavated faunal remains from the site of San Cristóbal point to the exploitation of a high range of biodiversity and a wide variety of ecological niches of the Lake Managua basin in Nicaragua.

Keywords: archaeology, zooarchaeology, Nicaragua, faunal analysis, San Cristóbal, Pre-Columbian, subsistence, Lake Managua

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Identifications were made with the help of Dr. Kevin Seymour at Royal Ontario Museum (ROM). Dr. Seymour generously allowed me to use the ROM comparative collection, as well as providing lab space for me while I was in Toronto. He graciously assisted me with identifying several ambiguous and unusual faunal specimens I had found.

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In Nicaragua, I am grateful to Susan Bursey Wyss for her hospitality in Managua and providing me with the opportunity to examine the San Cristóbal faunal collection from her 1976-79 field seasons. I would like to thank Dr. Geoffrey G. McCafferty from the University of Calgary, for his generosity as well as an invitation to participate on excavations in the Rivas region. I would like to extend warm thanks to Dr. Kitty Emery, of the Florida Museum of Natural History, for resourcefulness and literary contributions. I would like to thank Dr. Morgan Tamplin, Trent University, for his generous

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Dedication

To my mother Adeline Rewniak,

for her love, strength and continual care no matter how old I get.

To my Fiancée,

for her love, support and generosity, no matter where I am.

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CHAPTER 1
INTRODUCTION

From 1976 to 1979, Susan Bursey Wyss of Texas A&M University conducted an archaeological survey of the San Cristóbal archaeological site, near the south shore of Lake Managua, Nicaragua. Locations for excavation were based on surface reconnaissance of various mounded sites around Lake Managua (Wyss 1983:41). The site of San Cristóbal is composed of 60 earthen mounds, one to eight meters high. These mounds originally served as building platforms for the perishable pole-and-thatch houses and ceremonial structures of Pre-Columbian peoples in this region. Healy (1980:14) suggests that this community was a small Pre-Columbian farming village.

Wyss' (1983) systematic excavation of ceramic, lithic, organic, and faunal remains from San Cristóbal survived as a collection in protective storage in Managua, despite decades of political upheaval in Nicaragua. The total faunal collection consists of approximately 17,000 potentially identifiable specimens from well-dated contexts, ranging from about 500 BC-AD 1527. According to a brief and very preliminary analysis conducted during the late 1970s by Usrey (1979), the assemblage is predominantly composed of fish; other taxa include deer, agouti, dog, birds, snake, iguana, turtle, caiman, and frog.

Detailed study of this well-preserved collection, offers an exceptional opportunity to expand Wyss' work, and develop a regional faunal database to permit interregional comparisons within Lower Central America. This region, defined archaeologically, encompasses all of Nicaragua, Costa Rica, Panama, and most of El Salvador and Honduras (Lange and Stone 1984:3). This collection is even more significant because there is an almost total lack of zooarchaeological research and quantitative data from Pre-Hispanic Nicaragua, which precluded any understanding of regional faunal exploitation.

Aside from a very preliminary analysis from one excavation, the animal bones from San Cristóbal had not been analyzed before and this collection's large size and excellent preservation, it clearly made an important faunal assemblage that needed study. The questions asked of the excavated faunal assemblage from San Cristóbal are:

1) What animals were exploited by the early inhabitants of San Cristóbal, and in what abundance?
2) Does animal exploitation change over time at San Cristóbal?
3) How does the San Cristóbal faunal assemblage compare to other archaeological sites in Nicaragua, in Pacific Lower Central America, and in Atlantic Lower Central America?
4) How does the San Cristóbal faunal assemblage compare to ethnohistoric descriptions of Pacific Nicaragua?
5) What does the zooarchaeological study of the San Cristóbal faunal assemblage tell us about hunting, fishing, and gathering subsistence activities in Pre-Columbian Pacific Nicaragua?
6) What does the San Cristóbal faunal assemblage tell us about the environmental setting of Pre-Columbian Pacific Nicaragua?

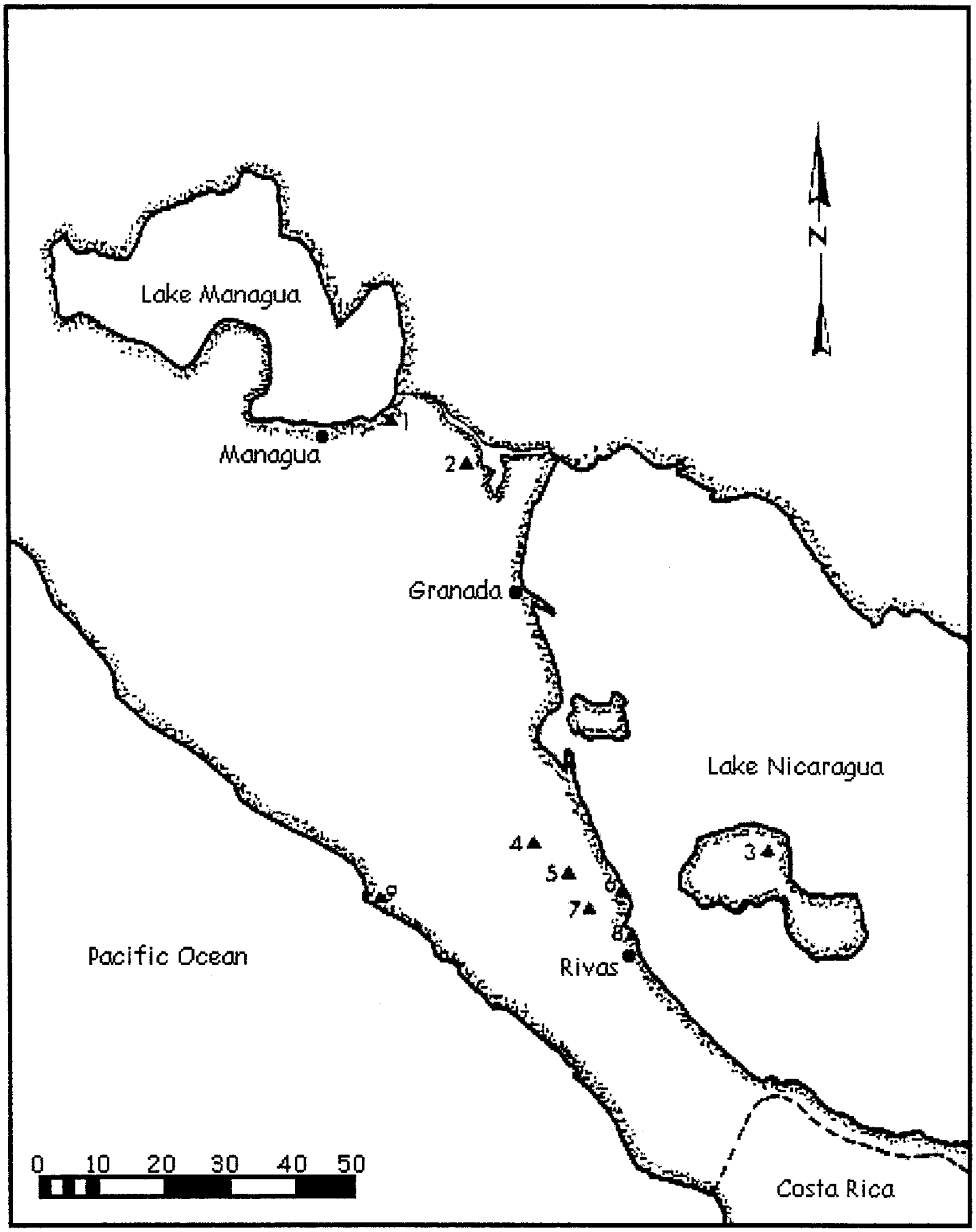

Figure 1: Archaeological Sites in Nicaragua: 1. San Cristóbal; 2. San Francisco; 3. Cruz; 4. Ingenio Dolores; 5. Palmar; 6. Santa Isabel "A"; 7. Santa Isabel "B"; 8. Puerto San Jorge; 9. Isla del Purgatoria (adapted from Wyss 1983:35).

Although I do not expect to be able to completely answer all queries about prehistoric faunal exploitation in Lower Central America, the identified faunal material from San Cristóbal is an appropriate starting point. In Chapter 2, I begin with a summation of ethnohistorical sources that have given us descriptions and clues about indigenous faunal exploitation, suggesting that faunal analyses for most of Lower Central America have been largely inadequate. In fact, the lack of fundamental data presents any meaningful synthesis of a regional bio-history, which continues to be vague and largely speculative.

Chapter 3 provides a theoretical context for this thesis. It discusses significant theories about the nature and extent of faunal exploitation in Lower Central America, and offers reconstructions of the paleoenvironment of Lower Central America prior to the Spanish Conquest of the 16th century. This chapter also examines similarities and differences in faunal assemblages among several sites and discusses their possible environments and the inhabitant's ecological adaptations, as we presently understand them. I also discuss probable ecological influences on prehistoric settlement patterns, the role of animals as subsistence stimuli, and the overall limits placed on environmental adaptation.

Chapter 4 summarizes the San Cristóbal project (1976-1979) to provide a context for the zooarchaeological analysis of the faunal database in Chapter 6. I review the nature and ecological setting of the San Cristóbal and Lake Managua region: includes a brief overview of the geology and geomorphology of the site, and summarizes the original, preliminary faunal analysis done at San Cristóbal. Chapter 5 describes the collections and laboratory methods used in our faunal analysis, and discusses the nature of the faunal material.

Chapter 6 presents a descriptive analysis of the taxa recovered from San Cristobal, their overall numbers and percentages found at the house mounds, period by period, from Pre-Columbian times to the Spanish Conquest.

In Chapter 7, I discuss whether changes in percentage frequencies of taxa reflect a shift in animal use or possible adaptations to environmental changes through time. This chapter also outlines regional (Nicaragua) and interregional (Lower Central America) subsistence strategies based on evidence from multiple sites. Using selected examples, it is suggested that it is possible to compare animal bone collections effectively by carefully matching research questions to data resources, even though precise inter-site comparisons are difficult.

Finally, in Chapter 8, I present my conclusions, answering the questions outlined earlier in this chapter, suggesting some specific situations of faunal exploitation such as fish harvesting, and white tailed deer trapping. I also address the potential of future zooarchaeological research in Lower Central America.

As stated earlier, this faunal collection is unique in that it is the first to be analyzed and quantified in detail from the San Cristóbal site, and the only such collection from Nicaragua ever to be thoroughly studied. The revised species list from this collection will aid in future analyses of samples from other archaeological projects throughout Nicaragua, and Lower Central America. The preservation of the San Cristóbal faunal remains is excellent and allows for identification of specimens to the species level. This helps us to determine the environments that would have supported such fauna and permits some educated comments on possible environmental change in Nicaragua.

This analysis also shows that the San Cristóbal residents benefited from a rich and diverse resource base which likely played an important role in the settlement and population development of Southwest Nicaragua and made a critical contribution to an adaptive diversity in subsistence practices. The faunal evidence indicates how much of the inhabitant's diet depended on aquatic food sources, supplemented by animals obtained by hunting or trapping. The analysis of the San Cristóbal faunal collection is an important contribution to the archaeology of Lower Central America, and reveals some essential information on the ancient economic and subsistence practices of Pre-Columbian aboriginal people. Because the archaeology of Nicaragua is not well known and the outcome of this research may provide a greater understanding of Nicaraguan history and ancient human-environment interactions, in general.

CHAPTER 2
ETHNOHISTORY AND PREVIOUS FAUNAL RESEARCH IN LOWER CENTRAL AMERICA

INTRODUCTION

Ethnohistorical data about Nicaragua were recorded during the sixteenth century, mainly by Spanish chroniclers: Gonzalo Fernandez de Oviedo y Valdés (1945) and by Alonso Ponce (1872). Regrettably, much of the information recorded in the 1500s contains only vague descriptions, which prevent objective reconstruction and characterization of settlements distributed along the Lake Managua basin during late Pre-Columbian times. However, historical records do point out that Native groups, the Chorotegas, the Nicarao (who likely entered the area just before the Spanish Conquest) and the Chontales, occupied the Lake Managua basin during the prehistoric period (Rigat and González 1996:179) (See Figure 2). Historically, the Chontales were distributed along the northern sector of the Lake Managua basin and spoke a "Matagalpa" dialect (Rigat and González 1996:179). Archaeologists identify this territory as the northern zone of the Greater Nicoya Subarea (Lange 1984b:188). Although Rigat and González (1996:129) point out that the Chontales group was thought to be of local origin, the Chorotegas and Nicarao either came from a Mesoamerican tradition, or at least had strong links to Mesoamerica. Healy (1980:336) recognized that the Mayan motifs appearing on Middle Polychrome period ceramics was likely associated with the arrival of the Chorotega groups to Pacific Nicaragua.

The question of the earliest arrival of humans in Lower Central America has been widely contested (MacNeish 1976; Bryan 1978). We know that Nicaragua was heavily settled by the time of the arrival of intruding Mexican groups; there is evidence of human

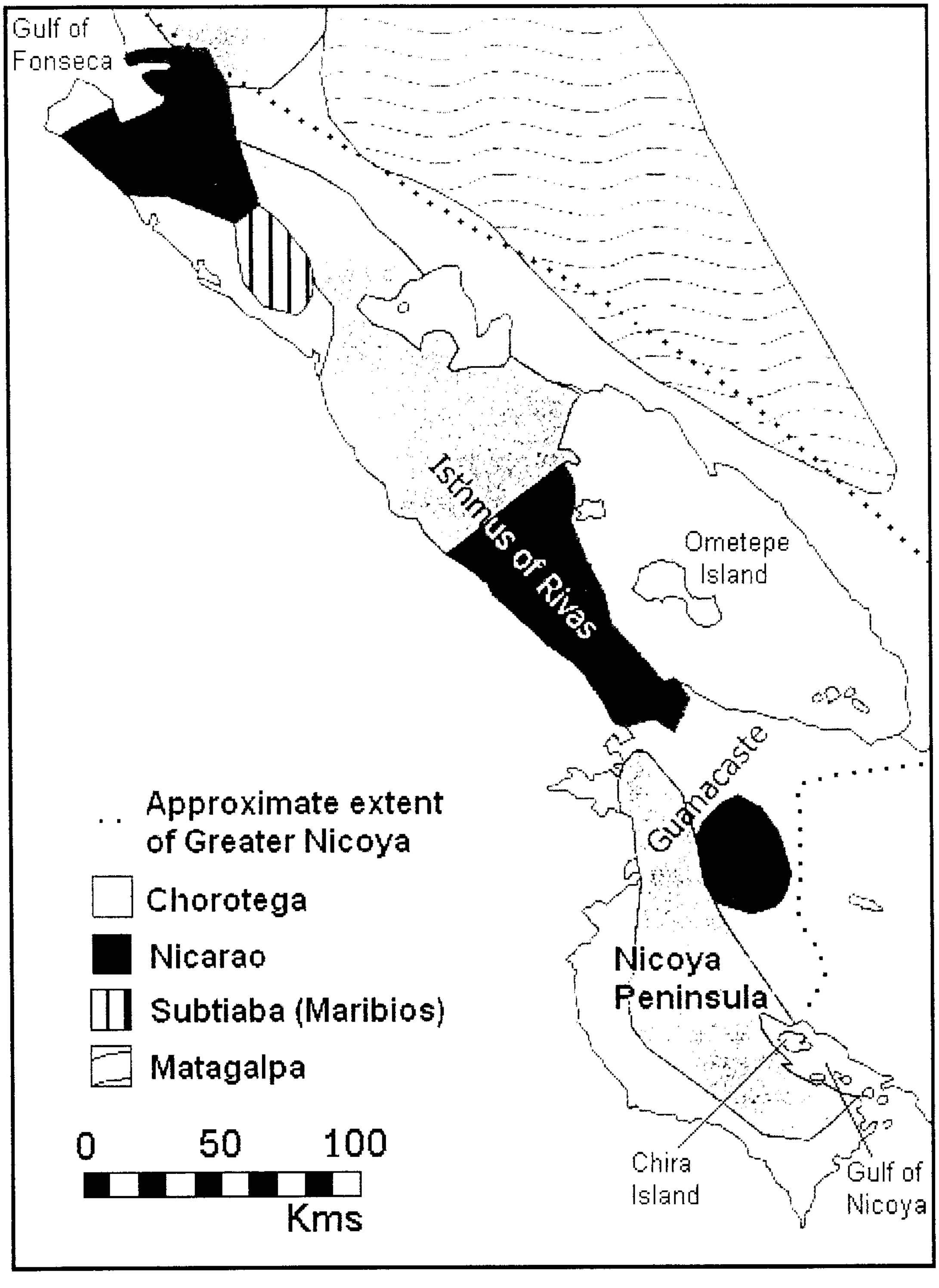

Figure 2. Known Ethnic Groups in Greater Nicoya Subarea, circa 1522 (modified from Salgado 1996)

occupation dating back to 3000 BC (Haberland 1978; Salgado 1996). The evidence came in the form of ancient human footprints, fossilized in a mudstone layer, in the quarries of El Caucé, on the western outskirts of Managua, Nicaragua (Bryan 1973:146). There are numerous opinions about whom these groups encountered and/or ousted upon their arrival. The most widely accepted hypothesis is that groups living on the fringe of Greater Nicoya at the time of Conquest were, in all probability, the Chontales, identified by Oviedo and other sixteenth century Spanish chroniclers.

The Pipil and Nicarao were Nahuat-speaking groups who moved from Central and Southern Mexico into Central America in phases of migration, which began perhaps as early as AD 700 and lasted until about AD 1350 (Borhegyi 1965; Fowler 1981; and Thompson 1948). The most significant factor in the latest successions of Nahuat migrations into Central America was the division of the Pipil and the Nicarao groups and the arrival of the latter into Nicaragua at about AD 1200 (Healy 1980; Fowler 1981). Unfortunately, the various accounts of these migrations are ambiguous and contain inconsistencies on such important concepts as the precise Mexican origins of the groups, the nature and the directions of the migrations, as well as the time frame. Therefore, the historical sources in themselves are insufficient to indicate, beyond doubt, the precise dating of the migrations.

However, based on Oviedo's historical accounts, at least two different aboriginal cultures from Nicaragua are known and identified: the Nicaraguans (Nicarao), and the Chorotega (the "Old Ones"). Archaeologists have reconstructed human habitation in this region from 500 BC to AD 1527 (Lange 1984b). The Nicarao held a minor area in northwestern Nicaragua, most of the Rivas region of southwestern Nicaragua, and perhaps a part of the Guanacaste region of northwestern Costa Rica (Fowler 1985:38).

Oviedo's physical presence among the Nicarao, prior to complete Spanish domination of this part of Lower Central America, suggests that he is clearly the most extensive and relevant ethnohistoric source on the Nicarao, and other native groups in the region. He entered their towns, talked with their *caciques*, saw their temples and houses, and witnessed several of their ceremonies. Strengthening the importance of Oviedo's work is his addition, in Book XLII, of a dictation of an interview with several Nicarao caciques and priests carried out by Francisco de Bobadilla in 1528. Oviedo allegedly obtained a copy of the testimony of the proceedings either in Spain or Nicaragua (Fowler 1985:47). Grasping the worth of this text, he published it in its entirety in the *Historia General* (Oviedo 1851-55:39-56).

The Chontales, inhabitants of the eastern side of Lake Managua, were only briefly mentioned and were said to be nothing like the Chorotega and Nicarao in appearance and dialect (Oviedo 1976:303). The Chorotega were part of the same linguistic family, Oto-Mangue, which is found in western Nicaragua, northwest Costa Rica, southern Honduras, and the southern states of Guerrero, and Chiapas in Mexico (Lothrop 1926:21). Stone (1966) suggests that the Chorotega-Mangue drove the Chibchan-speaking Corobici, the first inhabitants of the western shores of Nicaragua's lakes and the Nicoya isthmus, into the interior. Tamayo (1964:98) suggests that advanced Nicarao and Chorotega Mangue people, speaking a Mesoamerican dialect, occupied the shores of Lakes Managua and Nicaragua before and after Spanish Conquest.

Others have commented on local ethnicity. For example, a well-preserved, carved, wooden axe handle was discovered in 1962 on the Chiltepe Peninsula of Lake Managua.

The upper section of the axe handle is carved in the shape of a king vulture (Stirling 1964:500). The artifact is exceptional since wooden objects in this area are seldom preserved. Stirling (1964:500) believes that the axe handle was probably the work of the Pre-Columbian Chorotega-Mangue. He also suggests that it is surprising to find an artifact decorated like this so far north since the king vulture was a more common decorative motif in Costa Rica and Panama.

Wyss (1983:8) also suggested that some stone bowls at San Cristóbal may possibly demonstrate affiliation to the Corobici even though no historical records exist which can substantiate their presence in the area. However, she also proposes that the earliest occupants of Nicaragua were likely the Chorotega, because the people living around Lake Managua spoke the Chorotega language at conquest, and were referred to as the "Old Ones" by the Nicarao (Wyss 1983:121). In addition, only modest information exists concerning a much smaller cultural group, the Subtiaba or Maribios, which is concentrated in the modern Department of León, north of Lake Managua (Lothrop 1926; Healy 1980:20-21; Salgado 1996:21).

Although the current study will not likely contribute to, or resolve, the debate over the ethnicity of different native groups inhabiting Nicaragua, the analysis of the faunal remains will provide valuable information concerning some aspects of the lifeways of one prehistoric community, San Cristóbal. The information about Pre-Columbian aboriginal groups of Nicaragua provided by faunal analysis may at first appear indirect. However, it concerns not only the subsistence activities of people inhabiting this landscape and how they exploited their environment for food, but also their economic and social relations, expressed through animals managed for purposes beyond the needs of everyday subsistence.

Ethnohistorical Synopsis of Nicaragua

Basic subsistence patterns across Nicaragua have not been altered dramatically since Pre-Columbian times. Farming, hunting, gathering, and fishing all remain important subsistence activities today. The continuity in practices suggests the resilience of Native groups when confronted by environmental changes within their region. Some of the ecological dimensions of Lower Central American cultural groups may have selectively influenced the relative stability of a diversified subsistence system.

In 1528, Oviedo was the single most important, early Spanish chronicler to study closely and record what he saw in what is today Nicaragua. Oviedo's descriptions of the Central American wildlife, which were alien to the Europeans, are the earliest and most comprehensive available, describing a multiplicity of animals, birds, fish, reptiles, and shellfish. He included much data and observations of an ethnobiological nature. Other Spanish chroniclers included information on the animal life and vegetation, but their notes on the natural history were often quite limited, and more quaint than reliable. Then again, only archaeological research can substantiate the ethnohistoric accounts and present a more reliable picture of the plant and animal resources that were available over five hundred years ago.

The difficulty one encounters in using Oviedo as a source of ethnohistoric data, on the fauna of Lower Central America, is the clumsiness and disorganization of his massive *Historia General*. This is a problem, of which Oviedo himself was conscious of, when he stated:

> Voy discurriendo por diverssidades de materias, differentes e apartadas unas de otras...porque esta ensalada o mixtura de cosas toda es en la mesma Nicaragua... [I am rambling about through diverse topics, different and separated one from the other...because this salad or mixture of things is all in the same Nicaragua...] (Oviedo y Valdés 1851-55.pt.3, bk. 42, ch.11, p.107)

Furthermore, several early accounts by Spanish chroniclers (e.g., Ponce 1872) contain inadequate descriptions of wild animal and indigenous species, subsistence practices, and settlement patterns.

PREVIOUS FAUNAL RESEARCH

These early Spanish identifications of Native populations, of what is present day Nicaragua, were subsequently applied by late nineteenth and early twentieth century researchers to speculate on external cultural contacts and influences, generally attributed to Mesoamerica. Late twentieth century researchers applied these same data to more recent historical overviews, but also included secondary sources to supplement archaeological interpretations. Their new framework incorporates a more holistic understanding of cultural-historical sequences, patterns of localized development and regional interaction (e.g., Radell 1969; McCleod 1973; Newson 1987).

The Beginning of Zooarchaeological Research in Central America

Toward the end of the 19th century, an increase in systematic collection of animal specimens occurred, and comprehensive journals describing these collections were emerging. The most important published work during this time was the historic *Biologia-Centrali-Americana* (edited by Godman and Salvin 1879-1915), which appeared in 63 volumes. It was a fundamental resource for the study of Central American fauna and flora compiled from scientific surveys and explorations. Although this published work is quite technical, it does include useful ecological information of a more general nature. Essentially, the groundwork for ecological studies in Central America was laid before the 20th century, but a synthesis of these faunal data did not begin until the 1900s. About this time, C. Hart Merriam (1898) published his well-known papers on his "life zone concept". Merriam's proposal was founded on distinct, although somewhat inaccurate, principles about temperature and plant growth. It must be pointed out that the Life Zone concept is a generalization, originally delimited as a result of floral and faunal assemblages that are similarly expressed with increases in altitude and increases in latitude. According to Bennett (1967:6), it is difficult to know when one is in one zone or another and most of the time one may find oneself in a region of transition between one so-called zone and another.

The first notable application of the life zone concept in Central America was conducted by Goldman (1920), a mammalogist, who included a map and a discussion of life zones in a paper on the mammals of Panama. Goldman (1920) documented three major zones of Panama: Lower Tropical Zone, Upper Tropical Zone, and Temperate Zone. He divided the Lower Tropical Zone into two sub units: Arid Lower Tropical Zone and Humid Lower Tropical Zone. Goldman's application, however, was flawed because he lacked the climatic data necessary to support these divisions, although he referred to differences in seasonal rainfall. Bennett (1967:6) draws upon the shortcoming in Goldman's map to argue that it is a "failure to show that a large portion of the Azuero Peninsula of Panama has a long rainy season as well as elevations above 5000 feet." Other researchers, chronicling the different elements of the Central American fauna, have attempted to explain life zones without the support of maps and, with regard to their ecological content these efforts have been crude and unproven for the most part.

Few efforts have been made to organize or regionalize the Lower Central American area based on fauna alone, although one notable effort must be noted. Ryan (1963) developed a method of biotic provinces for Central America based on mammalian assemblages and distributions. His approach is engaging, but it is not very useful for zooarchaeologists. He attempts a regionalization based on too narrow a database. The numerical assemblage of mammalian taxa is without reference to any historical timeline, or to recent ecological factors concerned with the regional pattern he describes. The method appeals mostly because it is numerical, and suggests some kind of significant analysis has actually been carried out. Ryan's method did, however, appeal to Stuart (1964:338) who certainly supported it: "I do not doubt that it will remain a classic in the field of the regional zoogeography of Central America."

ARCHAEOLOGY OF LOWER CENTRAL AMERICA

The first modern archaeological studies of prehistoric coastal ecology were carried out in the late 1950s and early 1960s by Coe (1962a, 1962b) at sites on the Santa Elena Peninsula of Costa Rica in the Greater Nicoya subarea. About the same time, both Coe (1962a) and Baudez (1962) executed stratigraphic excavations in the Nicoya Peninsula. These two archaeologists pooled the results of their investigations to generate the first ceramic sequence for the Greater Nicoya subarea, which is also used as a basis for comparison with southwestern Nicaragua (Coe and Baudez 1961; Baudez and Coe 1962). In the latter part of the 1960s, Lange adopted more of a cultural ecological methodology. He concentrated on riverine and coastal adaptation in northwestern Costa Rica, and challenged the long-established theory that there had been strong Mesoamerican influence in this region (Lange 1969, 1970, 1971a, 1971b).

To the north, in Southwest Nicaragua, Willey and Norweb were investigating the Rivas region (Norweb 1964). These studies were followed by research conducted by Lange in the 1970s, whose work in the Bay of Culebras of Costa Rica indicated a human presence at coastal sites dating as early as 1000 BC (Lange 1978). Moreover, in the late 1970s, a few paleoecological studies of prehistoric coastal sites had been carried out in Lower Central America (Stark and Voorhies 1978; Linares 1979). These analyses focused on the relationships between ancient coastal groups and their environments.

Healy's 1974 analysis of the materials collected by Norweb and Willey in the Nicaraguan portion of Greater Nicoya, on the Isthmus of the Rivas, included excellent summaries of the archaeology, ethnohistory, and ecology of this area, but it is largely a ceramic report with the emphasis placed on chronological ordering of the data. His placing of the Rivas area in the Mesoamerican sphere suggested influence by Longacre's (1974) classification of the Chorotega languages (Linares 1979). However, if influence is inferred principally from ceramics then it may be fitting to integrate Rivas into the Mesoamerican realm. If other features, such as ecological adaptations or paleoecology are considered, placement of the Rivas region within Lower Central America may be more reasonable.

In contrast, Magnus (1974) developed an interesting model for the Miskito area of Atlantic coastal Nicaragua, comparing archaeological remains with contemporary ethnographic data. His model suggested that prehistoric peoples occupied permanent inland villages and temporary coastal fishing camps, but today the setting is reversed.

Magnus (1974; 1978:61) pointed out that three of the modern villages demonstrated important subsistence diversity, which is caused by both 'differential continuity' with pre-European tradition and by different responses to European contact. The Miskito inhabitants were able to exploit, nearly simultaneously, both aquatic- and terrestrial-based food resources. To do this successfully, they had to possess the knowledge and ability to utilize different environmental zones, each with a complex ecology. Given this scenario it can be suggested that very different adaptations could coexist in antiquity within relatively small areas and that tropical landscapes may provide alternative settlement patterns.

Constrained by the available archaeological evidence, Magnus (1978) examined subsistence data from four different prehistoric cultural assemblages. His analysis ignored some important uncertainties about how well the faunal data represented prehistoric diet and procurement and because most of his data are not quantified, it does not permit detailed comparison with the contemporaneous villages. Despite this, Magnus claimed that there was enough evidence to demonstrate a significant contrast between prehistoric and historic occupations. In prehistoric times regional settlements consisted of central villages, most likely found in riverine habitats, which were linked to 'coastal fishing stations' (Magnus 1978:64). In historic times, settlement patterns shifted to coastal villages with 'inland agricultural stations' (Magnus 1978:64). Magnus also proposed and hypothesized descriptions of the archaeological remains, which he thought would be produced in future by modern villages.

In contrast, Haberland's (1978) article, "Lower Central America," deals with the ceramic sequences and the gaps in the chronologies of Lower Central America. Although it is a valiant effort to resolve the chronological inconsistencies in Greater Nicoya, central Costa Rica, and Greater Chiriquí, it is now considered to be seriously outdated. Haberland was, like many professionals in the 1960s and 1970s, a firm believer in dealing with chronological and distributional problems before turning to such questions as ecological adaptation or settlement patterns. His preoccupation with ceramics reflects the lack of recovery of faunal remains, reconstruction of utility areas and the functional analysis of tools. The result is crude ecological interpretations based on poorly recovered, incompletely analyzed, and quite skimpy evidence.

Another example from the Atlantic coast of Nicaragua that merits discussion was Neitschmann's (1973) ethnographic study on the subsistence strategies of coastal villages of the Miskito Indians of Tasbapauni. Neitschmann demonstrated that the Moskito placed greater need on aquatic resources, predominantly turtle, rather than on terrestrial resources. Neitschmann's comparison of aquatic utilization and terrestrial hunting provides a situation that contradicts with some investigators of this era, who suggested that broad-based aquatic resources are less appealing for subsistence than are terrestrial fauna (e.g., Osborn 1977).

Problem-Oriented Archaeology

Archaeological research in Lower Central America is characterized by too many syntheses of ceramic sequences, superficial, generalized site surveys, and all too frequent diffusionist references to cultural influences from Mesoamerica. Because of the archaeological preoccupation with ceramics, not much attention has been paid to the recovery and interpretation of faunal remains and the reconstruction of activity areas (e.g., butchering and/or processing sites). In the words of Stuart (1964:338), "Central America is not a coherent faunal region." In sum, Lower Central America went through decades of scientific neglect. This situation has recently begun to improve.

Lothrop (1963:108), who pioneered problem-oriented excavations in southeastern Costa Rica in the late 1940s, reported that his excavations in the Diquís Delta revealed no traces of wood, shell, or bone. Regarding zooarchaeology, specifically, it was not until the pioneering research of Linares, in the late 1960s, that data was first collected on fishing, hunting, and farming practices, which allowed for insights into the subsistence practices of prehistoric coastal populations in Greater Chiriquí, Panama. The Pacific Chiriquí (Panama) and Diquís (Costa Rica) regions constitute the Greater Chiriquí interaction sphere as currently defined (Haberland 1976, 1984).

In effect, the first and only, complete faunal analysis from a site in Lower Central America with accurate tabular representation and quantification are from two sites in the Western region of Panama: Cerro Brujo and La Pitahaya (Linares and White 1980; Wing 1980). Wing's (1980) published synthesis compares the differences between fish samples, for example, at Cerro Brujo and La Pitahaya. When correlating archaeological sites that have produced faunal remains, we should keep in mind their particular locations. The Cerro Brujo site is situated on the Atlantic side of Panama, and La Pitahaya is on the Pacific side near the Gulf of Chiriquí. Seven other sites that have produced mammalian bone assemblages of note are also on the Pacific side of Panama, and all are within 18 kilometers of the existing shoreline (Cooke 1984:294). Prior to Linares' important early paleoecological study, research in Greater Chiriquí paid little attention to faunal remains.

In the early 1980s, Creamer (1983a) undertook surveys and excavations on islands in the Gulf of Nicoya, Costa Rica, documented several sites from the late prehistoric period and examined both archaeological and zooarchaeological remains. This research also quantified as important, early scientific faunal research in Lower Central America.

CHAPTER 3
PALEOECOLOGY OF LOWER CENTRAL AMERICA

INTRODUCTION

People both change and are changed by their environments. In subsistence-related terms, climatic changes can radically modify the types and availability of food. Crops grown on marginally productive lands are particularly susceptible to unusual cold-snaps, droughts, or floods. Hunting, fishing, and agricultural techniques can also alter an area.

Patterns for small mammal ecology that ignore the coevolutionary potential of symbiotic relationships with Pre-Columbian agriculturalists are bound to be incomplete. Linares (1976) has noted how changes in the landscape, due to agriculture, also modified hunting resources. She introduced the term "garden hunting" to account for wild species that were both enticed and exploited. Fallow fields attracted deer and other forest margin species to settlements and cultivated fruit trees increased the growth of populations of small mammals such as agoutis.

Changes in the climatic conditions can profoundly affect animal populations. Therefore, to understand resource use within an area some attempt to reconstruct its previous climates is necessary. Understanding change in human societies is a common goal of zooarchaeological research; but many geological, biological, and historical factors may also be responsible for change. In fact, only the paleoenvironmental record can provide a true long-term assessment of the impact of natural environmental events such as alluvial deposition, erosion, rainfall, prevailing winds, offshore currents, and geological phenomena such as volcanic action and earthquakes on regional landscape, in this case Lower Central America.

While the historic record might provide case studies for detailed assessments extending back a few decades, or even several centuries, only the paleoenvironmental record possesses the means of furnishing long-term assessments of environmental events and their effects. Therefore, both long-term and short-term responses to these events need to be known to have a full understanding of the interrelationship between environmental events and human societies.

Due to the paucity of contemporary archaeological inquiries into the ecological history of Lower Central America, I must rely heavily on inference from historical accounts, and distribution of present-day ecosystems. In addition, using case studies from Lower Central America, I examine the nature and effects of volcanism on animals, plants, human populations, and the environment. To achieve the aim of this study (i.e., to analyze the subsistence practices and related human behavioral patterns of the Pre-Columbian cultures of the Lower Central American region), I have adapted Steward's (1955) approach to the study of cultural ecology. One of the steps in Steward's procedure involves determining the extent to which subsistence-related practices affect other aspects of culture. There are many methods of studying this relationship. One technique of reconstructing past cultural patterns is through ethnographic analogy. Ideally, by comparing archaeologically reconstructed exploitative patterns with a series of well-researched ethnographic examples, it should be possible to suggest certain subsistence-related, prehistoric cultural patterns.

The first published volume of the massive *Handbook of Middle American Indians*, edited by West (1964), includes many chapters which are supposed to be related to the ecological conditions encountered by indigenous people prior to the Spanish Conquest.

Regrettably, most of the individual contributions leave it to the reader to draw parallels of ecological conditions with settlement and subsistence adaptation. West (1964) tried, through footnotes, to append ethnographic data but, sadly, this could not make up for the lack of thought given to it within the individual articles. However, there is enough material in this impressive volume to permit at least a preliminary synthesis of the ecology of Pre-Columbian people in Central America, if ethnographic sources are added to it.

Unfortunately, ecological ethnographies of inhabitants in the Lower Central American region, who relied on different subsistence bases, are rare. There is a classic study relating to cultural geography, in which Nietschmann (1973) did an in depth study of a contemporary Miskito village, Tasbapauni, at Pearl Lagoon on the Atlantic coast of Nicaragua. Nietschmann was concerned with the efficiency of human energy acquisition systems. Thus, he obtained data on crop, marine, and game productivity, labor, time and energy efficiency, consumption, nutrition, seasonal and spatial patterns, and he related it all to subsistence strategy, adaptation, and stress. Nietschmann (1973:166) says that "the coastal Miskito have adapted much of their technology, lifeways, and internal and external economic patterns to predictable behavior patterns and relatively dependable catches of green turtle." Nietschmann's (1973:Table 21) data indicates that 70 percent of the meat transported into the Tasbapauni village came from the green sea turtle.

Even though Nietschmann's classic study of the contemporary Miskito of Atlantic Nicaragua was impressive, it relates more to political ecology of a single Tasbapauni village, which is drawn into modern day market relations due to their over-exploitation of the green sea turtle. When there is scarcity, there are decisions, which have to be made about how resources are going to be allocated, who will receive these and who will not. Besides the distribution of resources and benefit streams, decisions are made over which groups in society bear the burden of environmental degradation. As I mentioned earlier, there is a lack of qualitative ecological ethnographies on the Pacific side of Lower Central America.

Until this is done, detailed correlations between certain subsistence patterns and other aspects of culture will be constrained. Some generalizations about subsistence can be made based on a comparison of several archaeological sites located throughout Lower Central America. Also, an inquiry into settlement patterns in Lower Central America would clarify the mode of prehistoric subsistence practiced and perhaps suggest alternative forms of native ecological and cultural adaptations. Information obtained from the San Cristóbal faunal remains, the focus of this study, will establish several trends. These will be discussed in terms of the following aspects: (a) the location of settlements with respect to major resource zones; (b) procurement behavior; and (c) how well the data represent prehistoric diet. These will be addressed to confirm the hypotheses that there were environmentally specialized settlements in Lower Central America.

Recognition of prehistoric habitations, in different environments, will be necessary to profile land use patterns and subsistence activities, as well as specialized ecological behavior appropriate to each environment. Examination of San Cristóbal faunal remains will help to reveal subsistence strategies, which were based primarily on aquatic fish resources, and supplemented by terrestrial forms for animal protein. These findings will be compared and correlated with evidence from other sites in Lower Central America.

CONTEMPORARY DATA

Lower Central America is a part of what New World archaeologists often call the *Intermediate Area* – a rather imprecisely defined cultural-geographic region (Willey 1959). Centered roughly at the thin elongated end of Lower Central America (Panama and Costa Rica), the isthmus broadens as it extends northwestward to include Nicaragua, eastern Honduras and El Salvador (See Figure 3). The southern most extension of the Intermediate Area would include parts of Ecuador, Colombia, and westernmost Venezuela.

Any definitive environmental contrast, which exists on either side of the Isthmus, emerges between the two coastal zones, the Pacific and Atlantic. The cause of this is the central mountain range, which strips the moist easterly winds of a great part of their humidity. As a result, the rainfall on the Atlantic slope is both constant and excessive, while the Pacific slope has a definite dry and rainy season (Joyce 1971:3). The difference between the two coasts is also reflected in the vegetation, the character of which is dependent upon elevation and rainfall.

Some of the most essential elements of the relationship between the people of Lower Central America and their natural environment are cultural ones. Cultural interactions help people adjust to one another and to their environment. Therefore, in the sections to follow, several topics of special interest are examined in relation to the environment of the Pacific region of Nicaragua and Lower Central America. These include: land; natural resources; rivers and lakes; and coastal versus inland settlement.

SETTING

In Nicaragua, there are three distinct geographical zones. The first is the Pacific coast, between the highlands and the Pacific, which is essentially of igneous formation. The second is the uplands of the interior. The final geographic zone is the Mosquito Coast which is geologically, moderately coralline and alluvial in nature (Joyce 1971:4). Accordingly, the environments of Nicaragua are quite diverse. This paper, however, will only focus on the Pacific region of Nicaragua. An association with geologically recent volcanic activity characterizes the Pacific region. Within it, two well-marked physiographic zones can be distinguished: the central depression and the coastal region. A structurally faulted block, or graben, which drifts northwest to southeast through Nicaragua forms the central depression (See Figure 4). The Gulf of Nicoya, further south in Costa Rica, is a product of the same fault system (Newson 1987:41).

Land and Soils

Nicaragua has suffered many extreme geological and climatic events during the late Holocene (Brenner *et al.* 2001:88). Today, Nicaragua is called "the land of lakes and volcanoes". Nicaragua contains regions of thick rain forests, rugged highlands, and fertile farming areas. The Pacific region, the focus of this study, is the more physically complex area of Nicaragua and embodies a range of active *calderas* (termed the Diriamba Highlands or *Sierra de los Morabios*). These *calderas* run approximately 16 to 32 km inland and have produced rich volcanic ash lowlands, which lie in a great basin-like trough (Healy 1980:9). Nicaraguan Depression is the name generally attached to these volcanic ash lowlands, which are formed by the fork of the Central American volcanic axis (Healy 1980:9). In fact, the greatest concentration of people in Nicaragua

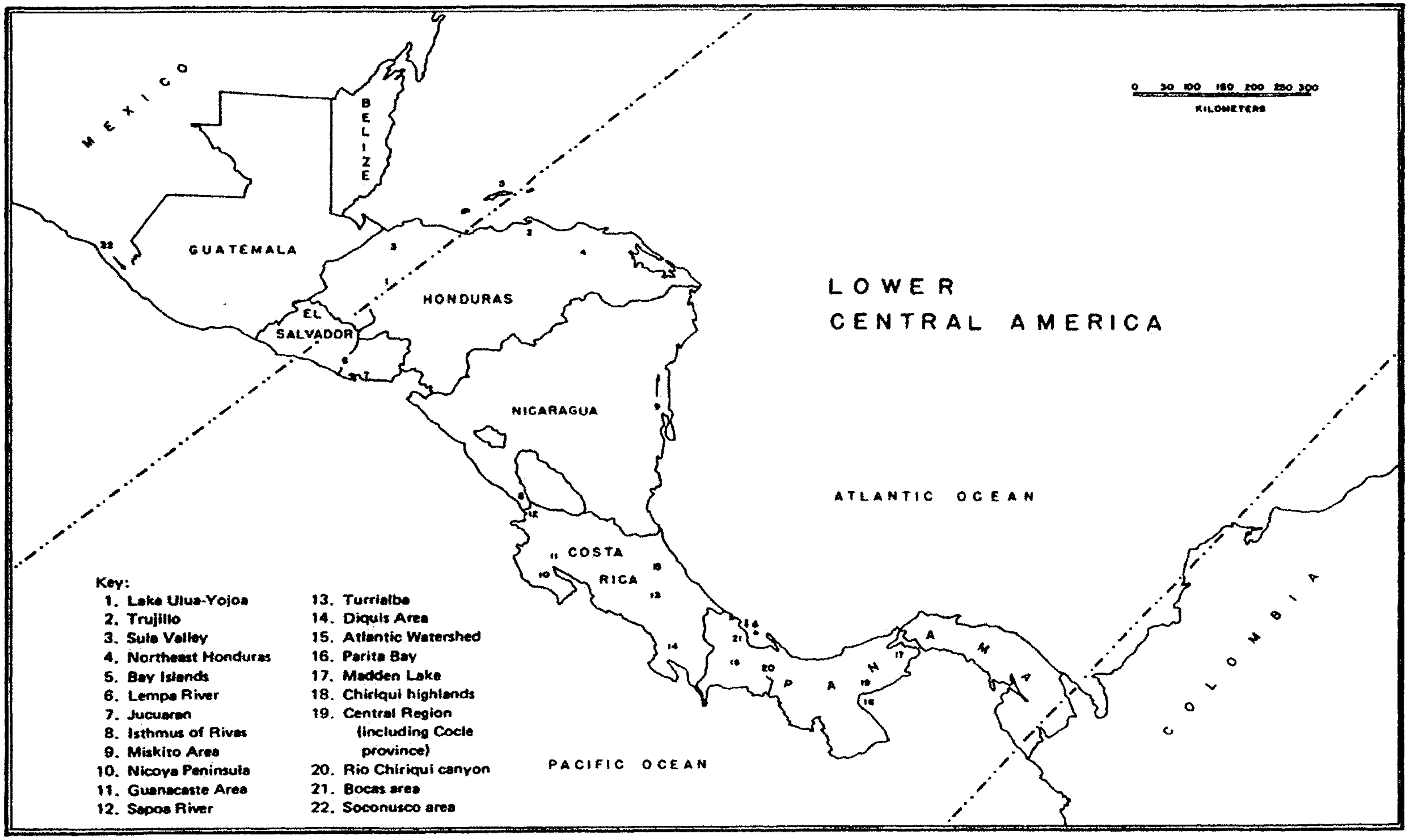

Figure 3. Map of Lower Central America (Adapted from Linares 1979:23)

occurred in the Pacific lowlands from Pre-Columbian times to the present day.

Basins and valleys within the volcanic belt of Pacific Nicaragua are low in elevation, for they are located within a "transisthmian depression", a large crustal fracture or depression that created the middle of Central America (West 1964:77). The depression is probably a graben structure formed in the late Tertiary or Quaternary period, which trends northwest to the Pacific Ocean as well as southeast to the Caribbean Sea. It forms the lowlands of Nicaragua, the central portion of which is occupied by the largest freshwater lakes of Lower Central America: Lakes Managua and Nicaragua, both drain to the Caribbean via the San Juan River (See Figure 4). Lake Managua, situated in the Nicaraguan hydrographic depression or Nicaraguan rift valley, is separated from the Pacific Ocean by a strip of lowlands, to the northwest of Lake Nicaragua, the largest lake in Central America. The origin of these two lakes is often described as tectonic or volcanic in nature.

Volcanoes are permanent features of Nicaragua's Pacific landscape and some active volcanoes with their frequent eruptions have produced soil that is among the most fertile in Central America (See Figure 4 and Table 1). The country is also subject to severe earthquakes. Its landscape ranges from tropical rain forest and marshes to forested mountain slopes. The Quaternary volcanoes of Nicaragua line the southern edge of the graben and some form islands within the lakes, such as Ometepe Island. Surrounding the lakes, and extending northwestward, is plains covered with fertile soils derived from ash ejected from the nearby volcanoes.

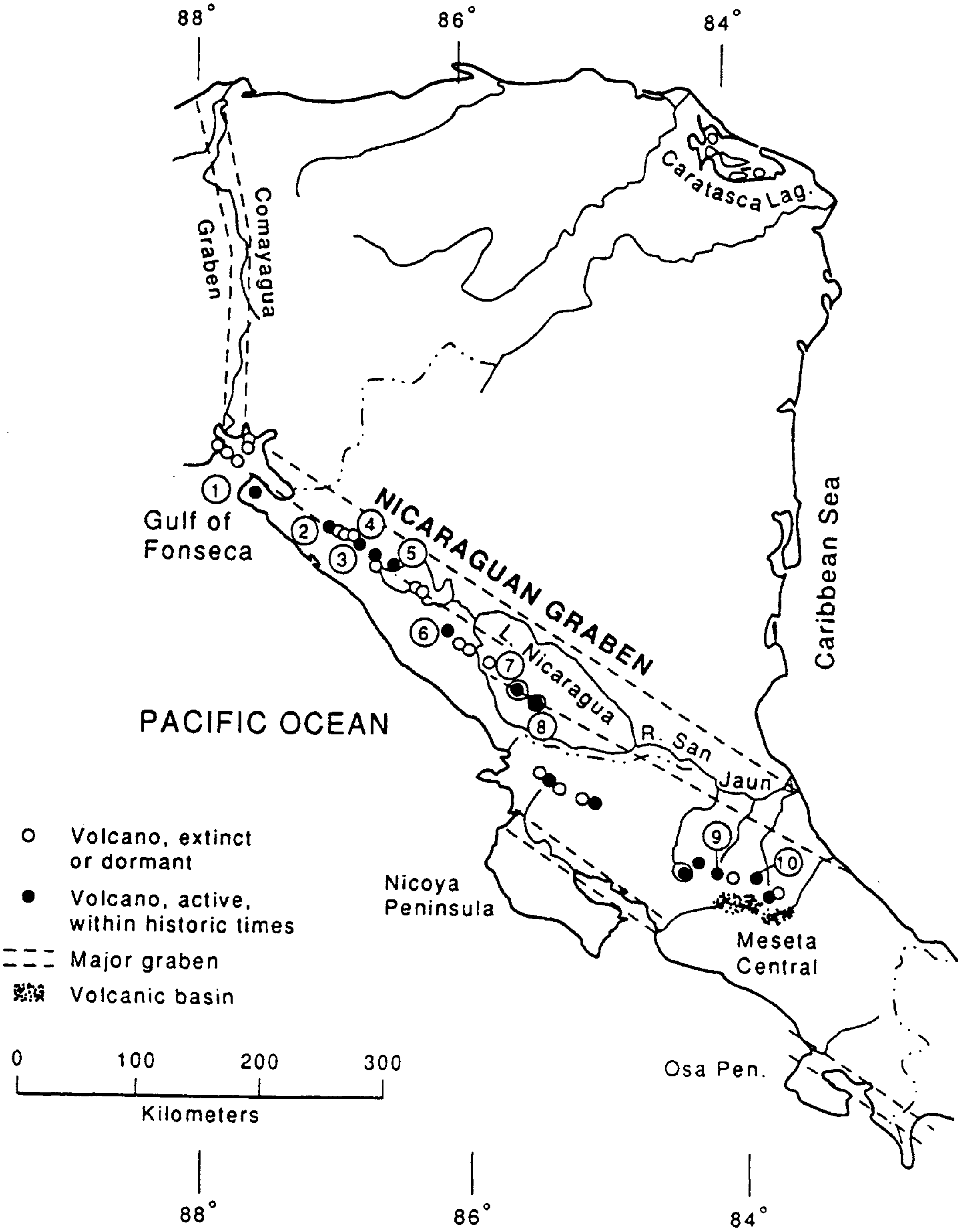

Figure 4. Volcanoes in Modern Times within Nicaragua. (1) Consiguina, (2) El Viejo, (3) Telica, (4) Las Pilas-Cerro Negro, (5) Momotombo, (6) Masaya caldera, (7) Mombacho, (8) Concepcion, (9) Poas, (10) Irazu, (11) Rincon de la Vieja, and (12) Arenal (adapted from Lange *et al.* 1992:9).

Natural Resources

For its size, Pacific Nicaragua is biologically rich and diverse. The Central American isthmus is estimated to hold 7% of the world's biodiversity in less than one-half percent of earth's land area (Coates 1997). This biological richness is due to two primary factors. First, the region's high species diversity corresponds to the great variety of landscapes that are packed within a small area: rugged mountains, lush forested lowlands, coral reefs, coastal mangroves, and large lakes (including Lake Nicaragua, which contains over 300 islands and is home to rare freshwater sharks and sawfish) (Coates 1997). Second, the isthmus serves as a "land bridge between the Americas" where species from the north mingle with those from the south and vice versa. Nicaragua lies at the heart of this land bridge, and represents a variety of plant and animal species (Olson and Dinerstein 1998).

The country's diverse fauna includes 750 bird species, 200 mammal species, 161 reptile species, and 59 amphibian species (Groombridge and Jenkins 1994). More than 9,000 plant species have been identified in Nicaragua, with an estimated additional 4,000-5,000 yet to be discovered (Groombridge and Jenkins 1994). Wild mammals include puma, small deer, and several species of monkeys, sloths, and peccaries. There are alligators and a wide variety of other reptiles, including highly venomous snakes. Many species of birds, including several varieties of parrots and hummingbirds, are endemic to Nicaragua, which is also the winter home for many North American birds. Along the Atlantic coast the exploitation of sea turtles, which are hunted for meat and eggs, has raised concerns about the species' survival. Nicaragua also supports populations of animals that have largely disappeared or are endangered elsewhere, including the harpy eagle, scarlet and green macaws, the quetzal, the giant anteater, five

Table 1. Historical Volcanic Activity in Nicaragua (Adapted from Lange *et al.* 1992:8).

Names of Volcanoes	Major Eruptions in Historic Times	Character of Activity, 1950-Present
Cosiguina	1835 (explosive eruption)	Dormant
El Viejo/San Cristóbal	1684-1985,1971	Small ash eruption Dormant, weakly fumarolic
Chichigalpa	16th century	Dormant, fumarolic
Telica	1529, 1685, 1965-1968, 1971	Minor ash eruptions Dormant, strongly fumarolic
Santa Clara/ San Jacinto	16th century	Dormant
Cerro Negro	1850, 1867, 1914, 1923, 1947, 1950, 1952, 1954, 1968, 1971	Very active; ash eruptions and lava flow; strongly fumarolic
Las Pilas	1952-1955	Fumarolic, solfataric, ash eruption
Momotombo	1764, 1858-1866, 1905	Dormant, fumarolic
Masaya (caldera)	1670, 1772, 1858-1859, 1902-1905,1924, 1946, 1965, 1970-1972	Very active; small lava flows; strongly fumarolic
Mombacho	1560	Extinct?
Concepción	1883-1887, 1908-1910,1921, 1948-1972	Active; Ometepe Occasional ash emission fumarolic
Madera	none recorded	Dormant?

species of wild cats, Baird's tapir, and three species of monkeys (Groombridge and Jenkins 1994).

Rivers and Lakes

Nicaragua is bounded on the north by Honduras, on the east by the Caribbean Sea, on the south by Costa Rica, and on the west by the Pacific Ocean (See Figure 3). Located within the tropics, it extends 490 km from east to west and 470 km north to south at its widest points. Rivers form large sections of its northern and southern borders, and its combined coastlines stretches 910 km. Its area of 129,494 sq km makes Nicaragua the largest of the region's countries. Within its borders lie the two largest lakes in Central America, Lake Nicaragua, and Lake Managua (Incer 1976).

Soils with high clay content bordering Lakes Managua and Nicaragua retain moisture well, and have long been favored by human populations for the fabrication of ceramic vessels (Lange *et al.* 1992:5). Lange and colleagues (1992:260) suggest that on the central and southern part of the Isthmus of Rivas, access to Lakes Managua and Nicaragua appear to have been a major determinant of early settlement patterns.

The lower course of the San Juan River marks the international boundary between Nicaragua and Costa Rica and is different from the other Caribbean streams of Lower Central America in that it drains the two large lakes that occupy the Nicaraguan depression, a great structural lowland that created the Central American isthmus (Tamayo 1964:97). Lake Managua (or Lago Xolotlan) has an average depth of 20 m, since the lake surface is 40 m elevation, but its bottom is still above sea level. Formerly Lake Managua drained into the Gulf of Fonseca on the Pacific coast via the Estero Real (Tamayo 1964:97). However, its outlet was blocked by lava from the volcano of Momotombo. It now drains into the larger and deeper Lake Nicaragua (or Lake Cocibolca) through the 30 km Rio Tipitapa channel. These great lakes at one time formed arms of the Pacific, and marine forms are still found in them, but now Lake Nicaragua drains into the Atlantic, via the Rio San Juan.

All of Nicaragua's major rivers run into the Caribbean. The Rio Grande and its tributaries are the most extensive river system, while the Escondido provides a major transportation route between the Pacific and Caribbean coasts. The Rio Coco runs along the border with Honduras, and the San Juan River begins in Lake Nicaragua and forms part of the present day border with Costa Rica.

COASTAL VERSUS INLAND ADAPTATIONS

Lower Central America

The long coastline relative to small land mass is a major geographical feature on the Pacific side of Lower Central America (Figure 3). However, we still have only a limited grasp of the complexity of coastal systems or how coastal people interacted with inland people. Such an uneven database makes broad comparative efforts difficult, especially since there are still large areas of Lower Central America where little is known about what happened in prehistory. This opinion has also been expressed by Lange and Stone (1984a:8) in reference to Lower Central America:

> "These gaps are particularly frustrating in attempts to deal with processes of cultural evolution and to learn why most of lower Central America never evolved beyond a low or intermediate chiefdom stage."

Among the various problems remaining to be investigated in Lower Central America are concerns about the relationships between coastal populations, their environments, and other inland Central American populations. The approach in this chapter is to facilitate cross-cultural comparisons and to bring to light the fact that, even with variations in ecological adaptation, the nature of the coastal associations developed by Lower Central American groups must be viewed not only in terms of resource exploitation but also within the framework of larger subsistence milieus.

For example, the relationship between coastline form and availability of resources is evident in Costa Rica in regions such as the Bays of Culebra and Salinas, and the Santa Elena Peninsula. In these areas, human occupation was dense, and substantial shell middens indicate evidence of marine exploitation. In contrast, the relatively straight coastlines of Nicaragua (e.g., San Juan del Sur) and other regions of Costa Rica (e.g., Nosara) provided limited evidence for human habitation or exploitation of aquatic resources (Lange 1984a:44). In Costa Rica, coastal resources such as dye, fish, and shellfish may have been exchanged for goods from the interior, such as meat, bone, or skins of terrestrial animals. Although somewhat difficult to identify, due to poor preservation, they represent items that could have been transported by individuals, and could have easily been exchanged from one area to another (Creamer 1992:2).

Coastal populations that draw on both aquatic and terrestrial biotopes for food are dependent on seasonal variations of both wild and domesticated foods. Consequently, coastal research must be concerned not only with fauna and their seasonality, but also with environmental parameters of temperatures, moisture, sunlight, and soils, which closely effect ecological zones. For example, seasonal rainfall and accumulated runoff bring marked changes in aquatic environments, principally in estuaries where a delicate balance of currents, turbidity, salinity, and temperature affect survival of various molluscs and fish (Stark and Voorhies 1978:278).

Hoopes (1994) analyzed data of coastal and inland adaptations in Lower Central America. He noted that the earliest ceramic-producing societies in Panama and Costa Rica did not inhabit coastal shellmounds, but rather inhabited inland areas, where they lived with mixed economies including horticulture, fishing, and hunting and gathering. Interestingly, archaeological sites from the Early Polychrome period (AD 500-800) are more coastal-oriented (e.g., Bay of Culebra, Vidor, etc.) and the influence of marine resources on site location is evident. However, not all significant cultural changes, in for example subsistence strategies can be tied to ceramic changes, especially if faunal preservation is poor. More importantly, the physical composition of the majority of early coastal sites has presented problems in most research. Lange (1984b:171) points out that most coastal sites in Central America (e.g., Guanacaste) were characterized by large shell middens, which were co-mingled with faunal material, heaps of shell, ceramic fragments, and other cultural debris. He claims that before AD 400-500, shell does not appear in archaeological sites, and without the shielding environment of a shell midden, faunal material is not preserved (Lange 1984b:171). However, from ancient coastal settlements, we now have strong evidence for long-term human impact on marine resources through over fishing (Pauly *et al.* 2000; Boesch *et al.* 2001; Wing 2001).

According to Lange (1984a:46), major fluctuations in seasonal rainfall affect the settlement patterns of the Pacific coast of Lower Central America, where year-round water is not always available, and subsistence, where even single growing season of crops is of marginal potential. Furthermore, Moreau (1980) suggested that any decrease, or increase, of freshwater run-off into coastal areas affects the salinity, temperature, as well as other variables important to coastal marine life. It is evident that information regarding coastal versus inland habitation is ambiguous at best. In this situation, Lange's (1984a:49) observation is appropriate, "concentrated efforts have been made to find sites away from the coast in Lower Central America, and either a total lack of sites or a greatly diminished site density provides definite indications of settlement selection criteria and prehistoric population density."

Costa Rica

Bay of Culebra Region

Norr (1996:264) proposed that the shift to intensive exploitation of marine resources, in northwest Costa Rica, may have been a consequence of environmental changes rather than cultural choices. A volcanic eruption and ashfall in the region *ca.* AD 1000, may have reduced the number of available "nearshore" aquatic fauna and forced the people to procure deepwater species (Norr 1996:264). A dietary shift at the Bay of Culebra sites (Figure 1), from nearshore-estuary fish to more pelagic fish, has been suggested from studies of faunal remains by Kerbis (1980) for the Vidor site after roughly AD 1000. Interestingly, Wyckoff (1973) has also pointed out the occurrence of a major subsistence change at the San Francisco site located between Lake Managua and Nicaragua (Figure 1). She indicated that the residents shifted their diet from a strong dependence on shellfish, during the Middle Polychrome period (AD 800-1350), to a diet centered on animal protein in the Late Polychrome period (AD 1350-1525). Apparently, the nature of the method of faunal collection, at this site, leaves some doubt to whether or not any further ecological trends may be revealed.

Lange (1978:103) pointed out that the Bays of Salinas and Culebra were important to Pre-Columbian people in a number of ways (i.e., protected shores, seasonally influx of nutrient rich freshwater, and increased marine production at the lower end of the food chain). Shorelines themselves are precarious, and thus the availability of mixed resources would probably have varied in long– and short-term cycles. The relatively high consumption of marine resources at the of Las Marías, along the Bay of Salinas to the north, may be part of the same temporal trend in subsistence observed at the Bay of Culebra sites (Norr 1996:265). More likely, however, the dry climate, with only seasonal abundance of freshwater, made the procurement of marine fish easier and more efficient than hunting and trapping terrestrial animals.

This same environment may also have been a factor adversely affecting the productivity and reliability of maize as a subsistence staple. The role of maize in the subsistence patterns of Lower Central America, especially western Nicaragua, is still debated. Therefore, we must set aside any conclusions concerning the temporal and/or cultural significance of agriculture, especially maize, for these people. However, stable-isotope analysis has become a valuable means for understanding prehistoric diet. According to Price (1989:1), isotope analysis provides a direct measure of the relative importance of the categories of plants and animals consumed.

Nosara Region

Based on isotope analysis of human bone, Norr (1996:265) argued that the greater dietary importance of maize and terrestrial fauna in the Nosara region of Costa Rica was likely due to the greater mean annual rainfall and presence of fertile valley soils. However, she also utilized isotopic data, from coastal Guanacaste in northwest Costa Rica, to suggest that during the period prior to contact, maize became less important in diet and was replaced by marine resources. It should be noted that generalizing statements about subsistence patterns are difficult to make in an area as regionally diverse as Central America. For example, Nosara is a Pacific coastal valley on the southern part of the Nicoya Peninsula of Costa Rica. A rich terrestrial environment and the lack of a protected bay may explain the limited exploitation of marine resources at this site along the coast. Norr (1996:255) proposes that the lack of both marine and terrestrial resources at Nosara sites may possibly be due to factors such as poor preservation or inadequate recovery techniques (e.g., fine-mesh screen for small fish bone recovery). Norr's analysis of the Costa Rican sites illustrates the existence of a complex pattern of dietary exploitation, with exploitation of either major resource base being variable with time period, geographical location, and climate.

Costa Rica also provides a remarkable paradigm for examining human/landscape coevolution from the beginning of the Holocene to the 16th century (Hoopes 1994). Archaeologist Rindos (1984) has applied the term coevolution to the unconscious relationship between humans, plants, and animals that gives rise to concurrent changes among all of them, eventually resulting in domestication. Furthermore, a recent compilation of a master registry of archaeological sites in Costa Rica provides some insights into the magnitude of Pre-Columbian occupation and its potential ecological influence (Vázquez *et al.* 1994).

Panama

In Ranere and Hansell's (1978) research report, resource procurement patterns were compared between coastal and inland occupations during late Preceramic and early Ceramic periods. The researchers inferred that inland sites were platforms for hunting and wild plant gathering. In contrast, the researchers established that all coastal sites yielded deposits in which aquatic resources significantly enlarged the diet of prehistoric inhabitants. On the other hand, terrestrial faunal remains were also reported as common.

Panama provides some of the most intriguing evidence for early human alteration of a tropical landscape. For example, Piperno and colleagues (1991, 1992) used the presence of charcoal and grass microfossils, together with taxa representative of secondary forests, and the disturbance of lake cores, to suggest intentional human use of fire. They believe that this deliberate use of fire was intended to clear landscapes, a modification that arose as early as 8000 BC.

In Chapter 7, I will return to ecological evidence from Costa Rica and Panama, when I contrast faunal evidence from sites there with that of San Cristóbal.

CHAPTER 4
SAN CRISTÓBAL (NMN2-1): AN OVERVIEW

Access to the abundant natural resources surrounding San Cristóbal, and the close proximity of Lake Managua, were likely determining factors in site location for its residents. Lange and colleagues (1992:4) have suggested that the greatest concentrations of prehistoric populations were along and near the shore of Lake Managua. Oviedo (1976:376) observed farming villages dotting the shoreline of Lake Managua. He described a permanent line of thatched roof and pole houses located around ceremonial mounds, temples and market areas.

Ecological Setting

Lake Managua (Xolotlán) lies within a fertile lowland basin (Nicaraguan Depression). Lake Managua is a closed-lake (endorheic) system in which evaporation roughly speaking equals inflow, and its water level is controlled mostly by evaporation. The shoreline of Lake Managua, from Managua to Tipitapa, is an uneven, windswept shore subject to heavy erosion when winds are from the northeast (Wyss 1983:21). The lake's average depth is 7.8 m and the deepest point (26 m) is located in a pit close to the volcanic Momotombito Island. The lake has a surface area of 1134 sq km and its basin covers approximately 4500 sq km (Rigat and Rivas 1996:178). The majority of the drainage basin is located to the north of Lake Managua, which is drained by three major tributary rivers, Rio Viejo, Rio Sinecapa and Rio Pacora. The total capacity of water varies widely within the drainage basin, geographically, annually, and seasonally.

The San Cristóbal site NMN2-1 is located around the south shore of Lake Managua and is part of this large basin (See Figure 5). Based on what little settlement data is available for this region of Nicaragua, prehistorically this basin was the most densely populated area. Historical records indicate that during the Pre-conquest period, the Chorotega, the Nicarao (who arrived in the area just before Conquest), and the Chontales (who were distributed along the northern sector of the basin and spoke a Matagalpa dialect) settled in the Lake Managua Basin (Rigat and Gonzales 1996:179). Lange (1984b:43) claims that a possible reason that settlement in prehistoric Nicaragua was concentrated inland, rather than on the coast, was because marine resources were not abundant in Pacific Nicaragua and were hard to control. This assumption may explain the limited use of coastal resources, but the speculation that sites are inland because resources were limited and were difficult to manage is nonsensical. The lack of architectural remains or other features may be a result of inadequate coastal survey, and the lack of faunal material may be due to the limited excavations in midden deposits rather than in surrounding mounds.

Climate and Soils

The climate of the Lake Managua area in which the San Cristóbal site is located is grouped as Aw' in the Köeppen system of climate forms (Vivó Escoto 1964). This tropical climate type is characterized by a definite and extended dry season (*verano*) from November to May and a wet season (*invierno*) from May to November (Wyss 1983:13). The marked wet and dry seasonality of this climate affected settlement and subsistence patterns in terms of access to year-round water. Because of the long dry season, the Pacific coast is a region of extensive grasslands with temperatures that escalate to over 29

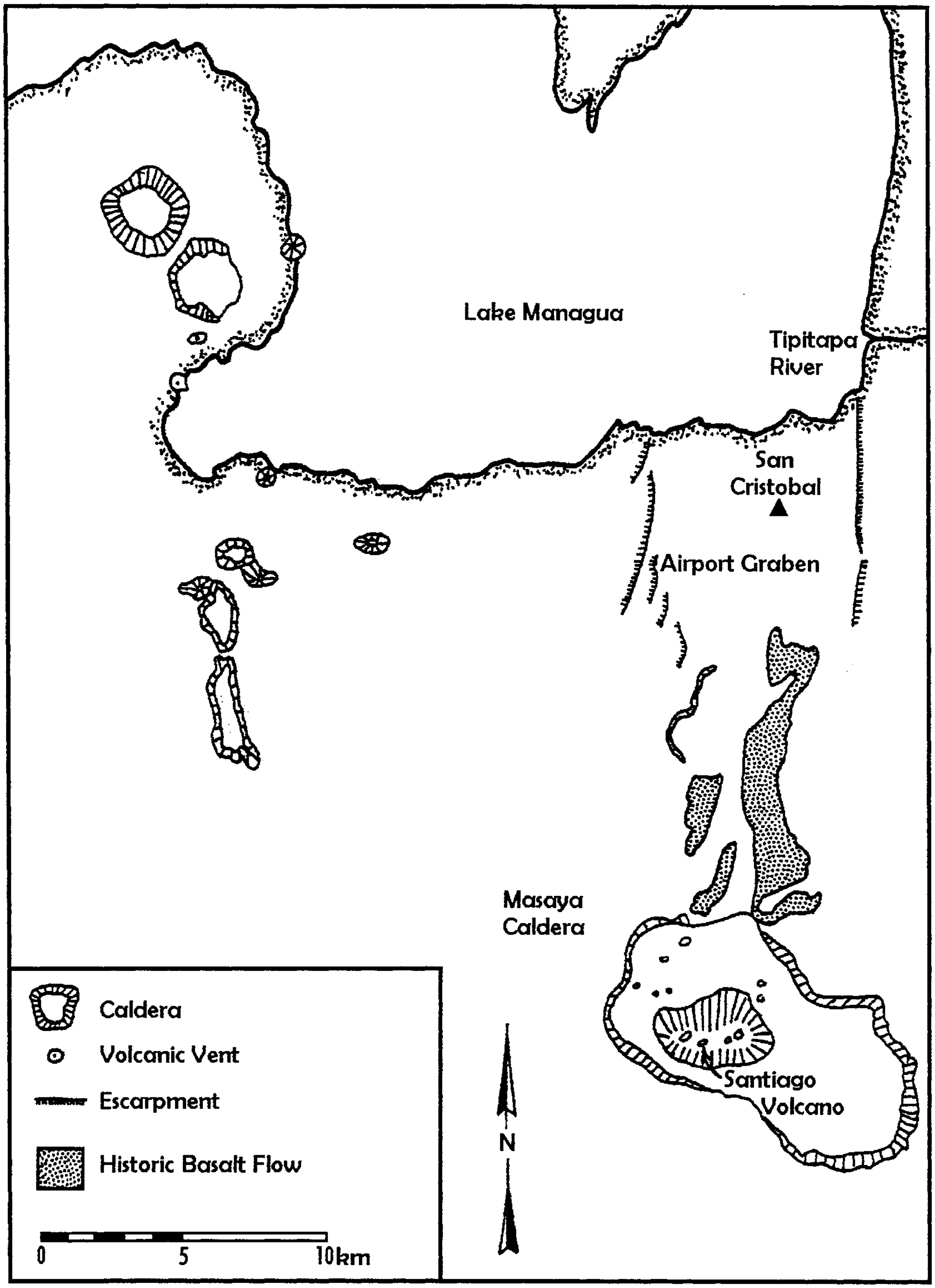

Figure 5. Prominent Land Forms in the Environment of San Cristóbal (modified From Wyss 1983: 23).

degrees centigrade and humidity levels reaching upwards of 90 percent (Wyss 1983:15). The seasonality would have also affected agricultural subsistence because there would have been only one growing season without artificial irrigation (Lange *et al.* 1992:11).

Stevens (1964:309) asserted that soils around the shore of Lake Managua retain moisture better due to higher clay content and thus have always been more beneficial to human occupation, which served as a foundation for agriculture from Pre-Columbian to modern times. According to Bourgeois and colleagues (1972:28), the soils also have high 'montmorillonitic' clay content, a resource potentially valuable to potters. Evidently, gaining access to the soils surrounding San Cristóbal and the convenience of, or easy access to, Lake Managua were influential reasons in initial settlement location. Wyss (1983:39) maintained that here are no rivers or streams in the area to the south of Lake Managua due to porous soil and the fact that surface water immediately filters through the ground soil and enters the lake at subsurface levels. As Lange (1984a:47) pointed out, the patchwork of fertile soils on the Pacific coast had a definite effect on subsistence practices and, more specifically, on the development of agricultural bases for permanent settlement. He also claimed that New World Native populations, who settled at the mouth of rivers, and developed "garbage plot" agriculture, may have accidentally spread the distribution of plants in alluvial deposits here.

In contrast to effects of water on settlement patterns, the soils of Pacific coastal regions of Lower Central America are of recent volcanic origin, and have been affected by additional volcanic deposits during the past 10,000 years (Lange *et al.* 1992:5). As maintained by Stevens (1964:268), there is also an erroneous belief that all volcanic soils bring remarkable fertility. He indicated that inconsistency in soil fertility is determined by the relationship between the original volcanic parent material and "its vulnerability to the principal soil forming processes (i.e., fauna, flora, human impact, and relief and drainage)."

Geomorphology of San Cristóbal

The major drainage basins in the Managua region are formed by tephra, which moves down to lower levels by wind and erosion. According to Wyss (1983:21), tephra explosively ejected from a volcano typically generates continuous layers over large areas around the source. Since it is deposited from the air, it initially covers the entire land surface, blanketing hills and ridges, as well as valleys and lowlands. Individual tephra layers usually have distinctive characteristics that allow them to be described and identified. Tephra eruptions are typically short, a matter of hours or days, so the entire layer can be used to represent an instant of geological time (Wyss 1983:22). Tephra is generally light and porous (pumice, volcanic cinder, and volcanic ash) and is vulnerable to rapid erosion until soil and vegetation begin to form on its surface. Much of the tephra is removed by erosion in the first months and years after it falls. The subsequent deposits of reworked tephra are approximately the same geologic age as the original layers (Woodward- Clyde Consultants 1976:14).

The soil, as well, is a homogeneous alluvial fill of volcanic ash overlying a solidified layer of tephra, the retiro tuff, at a depth of 1 to 1.5 meters (Wyss 1983:37). The retiro tuff deposited from the air is a result of volcanic eruptions of fine ash. It is usually seen as several layers of buff colored, fine grained, indurated tuff that are just below the present-day soil surface. This tuff is air dispersed throughout the Managua region, and can be seen in almost every road and ditch within its urban area. According to

Wyss (1983:25) the retiro tuff is believed to have been deposited 2,500 to 3,000 years ago in a catastrophic volcanic eruption.

The descriptive data presented in this chapter provides a background for some of the possibilities for prehistoric settlement pattern in the Lake Managua region and in Lower Central America. The implication of this data will provide a broader relationship to Lower Central America as well as patterns of subsistence at San Cristóbal.

Geomorphological Impact on Cultural Resources

The literature on volcanoes of Lower Central America, and the impact on the environment, reveals important information concerning the effects of volcanic activity on the local fauna, flora, human populations, and nearly all other aspects of the impacted environment (Linares *et al.* 1975; Sharer 1978; Sheets 1979, 1983; Sheets and Grayson 1979). Nicaragua exhibits environmental fluctuations. This suggests that volcanic eruptions in Nicaragua may have selectively influenced regional cultures in the nature of their settlement and subsistence strategies. Despite the danger of catastrophes, substantial human populations are often found in areas with volcanic activity. Interestingly, active volcanoes are present in Nicaragua (Momotombo and Cerro Negro) in association with Lake Managua, and the volcanoes of Maderas, Concepción, the Masaya Caldera, and Mombacho are in association with Lake Nicaragua (Lange *et al.* 1992:8). The Masya Caldera, a large crater, sent lava flows to within 2.75 km of San Cristóbal in its last eruption (1670 AD) (Wyss 1983:25). All have erupted in historic times and Cerro Negro, in fact, developed as an active volcano entirely in the historic era. According to Taylor (1963:51), moderate areas in the direction of Lake Managua are still almost bare of vegetation.

In the lives of the prehistoric inhabitants of the site of San Cristóbal natural phenomena, such as volcanic action, earthquakes, erosion, rainfall, and offshore currents, were very important variables. Coupling the environmental reconstruction with an analysis of subsistence related technology indicates which of the available resources were used and how the people may have obtained them.

In fact, Lakes Managua and Nicaragua were once connected to the Pacific Ocean. Because of volcanism, these lakes became isolated from the ocean, and slowly developed into freshwater bodies (Healy 1980:10-11). Moreover, the lakes contain several islands of volcanic origin, some rising 5,000 feet above the level of Lake Nicaragua (Joyce 1971:4).

In view of these changes, the marine life trapped here needed to adjust to new environmental conditions. The only known freshwater shark (*Carcharhinus leucas*) in the world has been caught in Lakes Managua and Nicaragua (Healy 1980:11). Further, support for this "trapped ocean" theory is evidence of other species caught in the aforementioned lakes, such as Tarpon (*Tarpon atlanticus*) (Healy 1980:11).

Clearly, the effects of the eruption of various volcanoes on the local fauna, flora, and the people of Nicaragua, may look very different in a few centuries from how they look today. Only long-term studies of volcanoes, and their impact on the environment through study of the archaeological record, can provide insightful answers to such questions. Sheets and Grayson (1979:629) suggested that the archaeological record provides the potential of searching for predictable responses to volcanic disasters by human societies, in general, and by specialized kinds of societies impacted by specific kinds of volcanic events. That is, the analysis of prehistoric volcanic disasters may provide a better means of achieving an understanding about how people respond to such natural disasters.

Alternatively, the sparse historical record may suggest additional hypotheses concerning these human responses, and might allow some tests of those responses to be conducted. Only the archaeological record can provide the large series of events needed to test those hypotheses across a variety of settings in both time and space. The archaeological record has the potential of allowing the study of volcanic disasters to move from the analysis of a small number of examples in present-day to the study of a large number of examples through all periods.

SITE DESCRIPTION AND ARCHAEOLOGICAL HISTORY

Locations for excavations by Wyss in 1977-1979 were based on a regional surface reconnaissance of various mound sites around Lake Managua. The San Cristóbal site, located on the south shore of Lake Managua, was marked by earthen mounds, generally larger in size and more numerous than at Santa Isabel "A" of the Rivas region in southwestern Nicaragua (Healy 1980). The San Cristóbal site is composed of 60 circular earthen mounds (1-8 m high), which originally served as building platforms for the perishable (pole-and-thatch) houses and ceremonial structures of Pre-Columbian peoples of this region (Wyss 1983:37) (See Figure 6). Most of the site was in pasture at the time of investigation, although it was previously ploughed and as a result disturbed to a depth of 17 cm.

As stated in Chapter 1, these circular earthen mounds have been interpreted as evidence of a small Pre-Columbian farming village. Supporting this interpretation, Rigat and Rivas (1996:184) suggested that these types of sites, marked by stone-covered earthen mounds, correspond to the usual pattern observed in regions highly populated with agricultural fields. In addition, ceramic analysis revealed that the village was

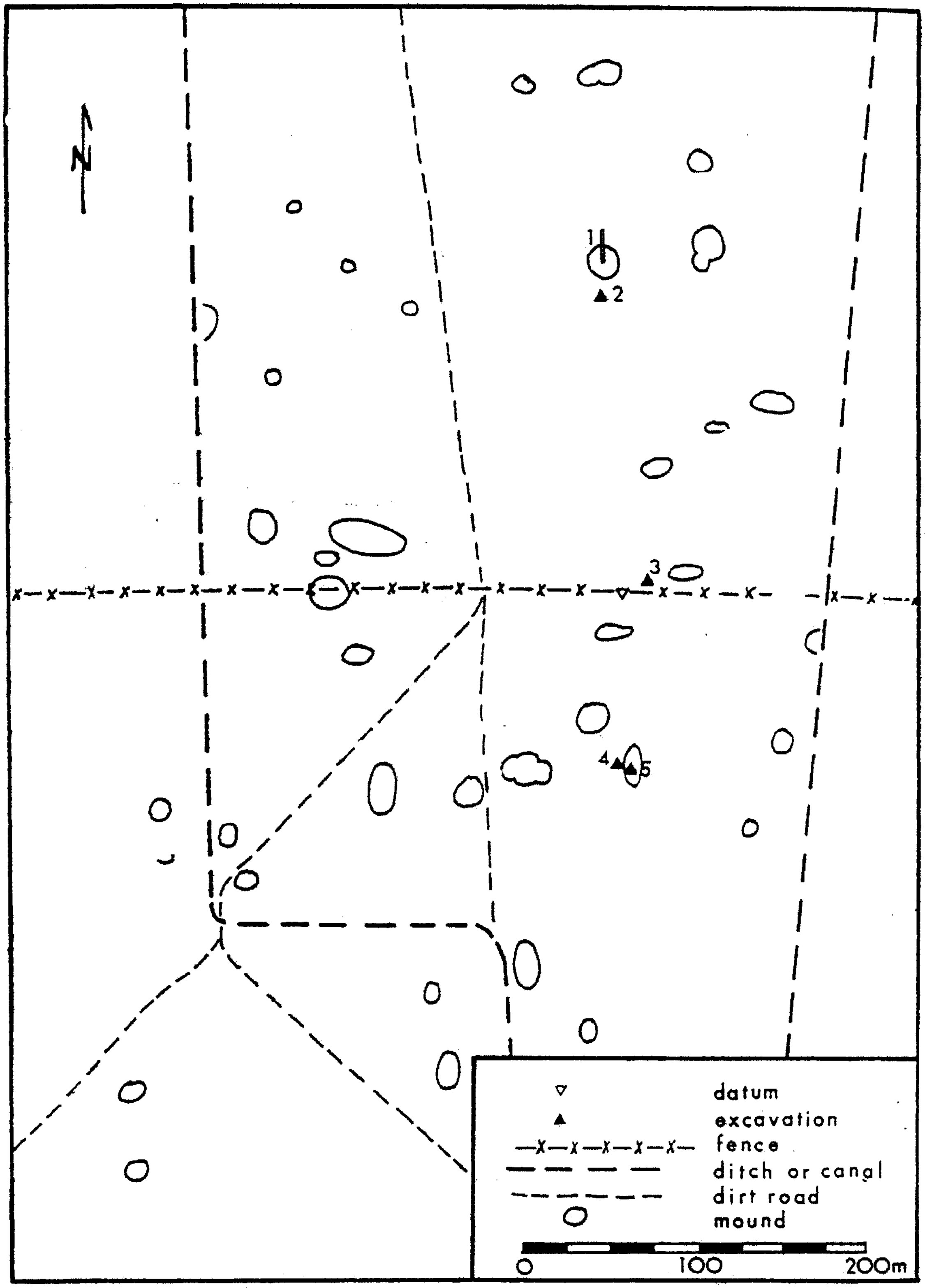

Figure 6. Site Map of San Cristóbal (Adapted from Wyss 1983:38)

inhabited from the Zoned Bichrome Period (ca. 500 BC) through the Late Polychrome Period (AD 1525) (See Table 2). Ceramics of the Zoned Bichrome Period are found in association with metates, an indication of an agriculturally based, sedentary people (Wyss 1983:26). However, little is known about these early, sedentary people, primarily because of the absence of architecture at the San Cristóbal site.

Wyss (1983) conducted the stratigraphic excavations, which produced the faunal assemblage under study here. She excavated, using arbitrary 10 cm levels, in four separate locations at San Cristóbal. Three of her excavations were 2m x 2m tests of essentially level ground at the site. These tests are not described in any detail in her report. The fourth excavation, however, was a large (20m x 2m) trench, which extended from just off the edge of a mound into the center of this artificial (likely domestic) structure. The trench was 20 separate, contiguous 2m x 2m pits which were given letter designations A, B, C, etc. (See Figure 7). All material was screened through 1/8" (3.14 mm) wire mesh. The excavations of this trench went, in some units, as deep as 150 cm below the modern ground surface, with most units hitting at least 100-110 cm, before sterile earth was encountered. Three human urn-burials were encountered at the site in this work.

Wyss (1983:54-110) describes, in considerable detail, the ceramics recovered from one unit (C) of this trench. She noted that the excavations produced an immense quantity of pottery (n= 87,400 sherds), as well as lithics, and faunal material. Wyss (1983:44) decided, given the quantity of pottery, to keep only "diagnostic material", defined as ceramic monochrome rims and bases, and all decorated (painted or plastic) sherds (n= 1,572). This was a common practice among researchers a quarter-century ago

Table 2. Comparison of General and Regional Chrononlogies (adapted from Dickau 1999)

Date	*Lower Central America*	*Greater Nicoya*	*Managua*	*León*
1500	Period VI Late Terminal Period	Late Polychrome	Ometepe	El Diamente
1400				
1300		Middle Polychrome	Sapoá	
1200				Pulpería La Cruz B
1100				
1000				
900	Period VI Regional Development Period			Pulpería La Cruz A
800			Bagaces	
700		Early Polychrome		Santa Rosa
600				
500				El Cortezal B
400	Period IV Formative Period	Zoned Bichrome		
300				
200			Tempisque	El Cortezal A
100				
0				
100				
200				
300				- - - - - - -
400				
500				
600			Orosí	
700				
800				
900				
1000				
1100	Period III Early Incipient Agriculture		Tronadora	
1200				
1300				
Source	Lange and Stone 1984	Coe and Baudez 1961	Vázquez *et al.* 1994	Wykoff 1976 (Cited in Salgado 1996)

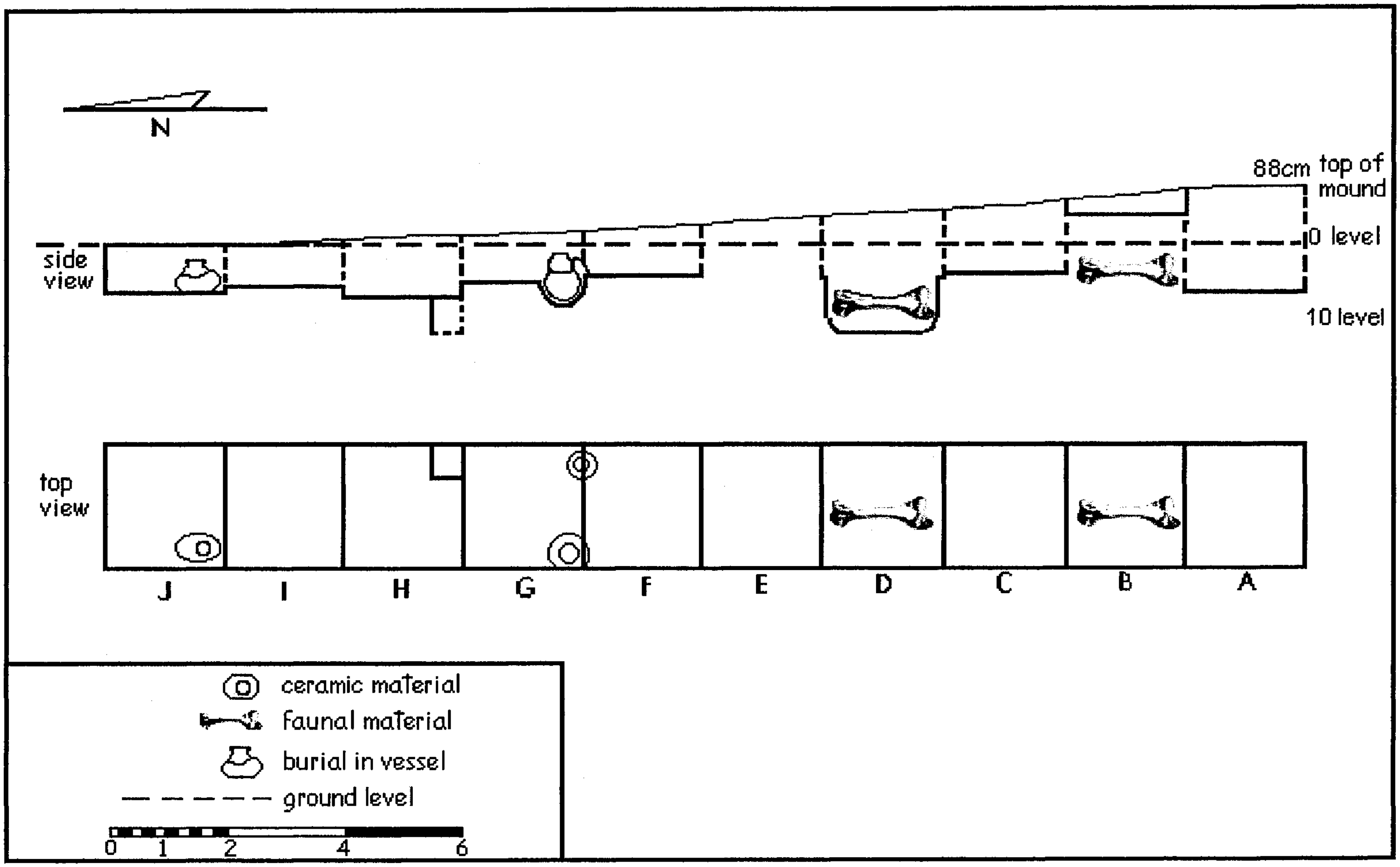

Figure 7. San Cristóbal Trench Profile (Adapted from Wyss 1983:51).

(personal communication, Paul F. Healy, 2005). However, she provides no excavation profiles, no tabulation or seriation of the diagnostic ceramics recovered. The diagnostic ceramics from San Cristóbal were simply compared to published descriptions of pottery of the Greater Nicoya subarea (Healy 1980) in order to gain some general sense of the age of the site (which, in the 1970s was not an unusual goal of archaeologists here). More research might have been followed, but a major civil war in Nicaragua disrupted the project, and no further study was possible. .

Given the considerable depth of artifact-bearing deposits (>1 m deep in most places), and the fact that Wyss (1983:50) indicates some stratigraphy was eventually visible (after excavations were finished) in some of her profiles, I think it is reasonable to assume that Excavation 1 (the mound trench) likely cut into deeply stratified deposits. Indeed, Wyss (1983:55) explicitly states that the unit from which her ceramics were derived for her thesis (Excavation Unit C) appeared to be "undisturbed".

Her ceramic analysis (which is the focus of her M.A. thesis) identified pottery types from San Cristóbal which belong to all four of the major chronological time periods for the Greater Nicoya subarea: Zoned Bichrome (500 BC-AD 300), Early Polychrome (AD 300-800), Middle Polychrome (AD 800-1200), and Late Polychrome (AD 1200-1525). She identified 21 different types and varieties (most well known, defined, and dated from other sites of the subarea). While no tabulation of ceramic types (unit by unit, level by level) was presented (a surprising omission), in most cases her type descriptions provide comments about the depth at which the ceramic types peaked in quantity. For example, Bocana Incised Bichrome and Usulutan Resist, two well known Zoned Bichrome types, peak at 120 cm, in the deepest levels of the excavations; while Princessa Polychrome, a more recent Late Polychrome type, peaks in quantity at only 30 cm deep. Information such as this, while not as useful as detailed accounts by level, do suggest that the deposits of Excavation 1 (and certainly Excavation Unit C) are stratified and contain ceramic materials representing all chronological periods. Using Wyss' ceramic type descriptions, in the absence of a seriation chart, I have assigned different excavation levels of Unit 1 to particular chronological periods in an effort to discern diachronic changes in faunal exploitation at San Cristóbal.

In this exercise, the deepest levels (100- 120 cm), I contend, date to the Zoned Bichrome period, the next deepest levels (80-100 cm) to the Early Polychrome period, topped by deposits from the Middle Polychrome period (40-80 cm) and, in the uppermost levels (0-60 cm), materials that date to the Late Polychrome period.

I recognize that this is an assumption. However, in the absence of a detailed tabulation of the pottery by the excavator, this hypothetical reconstruction is the best possible, given the limited stratigraphic details from the site. Until Wyss, or someone else, provides a more complete, detailed, ceramic serration and/or set of radiocarbon dates for the deposits of San Cristóbal, this is the next most reasonable approach to take.

It is, in my view, indisputable that San Cristóbal had a lengthy site history, spanning all four major chronological periods (ca. 500 BC-AD 1535). Furthermore, given the present information, there appears to be little evidence of stratigraphic disturbance at the site. It is also recognized that if, and when, a more thorough ceramic and chronological analysis of San Cristóbal is produced in future, with dates for each excavation level more firmly fixed, some revisions to the trends in faunal exploitation I have outlined here may then have to be made.

The alternative to such an approach was to define the site (and all faunal remains recovered) as belonging entirely to the most recent dated materials (Late Polychrome), despite the significant depth of the deposits. In effect, this would have lumped together what appear, at this juncture, to be temporally-distinct levels, all into one, late period. This would have allowed no diachronic perspective and seemed, at the time of our analysis, to be a less than satisfying approach. We have opted, instead, for an admittedly more speculative evaluation, dividing the deposits by depth, and based on fragmentary ceramic correlations. We accept that our diachronic interpretations (exploitation trends) may have to be altered or "tweaked" in future with additional, more secure chronological analysis at San Cristóbal.

Previous Zooarchaeology in Nicaragua

The zooarchaeology of Nicaragua is the least known of the Central American countries. Its prehistory has been eclipsed by historical documentation since Spanish conquest. Oviedo (1945:87-89) described what is today Nicaragua in his published letters as one of the richest areas in the New World. He cited the presence of several species of animals such as white-tailed deer, brocket or fallow deer, peccary, armadillo, coati, tapir, and rabbits. Despite the fact that Oviedo provided first-hand descriptions of the richness of the fauna in the San Cristóbal region, there has been a paucity of modern zooarchaeological analysis in this region and throughout Nicaragua. Stuart also described current zooarchaeological research in Nicaragua:

> Aside from a few general papers and some local lists of species, however, the faunas of Honduras and Nicaragua have yet to be explored. With so much diversity in the completeness of the data, it is difficult to analyze the fauna geographically to

> a uniform degree of detail for the entire region...it is obvious that Middle America is not a coherent faunal region. (Stuart 1964:338)

In the 1980s, Lange and colleagues (1992), made a hasty reconnaissance of sites on the Pacific coast of Nicaragua, as well as some sites to the east of Lakes Managua and Nicaragua. These studies produced a better map of local Nicaraguan prehistoric development. Also recovered were obsidian and ceramic specimens, which help to integrate Nicaraguan Pre-Columbian data with similar findings from southern Mesoamerica and northwestern Costa Rica. Although this more recent work has shed light on changing settlement patterns and subsistence activities, especially in relation to small-scale climate change and other natural phenomena, it did not reveal any archaeological data regarding human-animal interrelationships.

To date, with the exception of a small, though noteworthy, zooarchaeological study by Pohl and Healy (1980) of bony specimens (N = 333) from a site located on Ometepe Island, in nearby Lake Nicaragua, and from Santa Isabel "A" on the Rivas Peninsula there has been little else published on the Pre-Columbian fauna from Nicaragua (more on these sites in Chapter 7). In a broader sense, archaeological research in Nicaragua in general is largely limited to a pair of descriptive 19th century surveys (Bransford 1881; Bovallius 1881), an early ceramic analysis (Lothrop 1926), and a major archaeological study of the Rivas Region of southwest Nicaragua (Healy 1974, 1980). Aside from the latter's faunal analysis, only some preliminary zooarchaeological analysis was carried out at the San Cristóbal (Site NMN2-1).

Usrey (1979) conducted an incomplete unpublished preliminary analysis of the faunal material from Unit 1 of San Cristóbal in Nicaragua (See Table 3). Contextual information is lacking, there is insufficient quantitative data, and the study fails to

Table 3. Identified Faunal Remains from Site NMN2-1, Nicaragua (by Usrey 1979).

Scientific/Common Name	Unit No.	Faunal Material Recovered	Special Features
MAMMALS			
Odocoileus virginianus	G-4	Tibia: proximal end with joint	Rodent gnawed
White-tailed Deer	J-3	Left side of mandible with 1molar	
	I-6	M1 (Molar)	
	I-8	1 Molar	
	I-8	Right Femur (Lateral condyle)	(burned)
Nasua nasua	H-3	2 Molars	No jaw
Coatimundi			
Lynx rufus			
Bobcat	J-4	P3 (Premolar)	
Dasyprocta punctata	I-4	1 molar	
Agouti	I-5	1 molar	
Canis familiaris	H-6	P4 (Premolar)	
Domestic dog	F-3	M2 (Molar)	
REPTILES			
Lizards			
Ctenosaura similis	I-8	Section of front left side of maxillae near nasal opening	
Spiny-tailed Iguana	I-6	Premaxillae with teeth	
Heloderm horridum	I-6	Thoracic vertebra	
Mexican beaded lizard			
Caiman:		One tooth, pierced on 2 sides, possibly for ornamental purposes.	
Turtles: Only bony plates identified and found throughout all levels. It is impossible to determine from turtle fragments which genus is present, with the exception being that soft shelled and hard shelled turtles are both represented.			
Snakes			
Viparid sp.	I-5	2 Thoracic vertebrae	
Probably Colubrid	I-5	Thoracic vertebra	Large specimen (4-6 m)
Plus several small vertebrae of unidentified snakes.			
AMPHIBIANS			
Rana sp.	I-5	1 Thoracic vertebra	
Unidentified frog			
FISH			
Lepisosteus tropicus	found in All Levels	Numerous Scales	
Tropical Gar	and All Units		
Unidentified Catfish		1 Pectoral spine	

generate any hypotheses and questions which are necessary to understand any lack of the faunal assemblage.

CHAPTER 5
METHODS

INTRODUCTION

According to Klein and Cruz-Uribe (1984:1), the goals of zooarchaeological research are "...to reconstruct the environment and behavior of ancient peoples..." It is now recognized that excavated animal bones are as valuable as ruins and other artifacts in providing us with insights into the activities of ancient people (Klein and Cruz-Uribe, 1984:xi).

Zooarchaeology is still maturing in Lower Central America and too little data have been collected to discuss species variability, and it is difficult to generalize about animal use in the region. This is disappointing because Wing (1963) and other researchers have been using direct faunal and floral data for complex environmental and cultural research in neighboring regions since the early 1960s. What is even more disconcerting is that early researchers in Central America were already sensitive to the need for improved methodological accuracy, such as suitable archaeological sampling and recovery strategies to analyze archaeological assemblages that included the broadest possible range of faunal and floral specimens.

The primary goal of my research is to establish a holistic framework, based on Gonzalo Fernando Oviedo y Valdés' ethnohistorical data as a model, and the taxonomic study done for this thesis, to describe the Pre-Columbian culture of San Cristóbal as a cultural entity. This thesis also represents an attempt to widen the discussion of the appropriate use of zooarchaeological data correlated with a range of faunal samples drawn from both Atlantic and Pacific Lower Central America archaeological sites.

COLLECTIONS METHOD

Faunal material recovered from the 1977-1979 seasons at the site of San Cristóbal were collected by excavations from an intact house-mound into which a 20 x 2 m trench was excavated. The trench was divided into ten 2 x 2 m units with the designations from the center of the mound to the north as A, B, C, D, E, F, G, H, I, and J (Wyss 1983:43) (See Figure 8). Recovered faunal material turned up in units A, C, and D. Samples from these three units represented 17,119 fragments bones collected from fine (3.18 mm) mesh used in excavation, where all deposits were screened. Some researches believe even this size mesh can result in a bias toward large fauna only being collected in some regions (Casteel 1972). However, it appears that the San Cristóbal excavators were conservative in keeping bits and pieces of bone, which might have been discarded by many excavators. The relatively high proportion of unidentifiable bone is similar, in my experience, to sites where careful screening has been undertaken. Without the application of this fine mesh, there is little chance of recovering bones of small mammals, such as rodents or small carnivores. Because the 3.18 mm fraction revealed the presence of extensive fish fragments that would have gone undetected by a larger (6.40 mm) mesh screen. It is likely that collection using a larger mesh screen would alter any results about faunal exploitation and the subsistence strategies of the San Cristóbal residents.

LABORATORY METHODS: SORTING, ANALYSIS, AND IDENTIFICATION

Sorting and Analysis

The contents of the San Cristóbal faunal remains, once transported to Trent University's Archaeology Centre faunal laboratory and storage facility in 2005, were laid out in accordance to unit and numeric chronology (i.e., Unit A: A20-30 cm, A30-40 cm, etc.). As each bag was reviewed, the various components were removed with forceps, and microspatulas, or cleaned with fine paintbrushes. Initially bones were sorted into large, medium, and small categories for each class (e.g., large, medium, or small mammal). The logical next step was to sort bone fragments together that clearly represented the same skeletal part, such as the distal humerus of white-tailed deer. The fragments within each skeletal part were then sorted more finely on the basis of morphological similarities and differences. I sorted all bones into the major classes of animals and whenever possible tabulated them according to their taxonomic classifications (species, genus, family).

Identification

Driver (1992) discussed the problem of attributing species level identifications to fragmented archaeological material, and more specifically, the extent to which the context of the bones tend to limit the range of taxa to which a specimen can potentially be identified. When the identification of a specimen is attempted, it is usual that only species which are thought likely to have occurred at that place and that time will be considered. A species that may be morphologically quite similar, but has never before been identified from that region, may not be considered.

Klein and Cruz-Uribe (1984:6) suggest that identification of bone fragments can be more easily determined when using the process of elimination. To illustrate this method, a series of questions can be used to narrow identification of a species. For example, "Is the bone large enough to have come from a deer, a peccary or an armadillo, or is it small enough to be derived from a paca or rat?" However, the matter becomes further complicated when sexual dimorphism (size variation) is considered within a species. However, tooth size in comparison to bone length and size, can often indicate a species taxonomic classification (i.e. a bone which morphologically resembles that of a peccary bone can still be considered peccary even in the absence of dentition).

The most important aspect in faunal identification, however, is to establish a comparative collection of reliably identified, aged and sexed skeletons of modern animals. Therefore, preliminary identification of the San Cristóbal fauna were facilitated by the use of small comparative collections housed at Trent University's Archaeological Centre. However, identification of the bones was achieved primarily through direct comparison with modern skeletons from the reference collection held at the Royal Ontario Museum (ROM), which houses a very good comparative skeletal collection of tropical animals. Furthermore, I consulted with the ROM's staff in paleobiology about differentiating between particularly difficult faunal identifications, when necessary. Their technical specialty in zooarchaeology, and extensive research with faunal remains, were the grounds for choosing this museum. Identifications were carried to the finest taxonomic level possible, subject to limitations in the degree of similarity between species, the degree of fragmentation, the breadth of the comparative collection, and my experience. Additional textual references and relevant illustrative guides consulted include osteology manuals published by (Olsen 1968, 1972, 1973, 1982) and Gilbert (1993).

Observing surficial characters is clearly a part of zooarchaeologist's task. This involves distinguishing bone damage produced by people. Microscopic analysis also facilitated in the identification of small fragments, which sometimes exhibited diagnostic features, and/or forms of modification. However, formal bone tools are often difficult to identify to the particular skeletal element used and, in many instances, to the species exploited. This is because the manufacturing of items such as awls, pins, or needles affects bone fragmentation and the survival of any significant identifying marks.

Equally important, the differences in preservation and bone condition may reflect accelerated weathering and/or mechanical destruction at the site (including destruction by humans and rodents). Some of the differences between bone conditions may reveal differences in human activities, including bone modification, burning, and garbage disposal. Therefore, marks on bones made by humans were either interpreted as food processing marks resulting from butchering, skinning, or marrow cracking. In contrast, gnawing marks that were identified as rodent activity were then matched up to comparative material from marks made by carnivore teeth, rodent teeth or other agents, to help distinguish them.

Categories used in identification are coded using the format of Reitz and Wing (2001:Appendix 1). This format accommodates identification to the species or higher taxonomic levels (e.g., genus, family, order, and class). Scientific nomenclature follows Olsen (1983) and Gilbert (1993) for mammals, and Olsen (1968) for reptiles, amphibians, and fish. The less certain referrals to species or higher taxonomic levels were indicated by a "cf." Bone elements were also coded following the standard procedure with notations of portion and completeness. I also noted burning, relative physical condition, and mentioned any modifications made to the bones.

The identification of bone fragments proceeded in two stages. Firstly, the bone of which the fragment is a part was identified. For example, as a first step the bone fragment's precise position in the body needed to be determined before any identification as to the species from which it came can be made. Secondly, after identifying the bone I narrow down the types of animals from which the bone could have come. Having an idea of the size of the animal from which the unknown bone came enabled a list of possible species to then be drawn up. The unidentifiable bones were sorted out at an early stage in the analysis based on incompleteness, formlessness, and no evidence of any diagnostic features and thereafter ignored. Conversely, the identified bones were then sorted by specimen type, counted, weighed, and stored in separate sealable plastic bags.

The process used in faunal identification was painstaking and time consuming. This was necessary in order to identify elements in comparison with a comparative osteological collection, articulated drawings, and descriptions of zoological osteologies. For example, what emerged as a particular challenge at the initial stage of analysis was the occurrence of many fragmented fish bones. What survived were typically small, disarticulated, fragmented, and sometimes burnt forms. In this case, it was helpful to have access to some modern specimens for close comparison.

The fact that there are such a large number of fish elements, and the tendency for fish bone to break into tiny fragments, has meant that identification and interpretation focused on the more substantial fish skeletal elements such as: vertebrae centra, premaxillae, maxillae, dentaries, dermal structures, and cranial bones such as angulars and post-temporals.

NATURE OF THE FAUNAL MATERIAL

After identification, I laid out the identified specimens in stratigraphic order, associating each identified specimen with the level stratum [e.g., Unit A40-50 cm, C90-100 cm, D 70-80 cm, etc.] from which it came. Once this was done, I could answer some of the questions, which I initially asked, since I now knew what basic taxa comprised the faunal assemblage of each stratum. In particular, I answered any questions that required I know what taxa were present, and what taxa were absent, from any given stratum in the San Cristóbal site.

The faunal assemblage from San Cristóbal was extremely large, consisting of approximately 17,000 identifiable specimens from well-dated contexts. The simplest information, which can be gleaned from such a large faunal sample, after species has been identified, is their relative frequency (e.g., which animals were common, which less common?). In fact, this can be one of the most difficult questions to answer, in terms of making the calculation and in terms of interpreting its meaning.

To address my research questions successfully each faunal specimen was assessed according to the zooarchaeological methods as outlined by Reitz and Wing (2001): (1) calculating the frequency of species; (2) assessing the parts of the skeleton represented for each species; (3) isolating any bone artifacts such as pins, needles, awls; (4) interpreting alterations such as cut marks, breakage, heat treatment; (5) determining the seasonality of occupation; and (6) interpreting the inter-site comparisons (regional approach).

Quantification

Much zooarchaeological literature is entirely devoted to methods of quantifying faunal assemblages (i.e., Casteel 1976; Grayson 1984). "Quantification is necessary to compare animal use through time and space" (Reitz and Wing 2001:143). Klein and Cruz-Uribe (1984:24) state that quantification of taxonomic abundance is essential when comparing samples. Without this any differences or similarities can be put down solely to chance. Quantitative analysis involves intra- and inter-site studies to assess how much variation there is in the animal bone assemblage (Maltby 1979:3).

Therefore, all faunal material in this analysis was quantified by the bone fragment method (more on this method later), and by bone weight. Bone weight provides an important balance for bone count, especially for highly fragmented samples that can exaggerate quantification according to bone count (Casteel 1978). For example, some species such as fish have many more elements than others, and their relative representation may therefore be inflated by the use of bone count alone. Bone weight provides a more accurate assessment of the role of large taxa, which may be present in lower numbers in an assemblage but may represent far greater caloric contributions to the diet than many numbers of small taxa.

The simplest form of quantification of vertebrate faunal material is to produce a table of the presence or absence of the different locations. If possible, however, it is preferable to have abundance information. There are several ways to produce this, but the two principal methods used in quantifying taxonomic abundance are: NISP and MNI.

Number of Identified Specimens (NISP)

Lyman (1994:37) defines this as "the number of identified specimens in a collection, where identified usually means identified to taxon but may mean identified to skeletal element represented". Faunal analysts have adhered to using the NISP, or number of bone fragments method, for many reasons. For example, it is the oldest method, and is the only way early faunal reports can be compared. However, NISP does have some flaws. It ignores the fact that some species have more bones in a skeleton than others. For example, a dog has 52 to 58 phalanges a pig has 48. NISP also discounts the fact that some species may have been brought to a site intact, whereas others may have been dismembered elsewhere. This assumption was named the *schlepp effect* (Perkins and Daily 1968). The effect is extremely well documented ethnographically (Binford 1978, 1981). However, the main problem with the NISP method is that it is very sensitive to bone fragmentation and bones are not always equally identifiable (Klein and Cruz-Uribe 1984:25).

How convincing are these accusations about numbers of identified specimens? I will dispute that they are not adequately credible to substantiate the dismissal of NISP values as a basic unit of quantification, but I should consider minimum numbers in some detail before making any such contention.

Minimum Number of Individuals (MNI)

Klein and Cruz-Uribe (1984:26) define this as "the number of individuals necessary to account for all the identified bones". Different individuals calculate MNI in a number of different ways; often age, sex, bone size, and contexts are taken into account (Reitz and Wing 2001:195). Chaplin (1971:68-75) argues in favor of the technique of estimating the minimum number of animals for each species and using this as the main datum for site-count. He argues a little too forcefully in favor of this technique, for in my experience MNI calculation is not as exacting a method as Chaplin seems to indicate. Minimum number of animals should always be used in conjunction with other data, such as total number of identified fragments from each species, and the ratio of each species to the total and identified fragments. Chaplin has not included any discussion of the actual identification of whole or fragmentary bones, but has stressed the necessity of using real, comparative material rather than pictures in textbooks.

Although some faunal analysts consider MNI as the most popular method currently in use, there are still many problems to be resolved with this method. For instance, some body parts are more difficult to identify than others, and because the identification criteria are stricter for MNI than NISP, extensive fragmentation probably results in more bias in MNI than in NISP (Marshall and Pilgram 1993:261). The minimum numbers method (MNI) determines the necessary numbers of individuals of a species accounting for all identical bones found in a given faunal assemblage (Grayson 1973). MNI may, therefore, be a less representative descriptor of relative element frequencies than NISP when working with highly fragmented assemblages. One should also be aware of the tendency of MNI to produce inflated estimates for fragmented bones, along with the general problem of confusing non-human utilized bone with specimens that do reflect human activity (Grayson 1984:).

A fundamental problem in zooarchaeology is the relationship between bone fragments (NISP), individual animals (MNI), and actual contribution to diet or other activities. These two methods, NISP and MNI, are now well-established measures used by most zooarchaeologists to formulate a range of maximum and minimum counts for each species. Crabtree (1990:191) suggested that faunal analysts must be archaeologists first and zooarchaeologists second…"We should spend less time worrying about the relative merits of MNI, NISP, and other measures of taxonomic abundance, and more time considering how we can integrate faunal data with other lines of archaeological and historical evidence". Casteel (1977:132) writes, "While the frustrations involved in attempts to correlate faunal studies done by different investigators using diverse methods can readily be appreciated the idea of imposing a uniform framework for such studies before being fully aware of the range of applicability of even these few methods available at the present does not seem to be a step in the right direction."

Clearly, employing several methods in order to study a faunal assemblage such as San Cristóbal may open the analysis to some potential problems. The methodology proposed here, however, reflects my view of the controversy that exists over the merits of these two methods. Therefore, this section is also a justification of my choice of the "bone fragments method" (NISP) as a methodological for study of the San Cristóbal faunal assemblage. Additionally, the use of NISP and bone weight in my study is most appropriate for the dispersed contexts of the faunal assemblage from San Cristóbal, given the limitation of MNI for this kind of sample. Although the NISP method has been rejected by some scholars (e.g., Chaplin 1971; Klein and Cruz-Uribe 1984), as a basis for a complete study of a faunal assemblage, it does form a major part of my methodology. This decision also follows Grayson (1984:92) who concludes, "The number of identified specimens per taxon provides the best unit we have available for measuring the relative abundances of vertebrate taxa in archaeological and paleontological sites". It is important that this distinction be clearly understood. In addition to allowing for problems of quantification or methodology, one must also consider the importance of studying assemblages collected decades ago under less than ideal conditions.

CHAPTER 6
RESULTS AND INTERPRETATION

INTRODUCTION

This chapter presents the results of the analysis and identification of the faunal remains from the site of San Cristóbal (NMN2-1), Nicaragua. The first section examines the faunal remains themselves and their identification to various levels (species, genus, family). Because of the high quantity of remains found and identified, and the degree of fragmentation, the data do not support rigorous statistical tests. Instead, number of individual specimens and species present are given for the faunal assemblage of San Cristóbal.

RESULTS OF ZOOARCHAEOLOGICAL ANALYSES

The San Cristóbal faunal assemblage consists of the remains of more than 17, 000 vertebrates and invertebrates. Of the bones identified from the 1977-1979 excavations, roughly 74% were fish, 6% were terrestrial mammals and Figure 8 shows that a cumulative 4% were reptiles (including lizards, snakes and turtles). Although bone preservation is extraordinarily good, the San Cristóbal site shows a sizeable proportion of fractured elements (12.5%), which proved unidentifiable. Figure 8 provides a general overview of the proportion of fauna from San Cristóbal throughout its entire occupational time period. It also shows that identified birds, amphibians and rodents made up 0.5% or less of the entire collection, suggesting little reliance on these species. Molluscs, in comparison, make up a larger proportion of the collection, but still account for less than 3%.

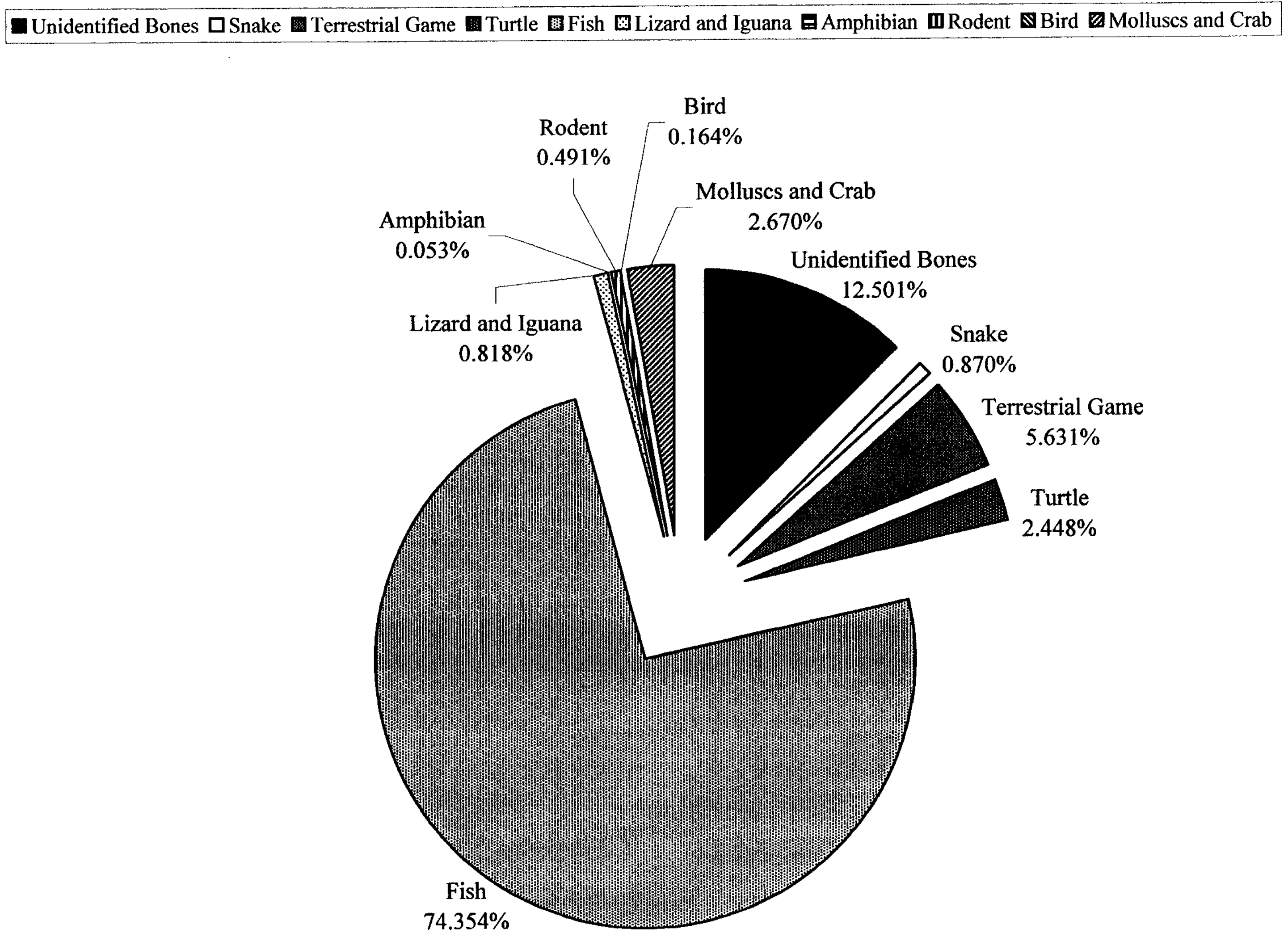

Figure 8. **General Fauna in the San Cristobal Assemblage**

Analysis reveals a diverse faunal assemblage comprised of a minimum of 51 species. The majority of identifiable species are aquatic and semi-aquatic, although 14 terrestrial species were also recovered from the faunal sample. Table 4 presents a list of species found at San Cristóbal. It provides estimates of the number of individual specimens (NISP): (1) for aquatic and semi-aquatic fauna and (2) for terrestrial fauna. All specimens were measured in terms of assemblage diversity and species composition; therefore, NISP and weighted percentages were calculated for all fauna.

Table 4. San Cristóbal Animal Taxa Represented for the Entire Occupational Period

Taxa	Common Name	N= # of Fragments	% NISP	% Weight (g)
Unidentified Large Mammal		644	3.769	9.815
Artiodactyla				
Odocoileus virginianus	White-tailed Deer	379	2.214	24.350
Mazama Americana	Brocket Deer	115	0.672	2.546
Subtotal		**1,138**	**6.655**	**36.711**
Unidentified Small Mammal		1233	7.203	8.494
Artiodactyla				
Tayassu pecari	White-lipped Peccary	15	0.088	0.118
Tayassu tajacu	Collared Peccary	141	0.824	1.031
Carnivora				
Bassaricyon gabbii	Olingo	3	0.018	0.039
Bassariscus astutus	Ringtail	1	0.006	0.014
Mustela frenata	Long-tailed Weasel	2	0.012	0.007
Nasua narica	Coatimundi	29	0.1690	0.490
Potos flavus	Kinkajou	7	0.041	0.082
Procyon lotor	Northern Raccoon	4	0.023	0.024
Didelphimorphia				
Didelphis marsupialis	Opossum	4	0.023	0.176
Lagomorpha				
Sylvilagus sp.	Cottontail Rabbit	14	0.082	0.159
Rodentia				
Agouti paca	Paca	5	0.029	0.036
Dasyprocta punctata	Central American Agouti	7	0.041	0.041
Oryzomys sp.	Rice Rat	66	0.386	0.147
Sciurus sp.	Squirrel	2	0.012	0.005
Xenarthra				
Dasypus novemcinctus	Nine-banded Armadillo	255	1.490	1.679
Subtotal		**1,788**	**10.447**	**12.542**
Reptilia	UnidentifiedReptile	1	0.006	0.048
Croc. *c.f. Crocodylus acutus*	American Crocodile	1	0.006	0.012
Iguana *Iguana Iguana*	Green Iguana	133	0.777	1.007
Lizard *Ameiva festiva*	Central American Whiptail	1	0.006	0.046
Anolis sp.	Anole	1	0.006	0.0
Ophisaurus sp.	Glass Lizard	1	0.006	0.012
Scleroporus sp.	Spiny Lizard	4	0.023	0.043
Snake *Agkistrodon piscivorus*	Cotton-mouth Moccasin	50	0.292	0.360
c.f. Drymobius sp.	Racer Snakes	7	0.041	0.043
Lampropeltis sp.	Tropical King Snake	2	0.012	0.014
Natricinae sp.	Water Snake	26	0.152	0.227

Taxa	Common Name	N= # of Fragments	% NISP	% Weight (g)
Spilotes sp.	Rat Snake	64	0.374	0.5
Turtle *Chelydra sp.*	Snapping Turtle	1	0.006	0.034
Chrysemys sp.	Painted Turtle	173	1.011	4.572
Clemmys sp.	Pond Turtle	69	0.403	0.254
Kinosternon sp.	Mud Turtle	49	0.286	0.599
Terrapene sp.	Box Turtle	127	0.742	1.708
Subtotal		**710**	**4.149**	**9.479**
Amphibia				
Toad *Bufo marinus*	Marine Toad	7	0.041	0.106
Rana sp.	Bullfrog	2	0.012	0.022
Subtotal		**9**	**0.053**	**0.128**
Aves	Unidentified Bird	261	1.525	1.879
c.f. Caragyps atratus	Black Vulture	1	0.006	0.053
Colinus virginianus	Bobwhite	1	0.006	0.005
Egretta caerulea	Little Blue Heron	7	0.029	0.063
Eudocimus sp.	Ibis	5	0.041	0.014
Penelope sp.	Guan	14	0.082	0.229
Subtotal		**289**	**1.689**	**2.243**
Osteichthyes				
Lepisosteiformes				
Atractosteus tropicus	Tropical Gar	515	3.008	2.828
Perciformes				
Caranx hippos	Jackfish	4137	24.166	10.948
Cichlasoma sp.	Cichlid	7781	45.452	18.228
c.f. Mycteroperca sp.	Grouper	4	0.023	0.299
Rachycentron sp.	Cobia	13	0.076	0.162
c.f. Sciaenidae sp.	Drum	121	0.707	0.401
Siluriformes				
Rhamdia sp.	Catfish	157	0.917	1.022
Subtotal		**12,728**	**74.349**	**33.888**
Mollusc		456	2.664	5.024
Nephronaias bivalve				
Euglandina cylindracea				
Pomacea flagelatta				
Pachychilus sp.				
SHELL SPECIMENS WERE QUANTIFIED TOGETHER		**456**	**2.664**	**5.024**
Crab Claw		**1**	**0.006**	**0.005**
Abundance Measures				
Total Number of Taxa (s)= 51		***∑N=17,119***		

Complete counts and comparisons for excavation units are identified in Appendix A.

Within the assemblage: bird, armadillo, deer, coatimundi, kinkajou, olingo, opossum, peccary, raccoon, and ringtail, rabbit and possibly weasel represent food items. The physical remains from some unidentified mammals and birds, as well as crocodile; rice rats, agouti and paca likely represent food sources as well, but could also be the result of non-cultural accumulation. The presence of a single vulture bone, small rodent remains, snakes, frogs and toads may indicate contamination of the faunal assemblage, or on the contrary, they may be indicative of non-food activities. In any case, it is unlikely that they contributed significant nutrition to subsistence behaviors.

In order to determine whether there were any significant temporal changes in patterns of resource procurement within the prehistoric sequence, quantified data on aquatic and terrestrial vertebrates were compared for each period/phase. Table 4 shows four main time-periods, which are based on varying depths of the three units excavated at San Cristobal (Units A, C and D). The Late Polychrome period (AD 1350-1525) is represented by a depth of 0-30 cm, the Middle Polychrome period (AD 800-1350) encompassed the depth of 30-60 cm, the Early Polychrome period (AD 500-800) is situated at 60-90 cm, and the Zoned Bichrome period (ca. 500 BC-AD 500) is associated with a depth of 90-120 cm. Table 4 also represents NISP and weighted percentages, over time, of identified aquatic species, terrestrial fauna, unidentified bird and small versus large mammals.

Table 5. Taxonomic Timeline of San Cristóbal Fauna by NISP and Weight Percentages Across All Units

Taxa **Note** Columns represent NISP % and Weighted % (g) Respectively For Units A,C,D	Late Polychrome		Middle Polychrome		Early Polychrome		Zoned Bichrome	
	NISP % N=615	% Weight (g) N=310	NISP % N=5399	% Weight (g) N=1141.6	NISP % N=7143	% Weight (g) N=1748.7	NISP % N=3953	% Weight (g) N=944
Aves								
Unidentified Bird	7.154	4.321	0.7224	2.0760	2.1560	1.8356	0.6071	0.9149
Caragyps atratus (Black Vulture)					0.0140	0.1258		
Colinus virginianus (Bobwhite)					0.0140	0.0114		
Egretta caerulea (Little Blue Heron)					0.0560	0.0743	0.0759	0.1383
Eudocinus sp. (Ibis)					0.0700	0.0343		
Penelope sp. (Guan)	0.163	0.838			0.1820	0.3946		
Subtotal-Abundance % of Period Taxa	**7.32**	**5.16**	**0.72**	**2.08**	**2.49**	**2.48**	**0.68**	**1.05**
Amphibia								
Toad								
Bufo marinus (Marine Toad)			0.0370	0.1752	0.07	0.1372		
Rana sp. (Bullfrog)			0.0185	0.0701			0.0253	0.0106
Subtotal-Abundance % of Period Taxa	—	—	**0.06**	**0.25**	**0.07**	**0.14**	**0.03**	**0.01**
Osteichthyes								
Lepisosteiformes								
Atractosteus tropicus (Tropical Gar)	7.480	2.612	1.5558	1.2088	2.7999	3.1338	4.6800	4.2979
Perciformes								
Caranx hippos (Jackfish)	17.724	5.063	28.5423	10.7744	26.3895	12.2605	15.2289	10.6596
Cichlasoma sp. (Cichlid)	21.789	2.838	46.2678	18.0624	42.9931	18.5280	52.5677	22.9468
c.f. Mycteroperca sp. (Grouper)					0.0420	0.5318	0.0253	0.3298
Rachycentron sp. (Cobia)			0.0370	0.1051	0.1260	0.2287	0.0506	0.1596
Sciaenidae sp. (Drum Fish)			0.4816	0.2453	0.9240	0.5719	0.7336	0.4043
Siluriformes								
Rhamdia sp. (Catfish)	1.951	0.0967	0.2223	0.1927	1.8620	1.8928	0.4554	0.4255
Subtotal-Abundance % of Period Taxa	**48.94**	**10.61**	**77.11**	**30.59**	**75.14**	**37.15**	**73.74**	**39.22**

Table 5. (Continued)

Taxa **Note** Columns represent NISP % and Weighted % (g) Respectively For Units A,C,D	**Late Polychrome** NISP % N=615	 % Weight (g) N=310	**Middle Polychrome** NISP % N=5399	 % Weight (g) N=1141.6	**Early Polychrome** NISP % N=7143	 % Weight (g) N=1748.7	**Zoned Bichrome** NISP % N=3953	 % Weight (g) N=944
Reptilia								
Unidentified Reptile					0.0140	0.1144		
Crocodile								
c.f. Crocodylus acutus (American Crocodile)			0.0185	0.0438				
Iguana								
Iguana iguana (Green Iguana)	0.163	0.516	0.6483	0.5781	0.9380	1.1952	0.7589	1.3404
Lizard								
Ameiva festiva (Central American Whiptail)							0.0253	0.2021
Anolis sp. (Anole)					0.014	0.0057		
Ophisaurus sp. (Glass Lizard)					0.0140	0.0286		
Scleroporus sp. (Spiny Lizard)			0.0370	0.0788			0.0506	0.0957
Snake								
Agkistodon piscivorus (Cotton-mouth Moccasin)			0.1297	0.2365	0.5460	0.6462	0.1240	0.0957
c.f. Drymobius sp. (Racer)					0.0980	0.1029		
Lampropeltis sp. (Tropical King Snake)					0.0280	0.0343		
Natricinae sp. (Water Snake)					0.1680	0.1430	0.3542	0.7340
Spilotes sp. (Rat Snake)			0.3334	0.4467	0.5040	0.7606	0.2530	0.2447
Turtle								
Chelydra sp. (Snapping Turtle)							0.0253	0.1489
Chrysemys sp. (Painted Turtle)	1.626	1.194	0.2778	0.9110	1.5400	9.1039	0.9613	1.7021
Clemmys sp. (Pond Turtle)					0.9660	0.6004		
Kinosternon sp. (Mud Turtle)	1.301	1.000	0.1297	0.3153	0.2800	0.1944	0.3452	1.5638
Terrapene sp. (Box Turtle)					0.7840	1.4296	1.3661	3.7447
Subtotal-Abundance % of Period Taxa	**3.09**	**2.71**	**1.56**	**2.61**	**5.89**	**14.36**	**4.26**	**9.87**

Table 5. (Continued)

Taxa	Late Polychrome		Middle Polychrome		Early Polychrome		Zoned Bichrome	
Note Columns represent NISP % and Weighted % (g) Respectively For Units A,C,D	NISP % N=615	% Weight (g) N=310	NISP % N=5399	% Weight (g) N=1141.6	NISP % N=7143	% Weight (g) N=1748.7	NISP % N=3953	% Weight (g) N=944
Mammalia								
Unidentified Large Mammal	8.780	15.608	6.6494	15.5922	3.1639	9.7844	0.1518	1.1277
Odocoileus virginianus (White-tailed Deer)	6.341	47.178	22.782	26.1037	2.0160	23.3030	1.8214	16.4574
Mazama Americana (Red Brocket Deer)			1.4818	6.8763	0.4900	1.5383		
Unidentified Small Mammal	21.138	15.092	8.2608	11.7730	6.2719	5.8043	5.2871	7.3404
Artiodactyla								
Tayassu pecari (White-lipped Peccary)			0.1297	0.1752	0.0840	0.1201	0.506	0.851
Tayassu tajacu (Collared Peccary)	0.1463	0.1419	0.1297	1.3490	1.3580	1.2066	0.0253	0.1915
Carnivora								
Bassaricyon gabbii (Olingo)					0.0420	0.0915		
Bassariscus astutus (Ringtail)			0.0185	0.0526				
Mustela frenata (Long-tailed Weasel)					0.0140	0.0114	0.0253	0.0106
Nasua narica (Coatimundi)	0.976	0.258	0.1667	0.4467	0.0980	0.6748	0.1771	0.2766
Potos flavus (Kinkajou)	0.163	0.322	0.1111	0.0438				
Procyon lotor (Northern Raccoon)			0.0741	0.0876				
Didelphimorphia								
Didelphis marsupialis (Opossum)			0.0370	0.2628	0.0140	0.2173	0.0253	0.0532
Langomorpha								
Sylvilagus sp. (Cottontail Rabbit)			0.0926	0.1226	0.0980	0.2059	0.0506	0.1702
Rodentia								
Agouti paca (Paca)	0.163	0.161	0.0741	0.0876				
Dasyprocta punctata (Central American Agouti)	0.976	0.064					0.0253	0.0426
Oryzomys sp. (Rice Rat)			0.4445	0.1840	0.5320	0.2001	0.1012	0.0532
Sciurus sp. (Squirrel)			0.0185	0.0088	0.0140	0.0057		
Xenarthra								
Dasypus novemcinctus (Nine-banded Armadillo)	0.488	0.129	0.2593	0.2278	1.9180	2.1502	2.5550	3.0745
Subtotal-Abundance % of Period Taxa	**39.17**	**78.95**	**40.7298**	**63.3937**	**16.00**	**45.3136**	**10.7514**	**29.6489**
Mollusc	0.163	0.419			0.2940	0.1760	10.9790	20.9362
Nephronaias bivalve								
Euglandina cylindracea								
Pomacea flagelatta								
Pachychilus sp.								
ALL SHELL SPECIES WERE QUANTIFIED TOGETHER								
Crab							0.0253	0.0213
Subtotal-Abundance % of Period Taxa	**0.16**	**0.42**			**0.29**	**0.18**	**11.00**	**20.96**

Bony Fish

Information about the use of aquatic resources by people who lived at San Cristóbal is based on the identification of a very large sample of faunal material excavated. A total number of 12,123 bone, scale, and tooth specimens were identified to at least the familial level. Fish remains contribute the majority of the faunal material recovered at San Cristóbal. These tie the village to Lake Managua with fish as a significant protein source. Seven different families of bony fish are represented in the San Cristóbal collection. All seven are very common: (a) Cichlidae: of the genus *Cichlasoma*; (b) Carangidae: of the genus *Caranx*, with one species identified, Crevalle Jack (*Caranx hippos*); (c) Serranidae; (d) Sciaenidae; (e) Rachycentridae: of the genus *Rachycentron*, with one species identified, *Cobia*; (f) Ictaluridae: of the genus *Rhambdia*, with one species identified, Catfish; and (g) Lepisosteidae: of the genus *Atractosteus tropicus*, specifically Tropical Gar.

The jackfish and cichlids predominate in the identified assemblage. Both species are represented by toothy structures like dentaries, vomers, and premaxillae. Other fish noted in the assemblage include: (a) drums, represented by pharyngeal arch teeth; (b) groupers, by their large vertebrae; and (c) gar, represented pieces of mandible, maxilla, and by scales. Tropical Gar (*Atractosteus tropicus)* is the only genus of fish that has been identified from their scales in the faunal remains under study.

According to Keene (1981:123), the pharyngeal arches of drum fish are one of the most numerous elements recovered in the faunal assemblage because they are unusually resistant to destruction. In contrast, the scales of Tropical Gar are diamond-shaped, or rhombic, but generally termed ganoid by ichthyologists (Olsen 1968:5). The faunal evidence alone does not indicate whether this species was used for food, which is most likely, or if the scales were obtained through trade for ornamentation. While no modifications, such as butchery patterns, were obvious for the gar remains, the presence of blackening suggests cooking over fire by humans.

Terrestrial Vertebrates

The identifications of the two species of peccaries (*Tayassu pecari*, white-lipped; and collared, *Tayassu tajacu*) were made on the basis of the size and form of a several worn incisors, molars, and premolars (See Figure 9). Thus, identification was possible to the species level. The cervid material from San Cristóbal was carefully compared with skeletons from both the white-tailed deer, *Odocoileus virginianus*, and the red brocket deer, *Mazama americana*. An almost complete comparative skeleton of the white-tailed deer is housed at the Archaeology Centre at Trent University. Both the white-tailed deer and brocket deer fragments were also compared to textual references and illustrative guides, which made conclusive identification possible to the species level. In addition, weights and measures of bone supported diagnostic classification. One hundred and fifteen fragments of *Mazama* and 379 fragments of *Odocoileus* were identified (see Appendix B, Raw Data). The brocket deer bones weighed a total of 105.4 grams. The bone of brocket is distinctive because of both the density and diagnostic features of the phalanges and ribs compared to similar white-tailed deer fragments that weighed more and were of a larger size (see Appendix B, Raw Data). It seems likely that at least some of the bone identified as “large mammal,” came from one of these two cervids. All of the *Mazama* bones, and most of the *Odocoileus* bones, came from animals generally attributed to that of adult size. This is because the fusion state (epiphyseal fusion) of bone

Figure 9. Collared Peccary Incisors and Molar.

was very pronounced in various cervid fragments (e.g., tarsals, humerus, tibia).

The importance of a few specific, terrestrial taxa in the San Cristóbal assemblage was obvious upon initial examination of species frequencies. White-tailed deer, *Odocoileus virginianus*, was distinguished on the basis of bone size and antler morphology. The bones of white-tailed deer are very common in the assemblage, suggesting use of deer as a dietary species and use of bones in tool manufacture. Viewed in observable terms, the faunal samples presented in Table 5 clearly shows that *Odocoileus virginianus* was the most important terrestrial mammal hunted during all periods of site occupation. In addition, evidence on 12 of 379 white-tailed deer bones recovered from NMN 2-1 showed they were worked: six bones had signs of cut marks, and six deer long bone fragments were polished (See Figures 10 and 11). Therefore, deer was not used only for subsistence but also in secondary tool industries.

Fifteen fragments of antler from white-tailed deer were recovered. Most of the antler fragments represent non-diagnostic segments of the antler and other parts were too highly fragmented. Therefore, to deduce whether or not antlers were shed from live animals or forcibly removed from the animal's skull is impossible from the fragmented antler material. Although a fair amount of antler material was recovered from San Cristóbal, little can be deduced concerning the seasonality of occupation, but because only male white-tailed deer produce antler. Therefore, it is obvious that adult male deer were hunted (Davis 1987:59). The higher proportions of white-tailed deer fragments relative to *Tayassu tajacu*, *Tayassu pecari*, coatimundi, kinkajou, rabbit, and other edible species, implies that some social constraints upon its harvesting may have been in use to explain

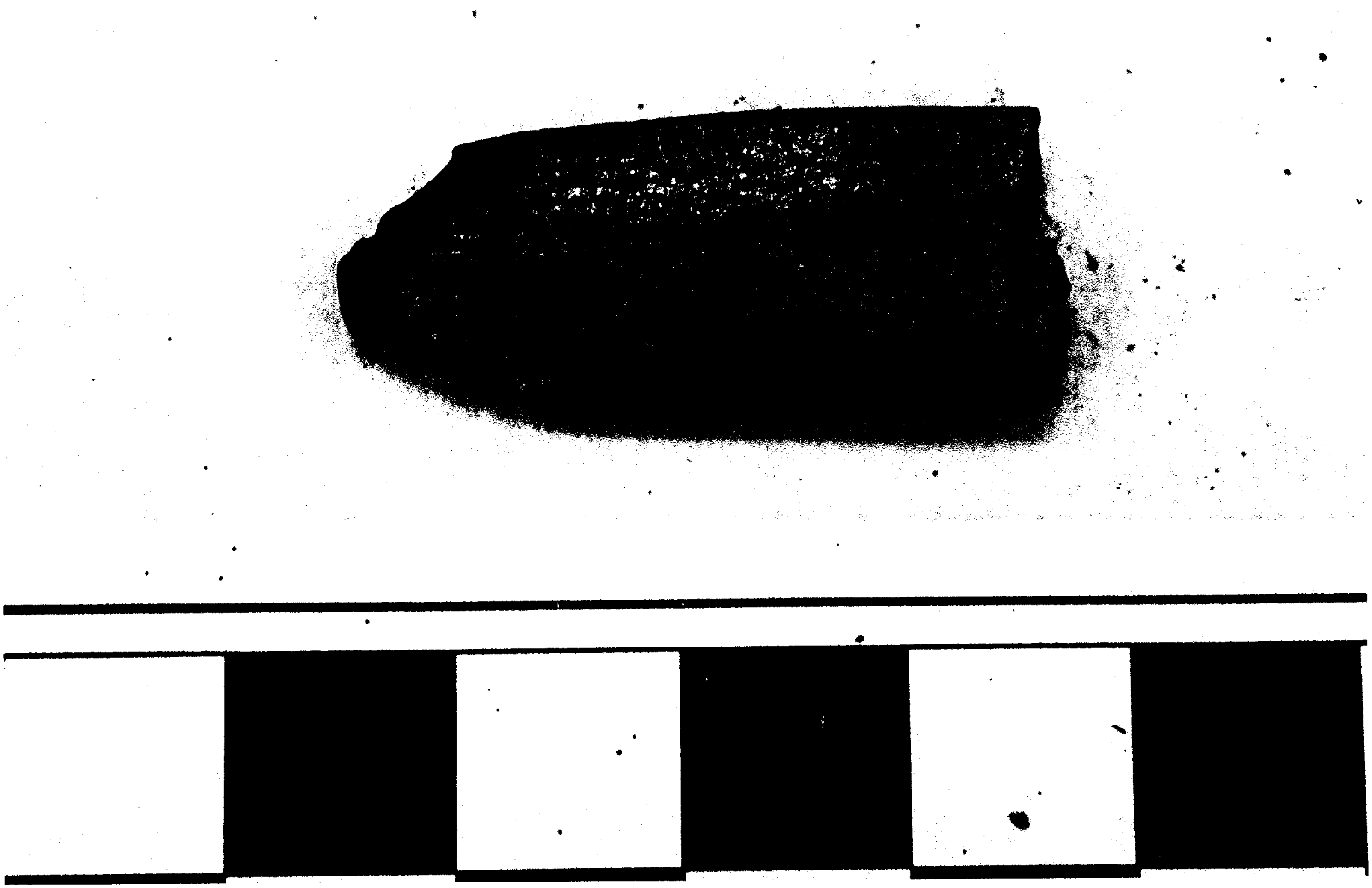

Figure 10. Modified White-tailed Deer Bone with Butchery Marks.

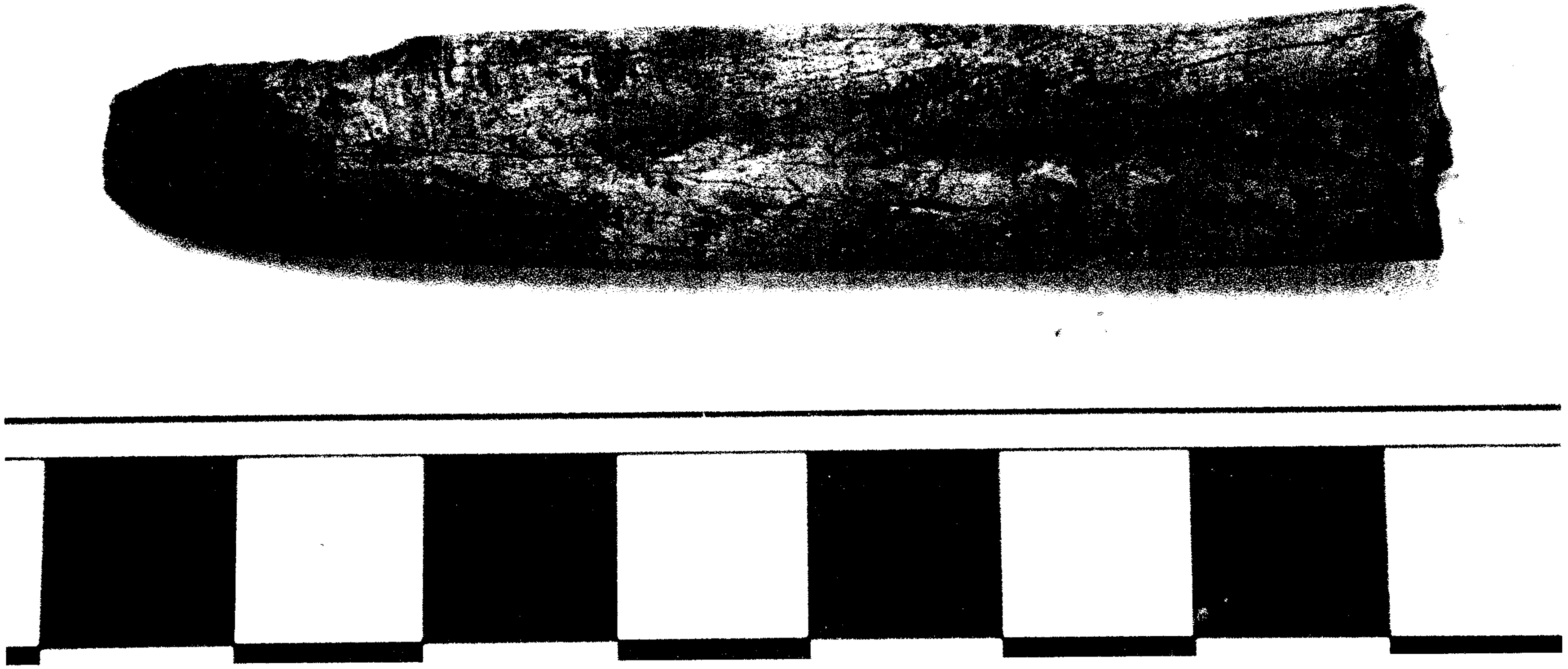

Figure 11. Modified White-tailed Deer Metapodial with Cut Marks and Staining.

the species continuing, long-term importance as a meat source for the San Cristóbal residents.

The other preferred species was the armadillo. Remains of the nine-banded armadillo, *Dasypus novemcinctus*, were very common at San Cristóbal, with 255 fragments recovered, mostly imbricating osteoderms (also referred to as ossified dermal plates or scutes). Unfortunately, minimum number of individuals (MNI) could not be determined from the imbricating osteoderms present in the assemblage, because of the nature of their arrangement. These plate-like structures form the protective covering for the armadillo and each scute fits together to form nine-banded plates. Although the 255 scutes naturally would combine to form armadillo plates, it cannot be conclusively determined how many individuals they came from. These insectivores would have invariably ranged in size, with larger armadillos necessitating the growth of more scutes. For this reason reconstruction was not attempted and determining a definitive MNI was abandoned.

However, armadillos are known to be an edible species and can attain an impressive weight of 7.7 kg (Hall and Kelson 1959 in Linares and White 1980:184). Their palatable nature was pointed out by Stuart (1964:318) when he said: "The flesh of the common armadillo (*Dasypus*) is highly esteemed as food, and I prefer it to that of all other game animals in the region [Central America]."

The paca (*Agouti paca*) is sometimes confused with the agouti (*Dasyprocta punctata*). Only 5 bone fragments represented pacas and 7 bones represented agoutis. Both animals corresponded to the small/ medium, mammal category. Both species of caviomorph rodents represented a minor portion of the assemblage, and were not essential food source, although they were important for intermittent consumption at San Cristóbal.

Looking at the avifauna, guan (*Penelope sp.*), a large game bird was the most abundant species, followed by black vulture, heron, ibis, and bobwhite. Birds seem to have formed a negligible component of the San Cristóbal diet. Unfortunately, only 28 out of 289 bones were identifiable. Bird bones tend to be lighter and more fragile and, thus, possibly more subject to deterioration than mammal bones. Therefore, identification to species was problematic due to bone deterioration and lack of any diagnostic bone features. Those analyzed from the faunal assemblage did show evidence of weathering and gnawing.

The diversity of species identified in the San Cristóbal assemblage, while impressive, is not remarkably different from that reported at other Lower Central American sites (Appendix A). However, some species appear to be absent from the San Cristóbal assemblage site, most notably tapir, canids, monkeys, and felids. Of course, we cannot rule out the possibility that elements from these species may be among the large and small mammals that could not be positively identified. Conversely, these species, are fairly rare at other sites, and may reflect a genuine scarcity of these species in the region during the period of intensive Pre-Columbian occupation.

The largest terrestrial species included white-tailed deer, red brocket deer, collared and white-lipped peccary, nine-banded armadillo, coatimundi, olingo, raccoon, ringtail,. The white-tailed deer is clearly the most broadly distributed mammal, occurring in all 3 units (A, C, D), and an important species for San Cristóbal settlers.

Aquatic and Reptilian Vertebrates

The reptilian faunal sample from NMN2-1 is quite extensive, especially turtle and iguana (See Table 5). Turtles are the majority of identified Reptilian taxa (2.45%), and these include primarily aquatic species such as painted, and pond turtles (Emydidae) and mud turtles (Kinosternidae). The frequencies of turtles are more than two times that of any other reptiles (e.g., lizards, and snakes) or amphibians in the collection. This is not surprising considering that the great lakes of Nicaragua, Lakes Managua and Nicaragua, offer an excellent environment for turtles, and other species. For example, arboreal/terrestrial iguanas (*Iguana iguana*) and lizards (*Anolis*) can be found along the shores of lakes today (Healy 1980:15).

Comparison of the frequencies of turtles demonstrates that turtles were selectively favored over small terrestrial game. This raises the question of what factor could account for this apparent food preference. Perhaps turtles were selected because of the greater ease of capture. Recovered turtle species were possibly exploited as both a supplemental meat source and a valuable source of raw material. For example, two carapace fragments were modified with a hole in the center at the proximal end, as if to fashion the fragments as pendants for personal adornment (See Figure 12).

INTERPRETATION

However, evidence of the economic orientations prevalent at the site during each of the cultural phases, as isolated by the 1977 to 1979 excavations, is limited to that provided by recovered faunal material. For example, avifauna data may be slightly skewed due to a lack of general fauna recovered from all other depths, other than that collected from 60-90 cm, throughout Unit D. This discrepancy concentrates Unit D

Figure 12. Modified Turtle Carapace.

faunal remains to only one time, Early Polychrome, which could distort some trends over time.

This aside, several explanations or hypotheses can be proposed to account for the frequency changes indicated in Table 4. Among them are:

1. Effects of intensive terrestrial exploitation.

A scarcity of white-lipped peccary versus collared peccary is obvious in the San Cristóbal faunal assemblage. This can best be explained by the general aggression and pack nature of the white-lipped peccary in contrast to the more docile tendencies of the collared peccary (Linares 1976:345). Animals such as the white-lipped peccary, which travel in large packs, require a sizeable expanse to forage and thereby increase the challenges for the hunter. He must travel greater distances and further develop his skill-set to compensate for the added effort. When considering the ease with which he could harvest the more commensal collared peccary that is used to living in a disturbed environment, it seems a more logical game choice.

The faunal assemblage shows that the low frequency of paca and Central American agouti may be indicative of incidental use (See Table 3). While the difference is minimal, it is apparent that the low frequency of both species in the collection is noticeably disproportionate to distributions in their natural habitat (Linares 1976:346). Although the agouti is only slightly more abundant than the paca, their proportional density in the collection does conform to natural trends where agoutis are generally more plentiful in the environment. As diurnal creatures, agoutis make a prized game source for trappers because visibility is fair and they are more inclined to forage in swidden fields, which makes them a likely target (Emmons 1990:225).

While it is asserted that deer dominated the terrestrial component of the faunal assemblage, this evaluation cannot be taken at face value. For example, no consideration has been given to the present day population decline of white-tailed deer, in Lower Central America, which could be accounted for by over-exploitation of the species by the many generations of opportunistic hunters.

2. Effects of intensive aquatic exploitation.

The characteristics of Lake Managua, and its surrounding vegetation, affect species composition and the potential for human exploitation. Only during the Zoned Bichrome and Early to Middle Polychrome periods did intensive exploitation of aquatic resources occur, principally of *Cichlasoma*, *Caranx*, and Sciaenidae species. The most noticeable decrease (55 %) is evident for *Cichlasoma* exploitation by the Late Polychrome period. *Atractosteus tropicus* (tropical gar) utilization increases from the Zoned Bichrome to the Late Polychrome, but there is also an obvious decrease (<70 %) during the Middle Polychrome period. This patterning of intermittent instability (i.e., increasing rather than decreasing species abundance) is also found in four other species, which include the grouper, cobia, catfish, and drumfish. Casteel (1973) pointed out that certain groups of species might consistently occur together archaeologically, owing to similarities in the season and location of activities, such as exploitation, processing, storage, and disposal. The drum and catfish attain relatively large body sizes, and their occurrence together, archaeologically, at San Cristóbal may reflect their invasion of the lake and/or the residents' exploitation of larger fish during the spring spawning season. For example, the *Mycteroperca sp.* (grouper) present at the site had extremely large vertebrae, each one spanning 15 mm or more in diameter. In a sample of 3 vertebrae, from the Early

Polychrome time period, all 3 weighed an impressive 9.3 grams total (see Appendix A). This suggests fish that were likely in excess of 100 cm and 1 kilogram.

Results of the analysis show that fish contributed a significant amount to the food consumed at the site. The most numerous freshwater species include cichlids, catfish, jackfish, and gar. Only a few fragments represent marine species: drum, cobia, and grouper, and these suggest limited distribution. Therefore, minimal frequencies within these fish taxa may suggest differential exploitation and differential availability. Such species may also have been taken sporadically or predominately during a short season, resulting in limited distribution across the site. Regardless of the fish species consumed, one large terrestrial mammal would easily have satisfied the residents' nutritional requirements rather than trying to harvest the equivalent amount of fish.

Synopsis of the Data

Looking more closely at the relative levels, representing different species through time, we can see indications of changes in subsistence emphasis (Table 5). The largest proportional account of fauna, 37 genera, was attributed to the Early Polychrome. This number decreased significantly by the Late Polychrome period, declining to 29 genera in the Middle Polychrome, and to 15 genera between AD 1350-1525, in the final prehistoric era. Curiously, San Cristóobal people were utilizing 29 genera during the Zoned Bichrome, which represents the earliest occupation. These numbers exclude the presence of shellfish, which were found across the entire occupational period except during the Middle Polychrome, and the single crab claw recovered from the Zoned Bichrome period.

Table 5 also indicates that while certain aquatic (e.g., *Caranx*) components remain relatively constant from the Late Polychrome to the Zoned Bichrome periods (17.72 vs. 15.23 NISP), the numbers of *Odocoileus* exhibit a four-fold increase and the large unidentified mammals demonstrate almost a hundred-fold increase. Given the difference in size between deer and turtle, and the fact that 30% of the unidentified large mammal bones were probably that of deer, it seems clear that the bulk of the animal protein consumed at the site was provided by deer, with turtle second in importance.

The faunal samples presented in Table 5 clearly show that *Odocoileus virginianus* was the most important hunted terrestrial mammal during the entire Middle and Late Polychrome periods. This may be explained by a change in subsistence patterns from heavier reliance on hunting and gathering in earlier periods to growing reliance on primitive agricultural practices in later times. This change in land use, forest silviculture combined with swidden agriculture, likely enticed larger terrestrial mammals to their homestead making a shift in protein consumption natural. Fish were being used, but to a lesser extent. In the Late Polychrome period all fish comprised roughly 47% of the peoples' diet, a stark contrast compared to more than 70% degree of dependency evident in every other time/period. Meanwhile deer, and other smaller mammals, including rodents, associated with the Late Polychrome period, increased in importance, comprising roughly 40% of the diet. In earlier times, mammal remains are progressively scarcer, suggesting that their rise was connected to their environment, and their consumption is indicated by their presence.

In comparison, taxa present in the Middle Polychrome sample from San Cristóbal indicate a diverse strategy of small game exploitation. Although, high-yield, large-game resources (deer and peccary) are still present and deer still dominate this Middle Polychrome sample. These results show a correlation between an increase in terrestrial game and a decrease in aquatic fauna from the Zoned Bichrome to the Late Polychrome periods (see Table 4). Since the San Cristóbal site included faunal material from different periods, it is important to examine the trends in the use of animals over time.

Trends and Taxonomic Diversity

Expressing caution about projecting trends from the San Cristóbal assemblage, the following tendencies over time can be noted:

1) Table 5 may convey the impression that fish were the only important components of the San Cristóbal diet. However, any such impressions are dispelled if we not only look at the weight percentages, but also the NISP. This trend is more accurately visible when comparing NISP percentages, rather than weighted percentages, because trends were contrasted against the entire taxa for a specific period (See Figure 13). For example, a single grouper vertebra weighed 3.1 g and had a diameter of 15 mm. In comparison, a jackfish vertebra weighed only 0.3 g (See Figure 14). Yet, both vertebrae indicate one specimen respectively, thus suggesting a subsistence change over time based on weights would be skewed. Moreover, 15 white-tailed deer fragments recovered from the Middle Polychrome period weighed 50.4g, whereas over 1,000 jackfish fragments recovered from the same period only weighed 43.2g (See Appendix B, Raw Data). Some species will naturally weigh more than others, but that does mean they were being exploited more. Obviously, fish were being procured in a greater quantity than the deer.

2) The percentage of fish, in comparison to the rest of the faunal material collected from the Zoned Bichrome period, increased from 73.74% to 77.11% in the Middle Polychrome

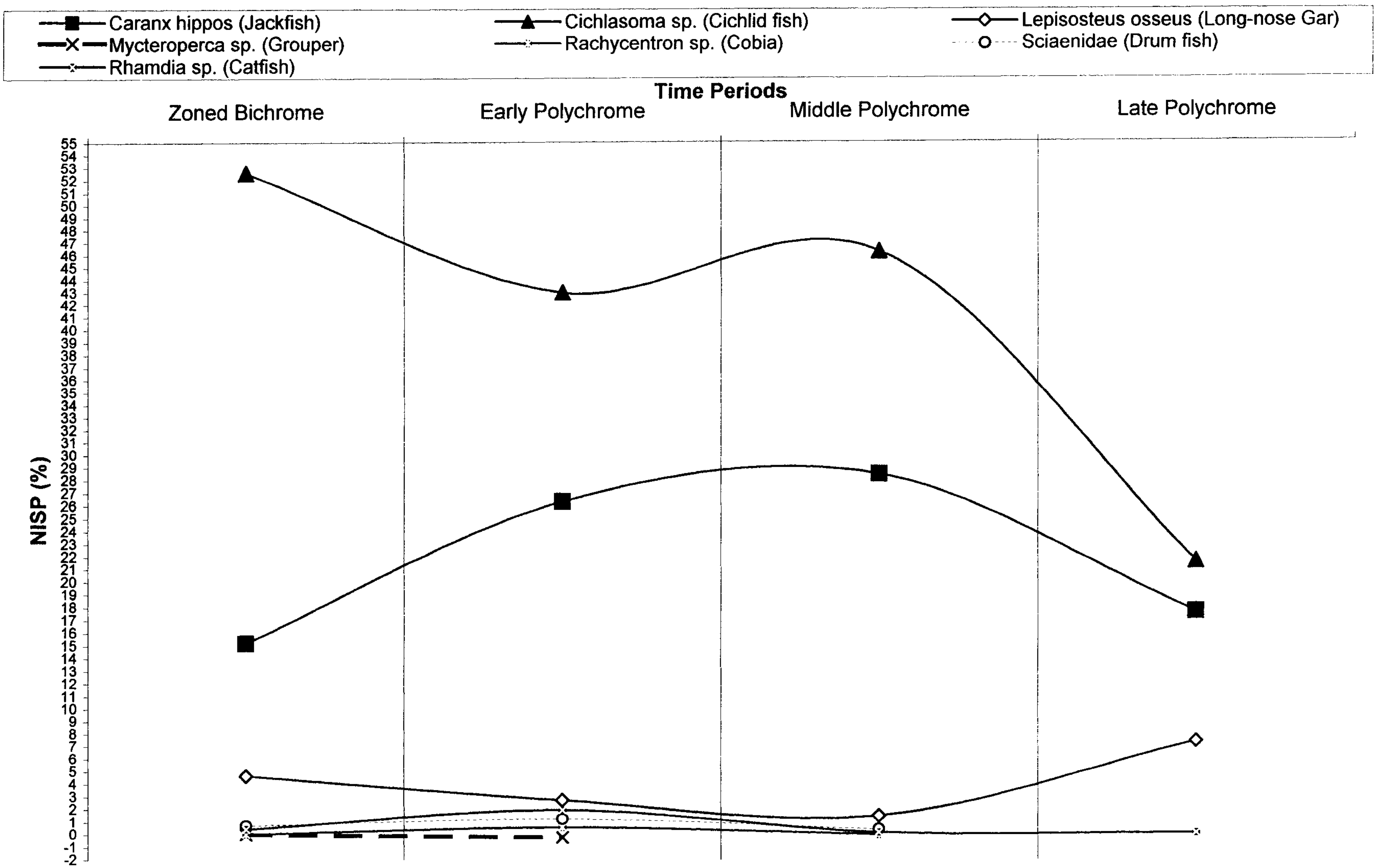

Figure 13. Fish Subsistence Trends Over Time

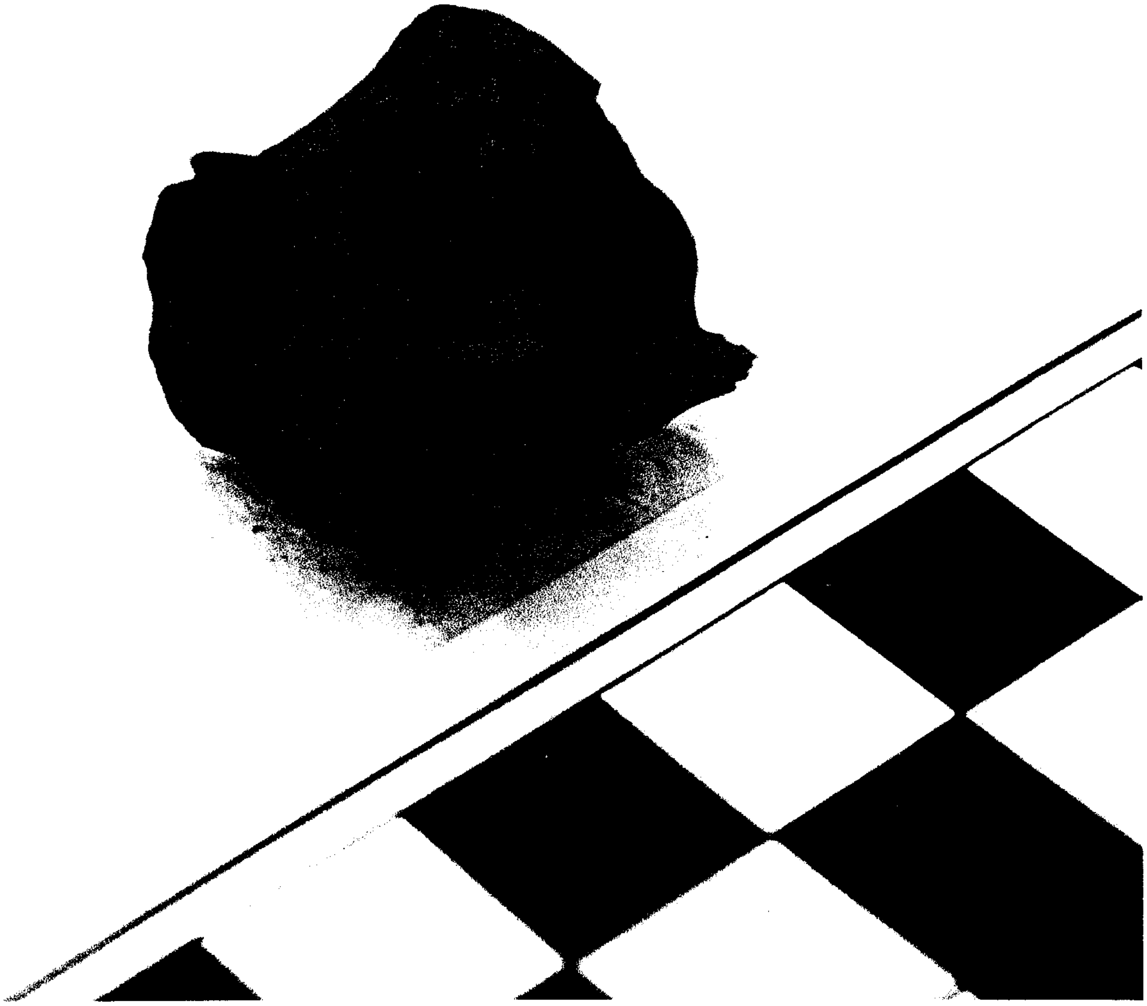

Figure 14. Grouper (*Mycteroperca sp.*) Vertebra that is roughly 15 mm.

period. However, dependency on fish dramatically decreased in the Late Polychrome period, where Table 5 showed a total NISP of 48.94 %. Clearly, the proportional decrease of aquatic fauna compared to the presence of white-tailed deer at San Cristóbal, illustrates a shift in subsistence orientation and a diversification of species exploited (Table 5).

3) Going over the relative levels of representation of different species throughout the San Cristóbal occupation, we can see traces of possible changes in subsistence emphasis (Table 5). Fish use at San Cristóbal provides a good example of specific mode of procurement. Because fish presence begins in the Zoned Bichrome period, a well-developed means of mass fishing may have been used (weirs, nets, or traps). Based on the frequency of fish from the Zoned Bichrome to the Middle Polychrome period, fishing strategies undoubtedly varied seasonally. One of the most interesting trends can be seen in the Middle Polychrome period with the large mammal specimens.

The presence of amphibian remains is restricted to frogs and toads. Almost the entire collection of amphibians was recovered from the three earliest periods (Zoned Bichrome to Middle Polychrome). It is doubtful that amphibians ever constituted a part of the dietary regimen, since their presence in only a few contexts makes forming conclusions about their role difficult. However, the archaeological distribution does suggest that a portion of the San Cristóbal population for a long time ate amphibians.

The representation of reptiles in the San Cristóbal record may reflect changes in the environment, especially by their notable absence in the Late Polychrome period. Turtle, iguanas, and snakes can all live commensally with humans, thus an increase in human population would have increased their available food (Teeter 2004:184).

CHAPTER 7
DISCUSSION AND COMPARISONS

INTRODUCTION

There are always challenges associated with analyzing animal bone assemblages from prehistoric sites. When we study an assemblage, like that of San Cristóbal, the ultimate aim is to draw certain conclusions about both the site and the people who lived there. This study is the first of its kind for the Lake Managua region in Pacific Nicaragua. The animal bones studied here are from one region of Central America, and one archaeological site where cultural activities have almost certainly created lateral variation in the deposition of remains. Excavations, therefore, may possibly provide a faunal collection which will be representative of the diet of the San Cristóbal inhabitants, and show the relative number of animals of each species that were captured and eaten.

This chapter will bring the results of the zooarchaeological research done with the San Cristóbal faunal assemblage into a broader context. The first section examines the remains, and evidence for patterns of animal exploitation (such as bone use), and correlates these patterns with zooarchaeological evidence from other selected sites in Central America.

PATTERNS OF ANIMAL EXPLOITATION

I must emphasize that I am reporting subsistence patterns, which are supported by meticulous taxonomic and quantitative analysis. Nonetheless, I believe that the subsistence adaptations of San Cristóbal residents were based on a broad economic framework that incorporated mostly aquatic, but also terrestrial resources. Through time, aquatic resources, especially fishing, became increasingly important, though it never fully displaced the hunting and collecting of terrestrial game.

Subsistence Adaptations at San Cristóbal

In the first two periods, the people of San Cristóbal were not concentrating on species that lived in forest-edge conditions and readily invaded man-made clearings. However, these data show that by the Late Polychrome period they were culling more of these niche dwelling species, such as peccary and deer, while still heavily relying upon fish protein. Evidence supporting this idea of progressive specialization is facilitated by the presence of protein sources from aquatic environments outlined in Table 4. Fish accounted for a substantial contribution (74 % of NISP) to the diet and the single most important fish, both in terms of numbers of individuals and amount of meat provided, is *Cichlasoma.* Literally thousands of fish vertebrae were analyzed, as well as appreciable numbers of fish elements, such as dentaries, dermal structures, premaxillae, maxillae, and cranial bones including angulars and post-temporals. These data show that of the 12,000 fish bones preserved, *Cichlasoma* comprised over 7,700 specimens and *Caranx* made up 4,137 specimens. However, the low frequencies within the other fish taxa may also reflect depletion, limited availability, or cultural change (Appendix B, Raw Data).

A modest variety of the available aquatic fauna, which was intensively used, included members of seven families (i.e. *Cichlidae, Carangidae, Serranidae, Sciaenidae, Rachycentridae, Ictaluridae, and Lepisosteidae*). Not only do fish predominate the aquatic fauna consumed, but two different species in particular, C*ichlasoma and Caranx,* are concentrated in the diet. The Cichlidae represent the largest biomass of any freshwater fish species in Nicaragua and are an essential resource for the human population of Nicaragua (Barlow 1976; Barlow and Munsey 1976).

Barluenga and Meyer (2004:2062) suggested that the Nicaraguan lakes provide a remarkable environment for human occupation because these lakes are in an area dominated by larger rivers, and their fauna is drawn from riverine fish. For example, Myers (1966:768) examined the distribution and character of freshwater fishes of Central America south of the Isthmus of Tehuantepec. He collected fish in the basin of Lake Nicaragua, Lake Managua, and the Rio San Juan: "...Varied assortment of Cichlidae, a *gymnotus*, a *Rhamdia*, some poeciliids, and some gobies. Garpike were present..." Many of the species used are common freshwater or marine species that can be found in various habitats. For example, jackfish are fast-swimming fish that can live in the brackish waters of estuaries, or they can occur on highly saline flats, or in coastal rivers (Wing 1980:196). Serranidae are marine bottom-dwelling, robust-bodied fish with large mouths, which vary greatly in size (Wing 1980:195). The drum fish are also marine bottom-dwellers, though they are shallow water fishes (Wing 1980:190).

Related to the habitats exploited by fishermen were the techniques they employed. For example, freshwater catfish would represent an aggregated resource during spawning season. According to Lagler (1956:42), catfish undertake upstream migration during spawning and can easily be collected in large quantities at dams and other obstructions. Most fish, at San Cristóbal, were probably caught by net, some by spear, or by hook-and-line. However, today the Pimelodids (freshwater catfish) are caught in Central America by hook-and-line or historically as Cooke (1988:134) suggests, by post-Columbian throw-nets (*atarraya*). The amount of fish caught at San Cristóbal suggests throw nets, as does the occurrence of net weights (i.e., notched ceramic sherds) in the San Cristóbal deposits. Both are significant and prove that fish were a main staple of the peoples' diets. Based on the large quantity of fish remains, recovered from all time-periods, it is safe to say that residents had an intimate knowledge of Lake Managua and its aquatic life, as well as strong fishing skills necessary for successful exploitation.

Another indicator of subsistence adaptation by the inhabitants of San Cristóbal was the possible exploitation of coastal resources (e.g., cobia, drum, grouper, and snapping turtle). Given the low frequencies of these coastal resources and the particular species found, points to a strategy of occasional opportunistic fishing for the San Cristóbal inhabitants (See Table 5). According to Randall (1968:57) since Serranidae (grouper) have no intramuscular bone, eating them is effortless. These days the groupers and drum fish are highly valued for their flesh. What is noteworthy is that the San Cristóbalans would have access to theses resources via waterways that connect Lake Managua with the Pacific Ocean. As I mentioned in Chapter 4 previously Lake Managua's drainage basin is located to the north of the lake and drained by three major tributary rivers, Rio Viejo, Rio Sinecapa and Rio Pacora. I speculate that the San Cristóbalans could have used these rivers as a transportation system.

Even when other foodstuffs increased in importance during the Late Polychrome, such as peccary and deer, fish were still a considerable resource as shown in Table 5. There is a visible trend obvious in the data of Table 5, where fish can be seen to remain at a high level, roughly 72 %, until the Late Polychrome period when their abundance drops to a low 45 percent NISP and mammal remains increase from roughly 12-40 % NISP.

Although the San Cristóbal residents consumed large quantities of fish, especially in Zoned Bichrome through Middle Polychrome periods, alternative foodstuffs such as deer, peccary, armadillo, etc. supplemented the native aquatic diet and would have provided a welcome change from a multitude of cichlids, jackfish, or catfish. Given the quantity of fish represented at San Cristóbal, it seems fair to state that aquatic fauna supplied a large portion of the community's protein needs, with a smaller, but still significant, portion provided by deer, turtle, armadillo, and peccary.

Animals are not harvested in a random way. As with even the most common subsistence system, preference in animals used for food is carried out. Linares (1976) suggested that a noticeable pattern could be seen in the hunting of terrestrial animals that are attracted to agriculturally disturbed land. She used the term "garden hunting" to describe how uncultivated fields would have attracted white-tailed deer, collared peccary, and other forest margin species, and how fruit orchards would have influenced an increase of populations of preferred small mammals, such as agoutis. Hoopes (1994) pointed out that models on small mammal ecology, such as that espoused by Linares, which ignore the 'coevolutionary potential' of symbiotic relationships with Pre-Columbian agriculturalists, are destined to be deficient. If white-tailed deer were, in fact, hunted near Lake Managua in prehistory, some reduction and clearing of forest must have taken place at the time of occupation of San Cristóbal to attract the species. Therefore, it is likely that deer were commonly hunted closer to the homesite.

In broad ecological terms, and limiting ourselves to the Lake Managua region, the later prevalence of white-tailed deer in the assemblage, and the overall species composition of the faunal samples, provides some clues about the nature of the habitats near the Pre-Columbian settlement of San Cristóbal. In the tropical rainforest, the leafy green browse is the common fodder for white-tailed deer (Emery 2004:91), though deer are known crop pests that are attracted to agricultural products and will feed in cornfields wherever they are available (Cormie and Schwarcz 1994:227). For example, deer are commonly exterminated by modern Central American farmers as a pest in their *milpas* Linares 1976; Magnus 1978). Furthermore, white-tailed deer prefer brushy, low, second growth forest. Successional vegetation, or low bush, in fallow fields and *bajos* is another environment occupied by white-tailed deer and is considered the most favored habitat of this species (Pohl 1976:136). Although, hunting is likely done throughout the year the greatest activity possibly occurs during the dry season when there are less agricultural responsibilities and people can range farther afield.

However, iguanas (large arboreal lizards) are probably hunted in the dry season when defoliated trees make this arboreal lizard easy to pursue. The reptilian faunal sample from NMN2-1 is quite extensive, especially turtle and iguana. Iguana thrives on river-edges and man-made clearings (Wing 1980:212). Pond turtles live in swamps and lakes filled with mud and overgrown with plants (Stebbins 1954:177-179). The mud turtle, *Kinosternon*, is also readily available in low, muddy areas (Magnus 1978:76). In addition, mud turtles are also abundant around human dwellings and cultivated fields (Cooke 1984:298).

During the wet season, hunting activity is likely concentrated near the village and cultivated areas. Bennett (1962:42) suggested that this seasonal pattern is characteristic among tropical people and is beneficial ecologically because continual high pressure is not maintained on animal resources. It would make sense to place partial limits on the hunting of the most important animal resources, socially, to ensure that there are enough around when you want to feast. However, San Cristóbal is characterized by a marked heterogeneity of animal species (n = 51) used in combination with a highly generalized use of available ecosystems. Therefore, the San Cristóbalans would not need to limit exploitation of the available animal resources encompassing the Lake Managua region.

A final word should be said about the molluscan remains from NMN2-1. It is obvious that shellfish collecting at San Cristóbal was not a specialized endeavor. The inhabitants of NMN2-1 were intermittently utilizing only four species of molluscs: (1) Juté (*Pachychilus sp.*); (2) Snail (*Pomacea flagellata*); (3) Bivalve (*Nephronaias sp.*), and (4) *Euglandina cylindracea* (See Figure 15). The bulk of shellfish remains (456 fragments) occurred in a concentrated lense in the Zoned Bichrome period, rather than being in an evenly distributed fashion throughout the occupation of this site (See Table 4). According to Powis (2004:126), freshwater bivalves such as *Nephronaias* are often recovered in association with *Pachychilus* and *Pomacea.* Their scarcity at NMN2-1 can be explained only in terms of cultural preferences and/or in terms of human labor investment or local extinction.

As might be anticipated from the community's location (i.e., near the south shore of Lake Managua), one would expect to find substantial amounts of shellfish within the faunal collection, but this was not the case. Shellfish collecting may have been an ancillary activity – that is, collecting while fishing or hunting. Healy and colleagues (1990:171) suggested that freshwater invertebrates such as the juté (*Pachychilus sp.*) were not only used for dietary purposes but were also included in ceremonial and ritual deposits.

Figure 15. The Rare Gastropod (*Euglandina cylindracea*).

The shellfish at San Cristóbal were most likely regarded as a famine food instead of a protein supplement. For example, one of the freshwater molluscs recovered, juté, tends to have a caloric yield (per 100 g) comparable to both turtle and rabbit (Healy *et al.* 1990:177). The dietary importance of shellfish remains a matter of conjecture, but elsewhere in Central America, the species identified at San Cristóbal were employed as a protein supplement (Moholy-Nagy 1978; Healy et al. 1990; Powis 2004). Table 6 illustrates generalized dietary yields of several vertebrates and invertebrates based on calorie, fat and protein content.

Table 6. Food Values Per 100 Grams (Adapted from Moholy-Nagy 1978:71)

	K calories	Protein (grams)	Fat (grams)	Carbohydrates (grams)	Reference
Land Snails:					
Helix pomatia	75	15.0	0.8	2.0	Biopress n.d.:11
Freshwater mussels:					
Proptera alata	77	9.5	0.8	7.8	Parmalee and Klippel 1974:431
Actimonaias carinata	58	7.8	0.7	4.5	Parmalee and Klippel 1974:431
Deer:					
Odocoileus virginianus	126	21.0	4.0	0	Parmalee and Klippel 1974:431
Venison, semi-dried salted	142	31.4	0.9	0	Woot-Tsuen 1961:79
Venison, roasted	146	29.5	2.2	0	Woot-Tsuen 1961:79
Turkey, medium fat	268	20.1	20.2	0	Woot-Tsuen 1961:79
Alligator, semi-dried	232	45.6	4.2	0	Woot-Tsuen 1961:72
Turtle, roasted	89	19.8	0.5	0	Woot-Tsuen 1961:86

To summarize, the inhabitants of San Cristóbal, overall by percent of NISP, exploited aquatic vertebrates more than terrestrial animals. Their preferred aquatic species were freshwater and coastal vertebrates. In contrast, their favorite species were forest-dwelling, largely herbivorous, animals which also ate cultivated crops. Snares, traps, probably bows and arrows, nets, hook-and-line, and weirs, were used in hunting and fishing respectively. Concerning the presence of turtles and birds, they signal the importance of wetland resources for the San Cristóbal residents. The constant presence of vertebrates such as iguana, varieties of turtles, and birds in samples of all periods suggests that the ecology of San Cristóbal and Lake Managua region remained relatively stable. In addition, the effects of agriculture on turtling, fishing, and hunting were reasonably stable with regard to the abundance of the wetlands encompassing San Cristóbal region. However, the fact that San Cristóbal residents relied on both aquatic and terrestrial biotopes is an important finding significant to understanding Pacific Nicaragua. Palatability, in terms of food preference, may be the primary factor influencing the use of various animal resources from habitats closest to the homesite.

Taphonomy of San Cristóbal Faunal Remains

The obvious questions of animal usage, and typical versus atypical daily activities, are critical for the employment of faunal remains in subsistence reconstruction of the San Cristóbal residents. The data show that faunal material was utilized significantly in many contexts: (1) subsistence; (2) manufacturing of expedient tools, formal tools, and/or ornaments; (3) clothing (e.g., animal hides), and adornment (e.g., beads, lip plugs); (4) ceremonial sacrifices (e.g., burnt animal bone evidence) and, perhaps, festive consumption. In discussing the use of animal resources, a distinction must be made between subsistence and non-subsistence uses. In a number of cases, such as polished white-tailed deer metapodials and modified turtle carapace fragments, San Cristóbalans were unquestionably cutting, drilling, and refining bone for non-subsistence purposes (See Figure 16 and 17). This explanation makes sense based on the depositional context of the San Cristóbal fauna and some associated artifacts (e.g., modified white-tailed deer tibia found in tandem with burnt deer phalanges, teeth, and vertebrae; and various fish bones found in association with notched ceramic sherds, and colander ceramic fragments; see Appendix B, Raw Data).

Wyss (1983:120), for example, excavated Combo Colander type vessels at San Cristóbal. She maintains that these vessels, with perforated bases, were deliberately designed for straining broth from tiny fish vertebrae. Additional, fragmented evidence of these colanders was found amongst the faunal material under study here. According to Wyss (1983:120), these vessels are mostly associated with coastal sites, yet they are present in great numbers (n = 244) at San Cristóbal. Wyss (1983:119) also found that ancient residents of San Cristóbal fashioned notched pottery sherds for weaving fishnets as spacers and also as net weights. These sherds were often derived from refuse of once functional vessels. The presence of many other types of evidence of utilitarian artifacts at San Cristóbal gives further credence to the fact that fish were not exploited as a famine food, or supplement to diet, but were a basic, staple food resource.

Additionally, if we think of the white-tailed deer as an esteemed valued creature, rather than just as an edible animal, I think we can better fit the faunal evidence to 16th century Spanish chronicler's references. For example, reference is made to use of deer skins for Chorotega children's clothing: "the feet [of children] were covered in deer skin which was caught up around the ankle with leather thongs" (Oviedo, in Wyss 1983:32).

In terms of the San Cristóbal faunal assemblage, evidence of modified bone, in form of needles, came from the metapodials (cannon) bones of white-tailed deer. This identification is supported by Stanchly (2004:40), who maintained that prehistoric bone tools, such as awls and needles, tend to be made from dense bone elements, such as deer

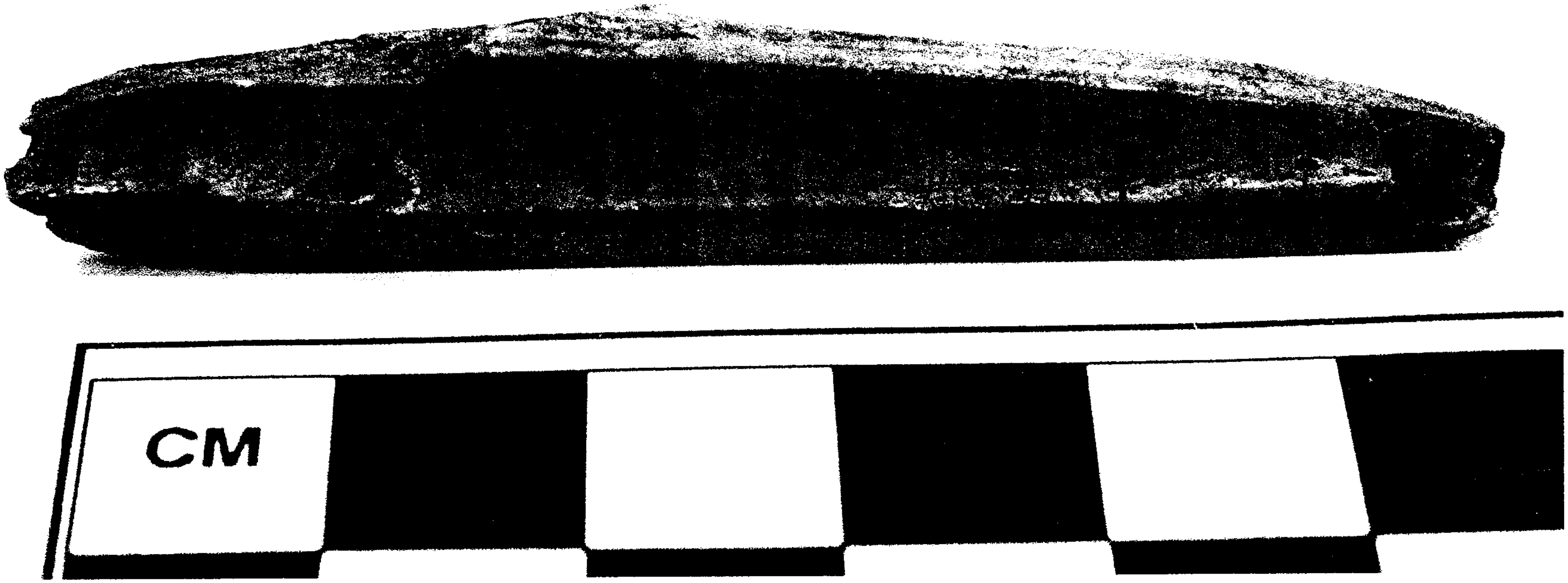

Figure 16. Modified White-tailed deer (*Odocoileus virginianus*) bone fragment.

Figure 17. White-tailed deer (*Odocoileus virginianus*) fragment modified into a scooping tool.

metapodials. He also suggested that, in many cases, both the final product and the accompanying bone debitage will survive because of the selection of dense deer bone. Without this information, the presence of white-tailed deer, peccaries, armadillo, turtles, fish and molluscs might all be inferred simply as evidence for typical subsistence at San Cristóbal. Fittingly, the excavated faunal remains from San Cristobal have provided an incredible database to explore changes in the use of aquatic and terrestrial animals in subsistence or ceremonial contexts through time.

In summary, historical texts supply testimony about various animal species that were exploited in Pre-Columbian Nicaragua. The abundant faunal remains from the San Cristóbal faunal assemblage confirms, and greatly amplifies, the list mentioned by Spanish chroniclers (e.g., Oviedo) concerning important animal species. Our faunal analysis adds other animals, including various rodents, crocodile, raccoon, lizards, terrestrial and aquatic turtles. Therefore, the diet of the San Cristóbal residents appears to have been even more varied, according to the faunal material recovered, than ethnohistoric accounts. Still, the zooarchaeological evidence is not homogeneous throughout Nicaragua. However, faunal evidence does suggest some parallels, relative to fundamental patterns of animal use, between San Cristóbal and other prehistoric sites of Lower Central American.

CORRELATION WITH OTHER SITES IN LOWER CENTRAL AMERICA

There are at least two major obstacles in comparing subsistence patterns of prehistoric peoples. First, no standard methods have been used to report the quantities of each class of food remains represented at sites, thus making direct comparisons difficult among sites. Second, the remains of plants and animal components are not generally directly comparable and have the potential effect of exaggerating the importance of faunal elements, or paleobotanical remains.

The principal goal of this chapter is to develop an understanding of faunal exploitation in Lower Central America by means of an investigation of a portion of its Pacific sector. To do this, various archaeological sites and their faunal data and subsistence patterns will be described (See Appendix A). The faunal remains that have been recovered from these sites will be listed, and compared with the data from San Cristóbal. These comparisons indicate either similarities, or differences, between the fauna exploited and the prehistoric subsistence practices of the sites. The second purpose is to illustrate and explain the degree of continuity with that of San Cristóbal. The projection of the kinds of faunal remains these sites produced will be done in general terms because many differences (e.g., contextual, environmental, ecological) between sites make a detailed, specific comparison impossible.

Comparison of my data with that published by other researchers has been problematic since their analytical methods are not always fully explained. Within Lower Central America, another serious problem is the general lack of quantifiable zooarchaeological data. Nevertheless, this section outlines the faunal assemblages and the remains recovered at several selected sites located in Lower Central America. The study closest to Lake Managua for which some zooarchaeological analysis has been done is in the Rivas region of southwestern Nicaragua.

Nicaragua

Cruz and Santa Isabel "A" Sites

Small (n = 159) but well-preserved faunal samples were found at the Cruz (J-RI-7) and Santa Isabel "A" (J-RI-4) (n = 177) archaeological sites in the Rivas region of southwestern Nicaragua (Healy 1980; Pohl and Healy 1980:287). The Cruz site is situated on Ometepe Island in Lake Nicaragua, while the Santa Isabel "A" site, a 12 km area signified by low earthen mounds, is on the isthmus of the Rivas. The archaeological site of Santa Isabel "A" may have been a center of Nicarao occupation, although the Chorotega are reputed to have settled in the territory before them. The ethnohistoric sources suggest that the Nicarao settled on the shore of Lake Nicaragua but were quite spread out (Fowler 1989:68).

Faunal material from these two archaeological sites in the Rivas region correlates closely with that of San Cristóbal. For example, the Cruz site contains a significant proportion of turtle bones, *Chrysemys sp.* (pond turtle), *Kinosternon sp.* (mud Turtle), and small quantities of an unidentified species. Healy (1980:15) suggested that the mud turtles may have been an important food source prior to European arrivals. Since the Cruz site revealed a high proportion of turtle bones, it seems reasonable to suggest that turtle served as a useful protein source for Cruz inhabitants and, being an island locale, that their diet was based largely on aquatic fauna, with a smaller quantity provided by deer.

In contrast, Santa Isabel "A" reveals an abundance of white-tailed deer remains and large mammal bone fragments, which may also be Cervidae. It is also suggested by Pohl and Healy (1980:290) that fish were an important ingredient in the diets of both Santa Isabel 'A" and Cruz residents. However, there is a general lack of fish remains in either collection, which is peculiar because of the close proximity of both sites to Lake Nicaragua. Although excavations generated many re-worked and notched sherds, which are associated with traditional Pre-Columbian fishing nets, fish bones were scarce (Pohl and Healy 1980:290). Moreover, Pohl and Healy (1980:290) maintained that if the fieldwork carried out during 1959 and 1961 had the option to develop various recovery strategies (i.e., screening, water flotation, and wet sieving) which are frequently used today, an altered view of the impact of fish in the Rivas region may have been evident. They extrapolate that this general scarcity of fish remains is because fish bones seldom preserve well, due to their thinness and small size. Alternatively, the paucity of very few fish bones at these sites could also be an indication that the people were not utilizing all available biotopes.

Although the subsistence of Santa Isabel "A" did not reflect a particularly efficient adaptation to the resources available, especially those of the adjacent Lake Nicaragua, it may also suggest that subsistence was based heavily on agriculture. For example, work by Magnus (1978:64) on the South Atlantic coast of Nicaragua, in the Miskito village of Kakabila, revealed a subsistence pattern remarkably similar to that of Santa Isabel "A". Archaeological remains of fish were limited and diet was supplemented with some hunting in the nearby forest. It can, of course, also be argued that the fish were filleted and prepared by the Santa Isabel "A" inhabitants at some form of fishing station away from the site. In such a case, no trace of fish remains would have been evident in the faunal assemblage.

Based on data of Tamayo (1964:97), Lake Nicaragua and Lake Managua contain a variety of food fish, among which are the tropical grunter (*Pomadasys* sp.). Many cichlids, including the red species *Cichlasoma managuense*, and the sardine-like *Melaniris sardina*, are found in abundance along the shallow shores. These species surely have been exploited since pre-Conquest times by the lakeshore dwellers.

An abundance of marine molluscs were also recovered at the sites of Cruz and Santa Isabel "A", predominantly in deposits dating to the end of the Middle Polychrome Period (La Virgen phase) and to the beginning of the Late Polychrome Period (Las Lajas phase). Pohl and Healy (1980) proposed that an important subsistence shift occurred at Santa Isabel "A", from a heavy dependence on shellfish in the Middle Polychrome to more hunting in Late Polychrome times. Additionally, the majority of the marine molluscs, predominantly *Spondylus princeps*, exhibited evidence of modification, cutting, or string sawing (Pohl and Healy 1980:291). This shell was likely used for jewelry production (drilled beads) and perhaps not food (personal communication, P.F. Healy 2005).

Due to the limited faunal material from the Cruz and Santa Isabel "A" sites there is some reservation by the investigators regarding their ability to establish ecological trends or subsistence behavior. However, the faunal evidence does suggest that fishing and hunting were both of some significance and, undoubtedly, complemented the farming activities of the Pre-Columbian Nicaraguan groups.

Costa Rica

Neighboring Costa Rica provides a remarkable paradigm for examining human/landscape coevolution from the beginning of the Holocene to the 16th century (Hoopes 1994). Rindos (1984) has applied the term coevolution to the unconscious relationship between humans, plants, and animals that gives rise to concurrent changes among all of them, eventually resulting in domestication. Furthermore, a recent compilation of a master registry of archaeological sites in Costa Rica provides some insights into the magnitude of Pre-Columbian occupation and its potential ecological influence (Vázquez *et al*. 1994). Three sites which are located in Northwest Costa Rica, in the Greater Nicoya Subarea, are examined here.

Vidor Site

The Vidor site (30471-227-1) is located approximately 1 km inland from Playa Panama, near on the southern side of the Bay of Culebra (Kerbis 1980:125). Excavations from 1973 and 1976, at the Vidor Site, yielded large quantities of fish bone fragments (n = 11,096), although, 3,748 of the bones were unidentified. As for the terrestrial faunal remains, an appreciable amount of terrestrial faunal remains (n = 1,367) were recovered (See Appendix A). Sedimentary deposits include volcanic ash and alluvium, the latter resulting from slope wash caused by seasonal heavy rains, and intermittent floodplain inundation (Kerbis 1980:125). According to Kerbis (1980:126), the terrestrial fauna as a group from Vidor pointed to ecological conditions equivalent to present-day conditions. In relation to contemporary animals, the rabbit (*Sylvilagus floridianus*) is confined to Guanacaste (Northwest Costa Rica) and the agouti (*Dasyprocta punctata*), armadillo (*Dasypus novemcinctus*), and the white-tailed deer (*Odocoileus virginianus*) also favor conditions found there, though they are not limited to the area (Kerbis 1980:126). The two dominant faunal species at Vidor are pelagic tuna (*Euthynnus lineatas*) and white-tailed deer (*Odocoileus virginianus*). According to Kerbis (1980:129), white-tailed deer was typically the most desired terrestrial game in Pre-Columbian Lower Central America, and remains of this species provide the majority of the terrestrial meat that was consumed nearby Playa Panama. Further evidence for similar utilization of white-tailed deer are also described in Healy (1974), for southwest Nicaragua and Sweeney (1976), in northwest Costa Rica.

In addition, the faunal evidence from Vidor site suggests seasonal differences in food procurement. Kerbis (1980:128) argued that seasonal shifts in available fauna, coupled with seasonal site habitation, might be factors in differences in the fauna represented. However, the faunal evidence may also be interpreted as year-round site occupation. Furthermore, tuna and whitetail deer, two species that contributed the bulk of the animal protein, are easily exploitable during the dry season. Kerbis (1980:128) suggested that the most favorable hunting conditions are represented by the disappearance of seasonal streams and high winds. The windy conditions can dissipate a hunter's scent and, since water and food resources are stressed, deer must rely on springs and concentrated food resources that make them vulnerable.

Lange (1978:113) advocated that there are possible habitat distinctions for different terrestrial resources because coastal populations increased over time. For example, sites (e.g., San Cristóbal, Vidor) from the Early Polychrome Period (AD 500-800) were more oriented towards the ocean or lake; thus, the impact of aquatic resources on site location could be seen. For example, most of the faunal material from the Late Polychrome Period (AD 1200-1600), at the Vidor site, consisted of fish bones (See Appendix A). Some terrestrial animals, mainly deer, were available at this time but people may have hunted out most of the available game, or pushed it to less inhabited areas (Lange 1978:112). This seems unlikely. Faunal remains were not preserved in association with Zoned Bichrome levels at Vidor, but are present in Early, Middle, and Late Polychrome components (Kerbis 1980:128). These data suggest continuity between the Early and early Middle Polychrome periods, and between the late Middle and Late Polychrome periods. Newson (1987:53) suggested that feral animals were more plentiful in Costa Rica in the Pre-Columbian period than they are in contemporary Pacific Nicaragua.

Kerbis (1980:130) proposed a hypothetical scenario that may have been characteristic of the short-term effects of ashfall evident at Playa Panama. He suggested that ash could have been deposited during the windy dry season, based on ash depth, distance from the volcanic source, and the location of Playa Panama. Upland erosion would have been rapid with the onset of the rainy season, while low lying alluvial plains were less likely to have been eroded. Deposits of ash-bearing alluvium would settle as streams lost their gradient on floodplains and estuaries. Therefore, the effects on the environment and on the flora and fauna would have been diverse. Cultivated areas of low topographic relief would have been severely affected, and would take the longest time to recover (Eggler 1967), and agricultural produce would not be available for some time thereafter. Wind-blown ash would immediately strip all vegetation, rupturing the terrestrial trophic levels at their source. However, terrestrial recovery by grasses could have been rapid, within months, and thus served as a foundation for future re-vegetation (Eggler 1967). The recovery of terrestrial fauna, however, would have lagged behind terrestrial flora. Terrestrial fauna would either leave or perish and pelagic fish would move to deeper or less affected waters, but soon return (Kerbis 1980:130).

Linares and Ranere's, pioneering monograph on the archaeology of western Panama also provides support for Kerbis' argument (Linares and Ranere 1980). They proposed that communities on the coast of the Gulf of Chiriquí emerged because of an expansion of maize agriculturalists onto the coastal plains, which was a result of their displacement caused by eruptions of Volcán Barú. Conversely, they also attributed the origins of maize cultivation in Panama to an expansion of populations in southern Costa Rica.

Vigilante Alta and Herramientas Sites

Even though current studies have been concerned with the effect of limited land area on subsistence, demography, and cultural evolution, the relative size of confined areas such as islands have not been examined in such assessments. Creamer (1983:395) suggests that islands provide examples of limited, circumscribed landmasses, and they are often small. The bounded nature of an island, and the restricted range of foods available within its environmental zones, clearly defines its site catchment area. Furthermore, a group's mobility is also directly curtailed by island size.

Creamer (1983b:395) argued that the range of foods available on two different sized islands (San Lucas and Chira Island) in the Gulf of Nicoya, Northwest Costa Rica, was restricted to the environmental zones present. San Lucas Island is 4 sq km, and is located less than 1 km from the west shore of the Peninsula in the Gulf of Nicoya. Conversely, Chira Island is 40 sq km in size, and is located close to the shore of the Gulf. In essence, smaller confined environments with limited overall resources will exhibit a greater probability of specialization from initial settlement and, in contrast to larger islands with greater resource availability, will develop a strategy of generalized resource procurement from the start.

Excavations at both Vigilante Alta and Herramientas, yielded a wide variety of marine and terrestrial fauna. More than 10,000 bone and shell fragments were recovered from Vigilante Alta, and 5,000 from Herramientas (Creamer 1992:12). Data from

Vigilante Alta indirectly suggest that some deer meat may have been brought to this island. Creamer (1992:12) suggested the possibility that deer were hunted on the mainland and brought back to island. She reasoned that this is evident by the paucity of mammal bones (n = 5) and the small size of the island (4 sq km). The scarcity of large mammalian faunal remains may also be due to the site's location on an island, where over-hunting and small range size may have prevented local hunting from being a major source of protein. Many species of animal were hunted for subsistence purposes, but some may have also been hunted as objects of exchange or symbolic value. At Herramientas, for example, several recovered tapir bones may have provided the meat for food, while the teeth may have been converted into pendants, such as one recovered at the Vidor site (Kerbis 1980:135). The gulf sites also yielded bones of macaw, which provided food but, more importantly, colored feathers were desired for exchange (Creamer 1992:13). Toads too were eaten, yet their bones may represent ritual consumption or processing of toads for hallucinogenic chemicals in their skin (Kennedy 1982:285).

The differences in species composition of the faunal samples from these two Costa Rican sites may have resulted from microenvironmental differences between the islands (i.e., the length of the shoreline covered by mangrove versus rocky or sandy shore). Therefore, the size of breeding grounds for clams and oysters here, versus reefs, could be significant (Creamer 1983:397). The same is true for fish. The larger island is located near the mouth of a major river, and the cloudiness and salinity of the water differ around each island, affecting the species and the quantities of the fish present.

San Lucas Island, where the site of Vigilante Alta is located, has quite limited land available for agriculture. Island size also limited the possible game population. However, on Chira Island, where the site of Herramientas is located, the larger size of the island appears to have allowed for more diversity in food procurement. Here was evidence of not only agriculture, but also mollusc collecting, fishing, and hunting. The variety and habitats of the terrestrial vertebrates procured suggest that the Herramientas island was not extensively cleared and neither extensive or intensive agriculture was likely to have been practiced.

Overall, excavations at both Vigilante Alta and Herramientas illustrate habitations of simple Pacific coastal groups in Lower Central America that appear to have relied on a mixed economy of fishing, hunting, collecting, and possibly cultivation for subsistence. Creamer (1992:8) suggests that these groups were involved in exchange to maintain themselves, developing ties with mainland groups to acquire lithic materials, for example.

However, there is no doubt that people of Costa Rica were part of their ecosystem. It seems likely that they would have gravitated towards patchy, open habitats characterized by trees that attracted game, such as may have been created by periodic volcanic eruptions or maintained through the use of fire.

Although, southwest Nicaragua and northwest Costa Rica form a cultural unit, called the Greater Nicoya Subarea, the archaeological evidence is not homogeneous here. Faunal evidence from the San Cristóbal, Cruz, Santa Isabel 'A', Vidor, Vigilante Alta, and Herramientas sites in Greater Nicoya suggests a few similarities and parallels relative to fundamental patterns of animal use as well as in the measure of ecological consistentency between the sites mentioned. Yet, some of the best evidence about what may have been happening in Lower Central America in relation to prehistoric subsistence strategies and animal exploitation comes from Panama.

Panama

Just south of Costa Rica and Nicaragua is the modern nation of Panama. Panama is a land of substantial ecological diversity and is one of the few regions in the world which possesses a multiplicity of aquatic and terrestrial animal species within a moderately small area. Linares (1980a:7), by her own assessment, stated that 4 % of the world's species of amphibians and reptiles is found in Panama. For example, the site of La Pitahaya (IS-3) described in the section below, exhibited a wide array of biological diversity even though it was distant from any major rivers.

La Pitahaya

The best known coastal site in the western, Panamanian portion of the Greater Chiriquí region is La Pitahaya (IS- 3), covering some 8.5 ha on the Gulf of Chiriquí in western Panama. To summarize, the site of La Pitahaya is on a peninsula protected on its northern side by inshore islands and by the Muertos Bay lagoon. Muertos Bay is characterized by mangrove stands, and murky waters (Wing 1980:206). The site's principal occupation dates to the San Lorenzo phase (AD 700-1000) (Linares 1980b:76). La Pitahaya (formerly called Isla Palenque) is a complex site, described by Linares (1980b:77) as a "large and nucleated center that was probably the seat of a permanent chief". Although La Pitahaya was a complex center of some sort not many explanations can account for its nucleation. However, certain subsistence practices appear to have allowed, or even initiated centralization. Linares and White (1980:56) suggested that "Intensive agriculture of house gardens and palm plantations near the site, and shifting agriculture of maize fields in nearby places like Boca Brava were practiced at La Pitahaya, whose inhabitants also utilized two protein resources, the white-tailed deer and marine catfish." Furthermore, Hoopes (1996:36) was quite clear on the point that "The nucleation of population at centers like La Pitahaya is attributed to a sustainable subsistence base of maize agriculture supplemented by tree crops."

The total NISP for the La Pitahaya site consists of 1,951 fragments, and the terrestrial mammalian component constituted 263 elements (MNI = 12), excluding rats (Linares and White 1980:190). The most abundant terrestrial animal recovered at La Pitahaya is the white-tailed deer, which alone contributed 80 percent of all usable meat from terrestrial mammals (Linares and White 1980:190). The people of La Pitahaya hunted the white-tailed deer almost exclusively. Linares and White (1980:190) maintained that the presence of deer and rabbit bones in the faunal assemblage substantiated that the La Pitahaya residents must have had access to grasslands and low-bush habitats. In fact, the white-tailed deer may have been the staple game in 7000 years of prehistory on the Pacific Panamanian coast, becoming the preferred food of high-ranking individuals in the periods preceding the Spanish Conquest (Cooke 1978). The other mammals consumed by the people of La Pitahaya were woodland animals (e.g., agouti, collared peccary, and paca), although each species was represented by samples consisting of only one bone.

Interestingly, relatively few bones from La Pitahaya confirmed evidence for human modification (e.g., butchering or skinning), although a few showed evidence of burning. Linares and White (1980:190) maintained that the small sample size and the generally poor preservation of the bone surfaces could be the reasons for the lack of evidence for modification. They also suggested that the favored cooking method was boiling, which might also explain the lack of evidence for burned bone.

However, marine rather than terrestrial vertebrates supplied the majority of the proteins consumed by the La Pitahaya residents. The fish (n = 1,529) and reptilian sample from La Pitahaya, based on number of specimens identified, were collectively 1,688; the entire sample includes at least >300 individual aquatic animals (MNI = 317). This pattern of utilization closely resembles that of the San Cristobal faunal assemblage.

In contrast, shellfish collecting at La Pitahaya was nearly ignored, possibly due to other abundant subsistence choices (Linares 1980d:247). Wing (1980:222) suggested that "the intensive maize-growing and probably palm-tending economy of La Pitahaya seems to have obviated the need to harvest "marginal" protein resources such as mollusks." Wing (1980:212) remarked that requiem (Carcharhinidae) and tiger sharks (*Galeocerdo cuvieri*) represented the biggest contribution of aquatic biomass to the La Pitahaya faunal sample and speculated that these sharks were ensnared not only for meat, but also for their teeth, which are most often used as tools or ornaments that were traded inland.

Regarding worked animal bone a metatarsal of a white-tailed deer was found at La Pitahaya. This object possessed two perforated small circular holes near the proximal end of the metatarsal, which was also intentionally sawed off (Linares 1980c:143). Comparable bone modifications were evident on deer metapodials recovered from San Cristóbal, with metapodials that were split longitudinally (Figures 11, 13, and 14). As noted by Cooke (personal communication in Linares 1980c:143), modified deer metapodials split longitudinally "are still being used in the Central provinces of Panama as huskers for removing maize grains."

La Pitahaya, unlike other sites discussed here, has the distinct advantage of well studied paleobotanical remains. Smith (1980) identified 29 palm fruit fragments, from La Pitahaya, which represented species of *Scheelia*, *Acrocomia*, and *Corozo* palms. The wide variation in size led him to suggest "a single, continuously varying palm fruit was being harvested from trees which were purposely planted and that they were not gathered from natural populations of palm trees" (Smith 1980:165). Carbonized maize remains and maize pollen were recovered from La Pitahaya...Maize was reportedly present in Chiriqui phase (AD 700-AD 900) levels at La Pitahaya, but its quantity and nature was not specified (Smith 1980:165).

Sitio Sierra (Ag-3)

An incompletely studied faunal sample, equivalent to that of La Pitahaya, comes from an archaeological site in the central region of Panama, Sitio Sierra, a village in the Santa Maria River valley. The site was occupied for most of the first millennium AD. Cooke (1975) excavated the site, while its faunal assemblage (n = 1495; MNI = 147) was analyzed by Wing. The mammalian sample from Sitio Sierra is dominated by the white-tailed deer (53 % MNI) and the nine-banded armadillo (20 % MNI). However, the faunal sample at Sitio Sierra consisted mostly of aquatic, ditch, and disturbed land forms species (see Appendix A), implying that by Period IV the land utilized by the village had been constantly cut over (Cooke 1984:284).

While two marine catfish species (Ariidae) made up an important part of the La Pitahaya faunal assemblage (40 % MNI), at Sitio Sierra five catfishes (one freshwater and four saltwater/marine) dominated the assemblage (70 % MNI). This suggested that a greater degree of specialization on a single aquatic species occurred at this prehistoric village. The most common species, however, is the small sardine (*Opisthonemus libertate*), which today is caught with weirs or fine-meshed gill nets (Cooke 1988:131). Although the great quantity of fish remains at Sitio Sierra documents the importance of aquatic-oriented resources, this was not the principal motivation for site location or settlement. The site was located 1 km back from the riverbank on ground high enough to escape flooding during the wet season. This supports the argument by Ranere and Hansell (1978:54) that access to the rich alluvial soils of the Santa Maria River floodplain was the determining factor. Furthermore, they suggest that the recovery of charred fragments of maize, along with manos and metates, indicates the presence of a maize agricultural-based system at Sitio Sierra (Ranere and Hansell 1978:54).

So far, all the comparisons with San Cristóbal have been with faunal assemblages from sites located on the Pacific side of Lower Central America. It is useful to compare faunal assemblages from the Atlantic side also to seek out any similarities. The nearest site yielding a quantifiable faunal collection comparable to that of San Cristóbal is the Selin Farm site in the Department of Colon, in northeastern Honduras.

Honduras

Selin Farm

Healy's (1983) study of a Selin Period (AD 300-1000) site in northeastern Honduras provides useful discussion of the possible prehistoric use of three different ecological zones: freshwater lagoon, mangrove coast, and lowland forest. He discusses long-term coastal adaptation as interpreted from the Selin Farm (H-CN-5) site. Working with a quantifiable faunal collection (n = <3,500), Healy was able to describe the comparative success of these different zones. In Pre-Columbian times, the region of northeast Honduras provided an exceedingly rich, and complex natural environment that was ideal for a broad-based, generalized subsistence strategy, which involved the exploitation of both land and sea-based resources (Appendix A).

The Selin period inhabitants of the site were hunting mammals, especially the peccary (*Tayassu sp.*) and armadillo (*Dasypus sp.*), from the lowland forest. From the nearby lagoon – estuary zone, native settlers were actively pursuing mammals while fishing for game fish, such as jack. *Caranx hippos* is a highly gregarious, schooling fish often found in offshore waters (Linares and Ranere 1980:149). The tarpon (*Megalops atlanticus*), grouper (Serranidae), and snapper (*Lutjanus sp.*) provided complimentary portions of the dietary needs at Selin Farm. Although the aforementioned fish species were very important, the jack alone represented over half (53%) of the total number of bony fish in the Selin site assemblage. At NMN2-1, the jack represented 24 percent of the assemblage, making it an important and the second most abundant, species at San Cristóbal. Thus, fishing at both sites (Selin Farm and San Cristóbal) appears to have been a significant activity, with Selin Farm settlers focusing on the jack, and San Cristóbal inhabitants (NMN2-1) centering on the Cichlidae (46 percent). From these data alone, one would conclude that the inhabitants of both sites were aquatic-oriented in obtaining their protein.

In conclusion, the richness and nearness of diverse ecological zones permitted the prehistoric Selin Farm natives wide-ranging use of these zones, which lowered the subsistence risk and resulted in a lengthy habitation of the site. Interestingly, Healy (1983:53) asks "if the subsistence resources and procurement systems of the Selin natives were so strong, why were their sites uniformly abandoned about AD 800 to 1000?" Clearly, abundance of food resources does not always guarantee successful adaptation.

Yarumela

One other archaeological site from Honduras has been selected for comparison. In contrast to Selin Farm, an Atlantic coastal site, the archaeological site of Yarumela is situated on the Humuya River near the center of the Comayagua Valley of Central Honduras. Dixon (1989:261) suggested that Yarumela was most likely founded because of its strategic location to some of the largest floodplains in the Comayagua Valley, which encouraged sedentary occupation. He also suggested that Yarumela's locality might have advanced its position as a redistribution center during times of poor agricultural production 'elsewhere' in the valley.

Faunal evidence from Yarumela, although limited, supports the assumption that permanent village life in the Formative period had become possible through a successful adaptation to the greater economic potential of the lowland river valleys (Colby 1988:84). Moreover, such faunal data are consistent with those from other early sites in Mesoamerica, and in Lower Central America, in similar environmental zones excavated to date. Faunal remains from Yarumela (n = 1,438) represent the oldest dated remains from any prehistoric Honduran site. The most significant protein source at Yarumela was the white-tailed deer, yet the majority of identified terrestrial mammal bones came from the cottontail rabbit (See Appendix A). Colby (1988:77) advocated that in all probability, many of the unidentified small mammal bones also belong to the rabbit. She also suggested that many of the large unidentified mammal bones were deer, and that the presence of their skull bones and 'extremities' indicated butchering and/or capturing near the Yarumela settlement (Colby 1988:77). In terms of weight of food provided, tapirs (675 kg.) were the most important species (Colby 1988:77, 92).

The other mammals represented at Yarumela included the white-lipped peccary, hooded skunk, gray fox, raccoon, opossum, nine-banded armadillo, and the domestic dog (See Appendix A). Colby (1988:78) professed that the occurrence of these mammals can be most easily accounted for in terms of "occasional opportunistic hunting in the immediate area". According to Colby (1988:71), the faunal evidence suggests an incipient village lifeway that was ecologically self-reliant and capable of meeting the most basic subsistence needs of settlers within its area.

Yarumela settlers relied entirely on their inland, riverine, permanent settlement that utilized faunal resources associated with milpa clearings and the Humuya River. The Humuya River continues today to be the most essential constant affecting which fauna can persist within the Honduran ecosystem (Colby 1988:71).

In sum, the environmental settings of the sites described above differ in several important ways, reflecting the diverse mosaic of local ecologies that characterizes Lower Central America. The ecological setting of each of these sites is somewhat different, although all are located near natural aquatic features. The variation in local environments and cultural settings associated with each period is reflected in the faunal samples recovered from these locations, described above. Human population levels, and the nature and extent of agricultural cultivation at each site, probably affected the quantities and types of game available for exploitation, although precisely measuring such impacts is difficult.

The analyses of faunal samples from Lower Central American sites outlines patterns of aquatic and terrestrial resource utilization across the entire Pre-Columbian era. Each of these settlements varies in interesting ways according to their ecological settings and relative positions in the economic systems of Lower Central America. Aquatic faunas, in particular, have often been interpreted as primary food resources for Pre-Columbian residents at many sites. This examination of six settlement sites indicates that the significance of terrestrial game—including deer, armadillo, agouti, paca, peccary, and the importance of aquatic faunas (primarily fish and turtles but also reptiles)—varies over time in the Lower Central American region. This variation may be attributed to changing local ecologies surrounding these ancient communities, which affected the availability of particular species over time, as well as cultural factors such as trade or exchange. For all periods a wide range of species were being exploited, with large and small mammals, turtles, and fish representing the most abundant taxa recovered at all sites. For most of the sites (e.g., Cruz, La Pitahaya, Sitio Sierra, and Selin Farm) when the faunal data are considered in terms of the estimated contribution of each animal or group of animals to the prehistoric diet, it becomes evident that terrestrial animals, did not provide the bulk of the animal protein in the diet. Rather, the evidence indicates that much of the diet was derived from and/or augmented by, aquatic food sources, which were then supplemented by animals obtained by hunting and possibly trapping.

Although the above archaeological data are fragmentary, they suggest some working hypotheses for the prehistoric subsistence patterns of the southwestern region of Nicaragua and most of Lower Central America. A working theory might be that these sites, described in Chapter 7, were areas of permanent habitation for an agriculturally-based people utilizing aquatic biotopes and terrestrial ones in their subsistence orientation.

Although my discussion in Chapter 7 drew on multiple sites, of different dates and places, I have chosen to illustrate most of my analyses with faunal assemblages from Lower Central America. I have chosen these specific archaeological sites for several reasons. First, all of the sites differ greatly in the size and in the number of taxa represented. Second, all the sites are located in settings that have been studied in great depth. As such, there is detailed information available on the archaeology, chronology, stratigraphy, and, in some instances, paleobotany associated with each faunal assemblage. Finally, the deposits collectively span long periods of time, a feature that was important and essential to my analyses.

Synthesis of Faunal Material from all Sites

Even though the faunal remains excavated from all sites reflect use of animal resources, these data indicate aspects of the specific adaptation of human populations to their environments. When the faunal data are considered in terms of the estimated contribution of each animal, or group of animals, to the prehistoric diet, it becomes evident that terrestrial species did not provide the bulk of the protein in the prehistoric diet at these sites, and aquatic species were more important (Table 7).

White-tailed deer is the single most heavily exploited species of all genera identified across all sites. It is, by far, the most important terrestrial mammal in their diets. Ethnohistorical data also suggests that the hunting of deer was directed by ritual, and that its meat was consumed festively in very large quantities following storage in special deposits (Cooke 1978).

Another significant feature of the San Cristóbal faunal correlation is that at seven out of the ten sites, two species of terrestrial mammal, aside from deer, are more frequent (NISP) than the remaining species: the nine-banded armadillo (*Dasypus novemcinctus*), and the collared peccary (*Tayassu tajacu*) (Table 7).

The San Cristóbal faunal assemblage reflects a resource acquisition shift and a change over time. Fish, such as *Cichlasoma* and *Caranx,* predominated the nutritional intake of residents during the oldest epoch (Zoned Bichrome), remaining relatively stable to the Middle Polychrome period, before declining sharply in the final Pre-Columbian time-period (Late Polychrome). While fish consumption declined while swidden agriculture grew in importance, it was still a significant aspect of their diet and comprised roughly 50 percent of their caloric intake.

Even keeping in mind that sample sizes varied across each excavated unit, lending more or less confidence in chronological trends, the San Cristóbal faunal assemblage contained more than an adequate number of faunal remains to inject a high degree of confidence in the findings.

Table 7. Comparative List of Species from Sites in Central America

	a San Cristóbal	b Cruz	c Santa Isabel A	d Vidor	e La Pitahaya	f Sitio Sierra	g Selin Farm	h Yarumela	i Herramientas	j Vigilante Alta
Large Mammals										
Unidentified (Large Mammals)	x	x	x				x			x
White-tailed Deer (*Odocoileus virginianus*)	x	x	x	x	x	x	x	x	x	x
Brocket Deer (*Mazama Americana*)	x			x			x			
Tapir (*Tapirus bairdii*)				x				x	x	
Manatee (*Trichecus manatus*)							x			
Human (*Homo sapiens*)	x	x	x	x		x			x	
Howler Monkey (*Alouatta villosa*)							x			
Medium Mammals										
Unidentified (Medium Mammals)		x	x				x			
Collared Peccary (*Tayassu tajacu*)	x		x	x	x	x	x			
White-Lipped Peccary (*Tayassu pecari*)	x			x						
Puma (*Felis concolor*)					x					
Jaguar (*Felis onca*)				x						
Jaguarundi (*Felis yagouaroundi*)						x		x		
Ocelot (*Felis pardalis*)								x		
Margay (*Felis wiedii*)								x		
Grey Fox (*Urocyon cineoargenteus*)		x		x		x				
Porcupine (*Coendu sp*).							x			
Otter (*Lutra annectens*)							x			
Domestic Dog (*Canis familiaris*)				x						
Small Mammals										
Unidentified (Small Mammals)	x						x	x		
Monkey (Cebidae)			x							
Paca (*Agouti paca*)	x				x	x	x		x	
Agouti (*Dasyprocta punctata*)	x		x	x	x		x		x	
Armadillo (*Dasypus novemcinctus*)	x		x	x		x	x	x	x	
Coatimundi (*Nasua narica*)	x		x							
Kinkajou (*Poto flavus*)	x					x				
Long-tailed Weasel (*Mustela frenata*)	x					x			x	
Olingo (*Bassaricyon gabbii*)	x									
Raccoon (*Procyon lotor*)	x		x	x		x		x	x	x
Ringtail (*Bassariscus astutus*)	x									
Opossum (*Didelphis marsupialis*)	x			x		x		x	x	
Cottontail Rabbit (*Sylvilagus sp.*)	x			x	x	x		x		

Table 7. Continued

	a	b	c	d	e	f	g	h	i	j
	San Cristóbal	**Cruz**	**Santa Isabel A**	**Vidor**	**La Pitahaya**	**Sitio Sierra**	**Selin Farm**	**Yarumela**	**Herramientas**	**Vigilante Alta**
Small Mammals										
Tayra (*Eira barbara*)						x				
Small Rodents (Rodentia)						x				
Hooded Skunk (*Mephitis macroura*)								x		
Rice Rat (*Oryzomys sp.*)	x					x			x	x
Cotton Rat (*Sigmodon hispidus*)				x		x			x	x
Squirrel (*Sciurus sp.*)	x			x						
White-footed Mouse (*c.f. Peromyscus nudipes*)				x						
Spiny Pocket Mouse (*c.f. Liomys salvini*)				x						
Bat (*c.f.* Phyllostomatidae)				x						
Reptiles										
Box Turtle (*Terrapene sp.*)	x									
Mud Turtle (*Kinsternon sp.*)	x	x	x	x		x				x
Painted Turtle (*Chrysemys sp.*)	x	x	x	x	x				x	
Pond Turtle (*Clemmys sp.*)	x									
Snapping Turtle (*Chelydra sp.*)	x									
Sea Turtle (Chelonidae)			x	x	x				x	x
Unidentified Turtle		x	x	x						
Spiny Lizard (*Scleroporus sp.*)	x									
Central American Whiptail (*Ameiva festiva*)	x			x		x				
Glass Lizard (*Ophisaurus sp.*)	x									
Cotton-mouth Moccasin (*Agkistrodon piscivorus*)	x									
Racer Snake (*Drymobius sp.*)	x									
Rat Snake (Spilotes sp.)	x			x						
Tropical King Snake (*Lampropeltis sp.*)	x									
Green Iguana (*Iguana iguana*)	x			x	x				x	x
Anole (*Anolis sp.*)	x									
Crocodile (*Crocodylus sp.*)	x									
Bony Fish										
Cichlids (*Cichlasoma sp.*)	x									
Jackfish (*Caranx hippos*)	x			x	x				x	
Catfish (*Rhamdia sp.*)	x			x		x			x	x
Cobia (*Rachycentron sp.*)	x									
Drum Fish (Sciaenidae)	x				x					x
Grouper (Serranidae)	x				x					x
Tropical Gar (*Atractosteus tropicus*)	x			x	x					

Table 7. Continued

	a	b	c	d	e	f	g	h	i	j
	San Cristóbal	**Cruz**	**Santa Isabel A**	**Vidor**	**La Pitahaya**	**Sitio Sierra**	**Selin Farm**	**Yarumela**	**Herramientas**	**Vigilante Alta**
Bony Fish										
Mackerels & Tuna (Scombridae)					X					X
Puffers (*Lagocephalus sp.*); (*Sphoeroides sp.*)				X	X				X	X
Porcupine Fishes (Diodontidae)					X					
Sleepers or Gobies (Eleotridae)					X					X
Snooks (Centropomidae)				X	X					X
Grunts (Pomadasyidae)					X				X	X
Porgies (Sparidae)					X					
Snappers (Lutjanidae)				X	X					X
Squirrel Fish (Holocentridae)					X				X	
Needle Fish (Belonidae)				X	X				X	X
Barracuda (*Sphyraena sp.*)					X					
Marine Catfish (Ariidae)					X				X	X
Toadfishes (*Thalassophryne reticulata*)				X					X	X
Leatherjackets (*Balistes sp.*)				X						
Spotted Sleeper (*c.f. Eleotris picta*)				X						
Mullet (*Mugil sp.*)				X						
Unidentified Fish			X						X	X
Eel (Synbranchus)									X	
Cartilaginous Fish										
Eagle Rays (*Aetobatus sp.*)									X	X
Nurse Sharks (*Ginglymostoma cirratum*)					X					
Reef Shark (*Carcharhinu sp.*)					X					
Tiger Shark (*Galeocerdo cuvieri*)					X					
Hammerhead Shark (*Sphyrna sp.*)					X					
Bull Shark (*Carcarhinus leucas*)				X						
Unidentified Shark (Carcharhinidae)			X						X	X
Machete (*Elops affinis*)				X						
Stingrays (*Dasyatis sp.*)				X	X					X
Amphibians										
Marine Toad (*Bufo marinus*)	X			X		X			X	
Bullfrog (*Rana sp.*)	X			X					X	
Freshwater Shells										
Jute (*Pachychilus sp.*)	X									
Snail (*Pomacea flagellata*)	X									
Bivalve (*Nephronaias sp.*)	X							X		
Euglandina cylindracea	X									

Table 7. Continued

	a	b	c	d	e	f	g	h	i	j
	San Cristóbal	**Cruz**	**Santa Isabel A**	**Vidor**	**La Pitahaya**	**Sitio Sierra**	**Selin Farm**	**Yarumela**	**Herramientas**	**Vigilante Alta**
Marine Molluscs										
Tellins (*Tellina rubescens*)								x		
Hard-shelled Clams (*Tivela delessertii*)								x		
Venus Clam (*Pitar lupanaria*)								x		
c.f. Rhinocoryne pacificom								x		
Olive Shell (*Olivella volutella*)								x		
Olive Shell (*Agaronia testacea*)								x		
Dove Shell (*Columbella fuscata*)								x		
Invertebrates										
Crabs (Decapoda)	x									x
Bird										
Unidentified Bird	x								x	
Little Blue Heron (*Egretta caerulea*)	x	x								x
Ibis (*Eudocimus sp.*)	x									
Guan (*Penelope sp.*)	x			x			x			
Bobwhite (*Colinus virginianus*)	x			x		x				
Black Vulture (*Caragyps atratus*)	x			x						
Great Currasow (*Crax rubra*)				x			x			
White-tailed Nightjar (*Caprimulugus cayennensis*)						x				
Ani (*Crotophaga sp.)*						x				
Dove (*Zenaida sp.*); (*Columbigallina minuta*)						x				
Aplomado Falcon (*Falco c.f. femoralis*)						x				
Great-tailed Grackle (*c.f. Cassidix mexicanus*)						x				
Fork-tailed Flycatcher (*c.f. Muscivora tyrannus*)						x				
Barn Owl (*Tyto alba*)						x				
Red-lored Parrot (*Amazona autumnalis*)						x				

Sources: (b, c) Pohl and Healy 1980:288-289 (Cruz and Santa Isabel A); (d) Kerbis 1980:135-140 (Vidor); (e) Linares and White 1980:188-190 (La Pitahaya); (e) Wing 1980:211-220 (La Pitahaya); (f) Cooke 1984:293-300 (Sitio Sierra); (g) Healy 1983 (Selin Farm); (h) Colby 1988:86-89 (Yarumela); (i, j) Creamer 1983: 399-401 (Herramientas and Vigilante Alta).

CHAPTER 8
CONCLUSION

The San Cristóbal archaeological site is located in southwest Nicaragua near the shores of Lake Managua. Based on ceramic remains, and cross-dating with other locations, the site spans from 500 BC to roughly AD 1530. Susan Wyss (1983) excavated the site from 1977-1979. Retrieval of the faunal remains, including bone and shell, was good and the collection was well preserved. Most of the site is currently in pasture, but was previously ploughed for modern agricultural activities. Prior to 2004, the faunal assemblage was in storage for 30 years and was removed for the purpose of analysis at Trent University. Based on this study, over 17,000 specimens were examined and 14,980 (87.5 %) fragments were identified as to species, genus, and family using standard faunal techniques. This constitutes the largest known scientifically identified faunal collection in Lower Central America. In Chapter 1, I identified a series of questions pertaining to the San Cristóbal faunal assemblage. From the analysis the following key findings were reached:

1) The animals exploited by the San Cristóbal residents.

By far, the most numerous faunal component in the San Cristóbal collection were Osteichthyes (bony fish). Analysis indicated that over 12,000 fish bones were preserved throughout the occupational period of the site, representing seven different kinds, of which the *Cichlasoma* comprised over 7,700 specimens and the *Caranx* made up 4,137 individual samples. However, San Cristóbal site is less than 1 km from Lake Managua and was likely flooded during the rainy season thus the high percentage of fish vertebrae could easily have resulted from the fish being trapped in pools (Wyss 2004, personal communication).

Numerically, deer and the armadillo were the most common terrestrial fauna, even though the overall count of each individual was small (Table 2). Other mammals such as peccary, coatimundi, opossum, kinkajou, raccoon, and rabbit were also represented by lesser counts in the assemblage.

For additional inferences on animals utilized, the total absence, in the San Cristóbal collection, of monkeys of several genera (e.g., *Cebus, Ateles, Alouatta*), tapirs (*Tapirus sp.*), three-toed sloth (*Bradypus sp.*), and the spiny rat (*Proechimys sp.*) is of note. The spiny rat is one of the most abundant rodents of Central America (Emmons 1990:234), but is lacking from this location.

2) Changes in animal exploitation over time at San Cristóbal.

The San Cristóbal site exhibited extraordinary stability in overall subsistence throughout its entire occupation. However, following the beginnings of widespread agriculture during the Zoned Bichrome period, particularly under likely conditions of population growth, the faunal data shows changes in terms of yields of aquatic and terrestrial animals. Specifically, the data shows some degree of subsistence change in both the Middle and Late Polychrome periods. The most profound of these changes is seen in the Late Polychrome period when there is a marked increase in the quantity of terrestrial vertebrates and a corresponding decrease in aquatic forms. Less dramatic, but still significant, are the evident changes in small mammals. Species diversity of small mammals disappears at the end of the Middle Polychrome period.

The residents of San Cristóbal may have possibly believed that their aquatic resources were more reliable. In other words, fish may have been perceived as being significantly more constant, predictable, and abundant or relatively non-fluctuating in availability, than their terrestrial counterparts. Low frequencies within certain fish taxa (e.g., Serranidae, Sciaenidae, Rachycentridae) may also reflect differential exploitation and fluctuating availability. Given the distance (approximately 45 km) of San Cristóbal from the Pacific Ocean, the people might only occasionally have fished for some of these marine species.

The wide array of animal species present at San Cristóbal suggest that the inhabitants did not rely entirely on agricultural production, but found it prudent to buffer their livelihoods against unreliable availability of food from farming, with opportunistically hunting, collecting, and fishing a variety of vertebrate species. As open fallow fields became more common through time, due to the growth of agriculture, so to was an expansion of exploitive terrestrial game like deer. This may explain the increase in terrestrial remains throughout the Late Polychrome period at San Cristóbal.

Through a shift in their subsistence practices, of swidden agriculture and forest silviculture, San Cristóbal people resided in a state of dynamic symbiosis with their food sources. It is not always clear why such shifts in resource procurement patterns should take place. Wild game resources may have increased in the Lake Managua region for several reasons. It may be that some game resources increased concurrently with the clearing of land for agriculture, or it may have coincided with shortened fallow periods or perhaps cultivated lands and higher crop yields were needed to feed an expanding population.

3) Illustrations from the faunal assemblage indicating how animals represented at San Cristóbal were hunted, caught, butchered, or cooked.

It is clear that the San Cristóbal residents had an intimate knowledge of the animals they hunted and fished. For example, the nine-banded armadillo often use well-worn pathways and small diggings in the soil illustrate their foraging behavior (Emmons 1997:49). Other mammals, such as rabbits, skunks and possums, often use armadillo burrows for shelter (Humphrey 1974:458). In addition, armadillos have very poor vision at night and have even been known to run into a stationary person (Emmons 1997:49). Therefore, knowledge of the armadillo's behaviour would be advantageous in terms of hunting strategies. In fact, the evidence clearly suggests that San Cristóbal residents had strong hunting preferences for certain terrestrial animals such as white-tailed deer, and the nine-banded armadillo (Table 1).

Low frequencies within certain fish taxa (e.g., Serranidae, Sciaenidae, Rachycentridae) may also reflect differential exploitation and fluctuating availability. Given the distance (approximately 45 km) of San Cristóbal from the Pacific Ocean, the people might only occasionally have fished for some of these marine species. White-tailed deer, being a very robust species that survived historic over-harvesting by man, is one of the few species that can still be seen in and around cultivated or cleared fields and can be hunted near home. The agouti, and even the paca, are much more diurnal than the white-tailed deer, and San Cristóbal residents may have used snares and traps, which are effective day or night, to hunt these caviomorph rodents.

Relatively few bones confirmed evidence for human modification (e.g., butchering or skinning), although there were an appreciable number of bones that showed evidence of burning. Therefore, it can be deduced that favourable cooking methods must have included an open flame or by boiling. For example, Wyss (1983:120) suggested that colander vessels recovered from San Cristobal, were perfectly shaped for straining out fish bones from a broth. The largest type of animal in the collection, the white-tailed deer, exhibited a higher percentage of butchering marks than the smaller brocket deer, or any other animal for that matter (see Appendix B, Raw Data; Plates 1-4). It may be that the larger animals were more difficult to dismember than the smaller ones, resulting in more bone damage. Cutting larger animals, such as deer, into manageable pieces would also result in more cuts per animal than on smaller animals.

To summarize, the inhabitants of San Cristóbal exploited aquatic vertebrates more than terrestrial animals. Their preferred fish were cichlids and Jackfish. Their favourite terrestrial species were forest-dwelling herbivores, which were large to medium-sized animals (e.g., white-tailed deer and peccary) that also ate cultivated crops. Snares, traps, probably bows and arrows, nets, and weirs, were used in hunting and fishing respectively.

4) Ethnographic descriptions of fauna versus zooarchaeological data.

The diet of the Pacific Nicaraguan residents appears to have been unusually varied according to both the archaeological record and Oviedo's accounts. Oviedo (1976:185) observed that the inhabitants ate many deer, pigs, and fish, which were present in enormous quantities locally, as well as maize, beans, and a variety of other foods. Oviedo also noted, for example, "I have found [toads] tied up in the houses of the Indians, and I have seen them eaten roasted; there is no living thing which they refrain from eating, no matter how nasty it is" (1976:186).

Oviedo (1976) provides accounts that toads were a delicacy to Pacific Nicaraguan natives, however their presence in the San Cristóbal faunal collection is minimal. More obvious, though, is the presence of other exotic species such as the armadillo and various snakes. Also left undocumented by Oviedo (1976) was the occurrence of olingo, coatimundi and ringtail in the region, which quite possibly constituted dietary elements as well.

5) Comparison to faunal studies at other archaeological sites in Lower Central America.

Excavations at both Vigilante Alta and Herramientas in Costa Rica illustrated habitations of simple coastal groups that appear to have relied on a mixed economy of fishing, hunting, collecting, and possibly cultivation for subsistence. In addition, a few of the sites (e.g., Herramientas, La Pitahaya, Vigilante Alta, and Vidor) chosen for comparison have a clear prevalence of marine species, which indicates a dependence on resources of the sea.

In contrast, shellfish collecting at both San Cristóbal and La Pitahaya was quite neglected by residents, possibly due to alternative subsistence choices. Therefore, it is difficult to make sound dietary reconstructions based on shellfish collecting habits, because an inadequate sample size would taint any theoretical dietary conclusions. Furthermore, there appeared to be an imbalance in the exploitation of fishing-based protein and terrestrial-based protein at San Cristóbal, as well as at several sites across Lower Central America, such as La Pitahaya, Vidor, Sitio Sierra, and the Selin Farm. For example, faunal analysis from the Vidor site indicated that during the Middle Polychrome period there was a relative increase in aquatic exploitation (fishing) and decrease in terrestrial hunting from the previous Early Polychrome period. In comparison with Middle Polychrome remains, most faunal material from the Late Polychrome period consisted of fish bones at the Vidor site. At San Cristóbal, in contrast, terrestrial remains increased during the Middle and Late Polychrome periods at San Cristóbal, although fish still constituted the majority of the remains recovered. At Sitio Sierra, a vast number of fish remains recovered in Cooke's excavations clearly documented the importance of aquatic resources. Catfish (70% MNI) dominated the faunal assemblage at Sitio Sierra, suggesting that a greater degree of specialization on a single aquatic species occurred at this village. However, it still appears that the village's diet was principally fish. Terrestrial animals such as deer, peccary, armadillo, and other various small animals provided a smaller, yet still significant, portion of food.

I did not expect the evidence from San Cristóbal to be characteristic of all sites throughout Lower Central America. For example, localities with extensive, rich terrestrial fauna (e.g., Selin Farm, Sitio Sierra, and Vidor) may prove to be settings in which fish-collecting represented an attractive labour solution for faunal protein procurement both prior to and following the establishment of a agriculture lifestyle.

Some close similarities exist between the Atlantic/Caribbean coast site of Selin Farm, in Honduras, and San Cristóbal. Comparison of the frequencies of small, medium, and large terrestrial fauna (excluding all birds) shows that the Selin residents also showed a preference mostly for medium-sized to large animals in contrast to small animals (Appendix A).

6) What does the zooarchaeological study of the San Cristóbal faunal assemblage tell us about the environmental setting of Pre-Columbian Pacific Nicaragua (e.g., any changes likely—given species present or pre-dominant)?

In broad ecological terms, the prevalence of various terrestrial and aquatic vertebrates, and the overall species composition of the San Cristóbal faunal assemblage, provides insight into the environmental setting and the nature of the habitats bordering the site in Pacific Nicaragua. For example, *Mazama* (brocket deer) favor the dense vegetation with abundant herbaceous understory of plantanillos, swampy areas, and riversides, but they forage throughout the forest (Emmons 1997:178). Unlike the white-tailed deer, the brocket deer are adapted to rainforest life. With their low forequarters and simple antlers they can slip easily through dense vegetation (Emmons 1997:178). This suggests the presence of dense vegetation and/or swamp zones near prehistoric San Cristóbal.

The nine-banded armadillo is the most commonly seen species of armadillo. It is found in thickets, dense vegetation, and in a wide range of mature and secondary habitats from deep rainforest to grassland and dry scrub. (Emmons 1997:49). Agoutis are terrestrial, solitary, and diurnal. They are found in mature, secondary lowland and montane rainforest, as well as in deciduous forest and in gardens (Emmons 1997:229). Paca are terrestrial, solitary and nocturnal. They are seen in swampy areas and dense thickets, which are most commonly found near water, but they are also sometimes seen in open forest far from water (Emmons 1997:225). All these examples paint a picture of San Cristóbal's ancient environmental setting.

In the Lake Managua area, from approximately AD 800-1600, people were practicing a mixture of seed agriculture and cultivating crops generally associated with Mesoamerica, such as maize, beans and squash, as well as palm and tree fruits. Based on Ethnohistorical accounts and archaeological evidence, it is generally accepted by most researchers that agriculture did not become the primary subsistence base of western Nicaragua until the Early Polychrome period (AD 300-800). However, agriculture was apparently practiced on a smaller scale long before this (Healy 1980:344-345; Lange *et al.* 1992). It is possible that archaeological evidence recovered at San Cristóbal would tie and/or confirm an early agriculture base in western Nicaragua. However, Wyss (1983:119) does not disclose any context for the mano and metate fragments she recovered, which would have bolstered this claim. Yet, in Rivas, a stone metate fragment was found within a Zoned Bichrome (500 BC-AD 300) context (Healy 1980:344).

Archaeological studies and ethnohistorical accounts (Oviedo 1976) have established that a number of plants (i.e., avocado, beans, cassava, corn, papaya, pineapple, spondia, and zapote) were cultivated in Nicaragua and Honduras (Healy 1984:34), Costa Rica (Blanco and Salgado 1980), and Panama (Smith 1980). The inhabitants of sites along Lake Managua, lived in a rich environment with high agricultural potential, but also with deciduous tropical forests that were home to an abundance of value-added species.

> “Rather than completely clearing trees for agricultural fields, I hypothesize, based on the remains found, that Nicaraguans living from approximately AD 800 onwards until AD 1600 used both cleared field agriculture and managed forest silviculture, along with small door-yard gardens, to procure their food,” (Dickau 1999:154).

The animal component of human subsistence in the San Cristóbal region was probably directed towards acquisition of protein. The low frequency of lower limb bones from white-tailed deer also suggests a lack of concern with high-fat areas of the skeleton.

In addition to protein, one should not forget that animals would have supplied a number of useful products such as bone and hide.

Considering the faunal assemblage within the context of local environmental conditions, it would appear that there is some correlation between the relative frequency of species in the assemblage and the type of environment around the site. The two major variables in environment within the San Cristóbal zone are topography and water availability. The faunal assemblage of the San Cristóbal site, located within a dissected environment adjacent to a permanent watercourse, is dominated by medium-sized ungulates, such as the white-tailed deer. Some of the large mammal bones appear reddish in color, which may reflect staining rather then burning and some bones are calcined. Calcification may have enhanced bone preservation by rendering the bone more inert (Styles 1981:238).

The subsistence stability, at San Cristóbal, combined with the inhibiting effects of volcanic eruptions, tended to support the maintenance of moderate-sized populations and mostly self-reliant village settlement. The information is rather poor concerning what processes have contributed to the formation of the archaeological faunal record. Nevertheless, I feel the examples have some merit for illustrating subsistence strategies. One of the problems I addressed at San Cristóbal, by studying other Lower Central American sites, is whether there was a propensity toward selective use of certain animals as a food resource. We now have concrete faunal evidence to demonstrate that during all, or part, of the year prehistoric people at San Cristóbal derived the majority of their subsistence from aquatic environments.

The secondary purpose of this paper was to present a survey, in ecological contexts, on the lifeways and subsistence strategies of the peoples of Lower Central America with emphasis on the importance of native animals in their diet. The nature of social organization (i.e., the band, tribe, and chiefdom), land use and resource exploitation, settlement pattern, and the extent of social, economic, and political spheres of control are among the numerous complex social and cultural variables that play a role in mediating the interrelationships between volcanic events and human societies.

Subsistence patterns described in this paper indicate that, for most of the prehistoric populations in Lower Central America, there is a strong correlation between settlement environment and subsistence strategy. Nevertheless, the true relationship of the Lower Central American populations and those of Lake Managua, Nicaragua, through time, is still largely uncertain.

This paper also provides a glimpse of the complexity of ecology over the long term. The history of land use and landscape ecology in Lower Central America was a mottled one, with punctuated changes, long intervals of stability, and shorter episodes of mismanagement, periodically interrupted by ecological recovery. In all areas, changes in the climatic conditions can profoundly affect their animal populations. Therefore, before any real understanding of resource use within an area can be accomplished some attempt to reconstruct previous environmental conditions is necessary.

The most important aspect of the models cited previously is that we are still missing key pieces of the puzzle, sites with a high potential for revealing direct subsistence remains need to be tested using modern techniques for the recovery of all types of faunal remains. In Lower Central America, research is just beginning to determine reliable chronologies and to identify the factors that affected early tropical settlement and subsistence strategies. It is, therefore, hoped that the information presented here contributes to an understanding of the paleoecology of the indigenous peoples in Lower Central America and to a greater appreciation of the importance of land-man-animal relationships. Studies like this should inspire archaeologists to the need for addressing issues related to early cultural systems and for conducting field investigations and analysis in relationship to regional and interregional concerns in Central America.

FUTURE RESEARCH

A regional picture of subsistence practices based on comparable faunal samples should be accumulated. Sex and age analysis of deer remains (e.g., white-tailed deer) might provide evidence for over exploitation, for example. The analysis of the degree of ash layer weathering in stratigraphy might indicate whether a site was abandoned during, or after, a particular ashfall, and may provide evidence revealing the length of abandonment. Data must be compared with information from adjacent areas not affected by ashfall. Analysis of sites adjacent to freshwater and substantial estuaries within an area of ashfall is necessary in estimating the magnitude of the impact of the eruption and vulnerable resources. A phytolith study would provide hard evidence for pre- and post-ashfall agricultural practices, as well as floral succession and recovery. However, if we investigate a freshwater lake itself, such as Lake Managua, concerning the inter-relationship of settlement of the San Cristóbal inhabitants and changes in the natural environment of the region, several issues would be addressed. For example, by extracting a deep sediment core from the edge of Lake Managua and then employing physical and chemical analysis of its sediments, including an archaeological survey of the lake's watershed and local aquatic regimes, we would be able to examine and better interpret the nature of Pre-Columbian occupation, focusing particularly on the causes and consequences of subsistence behavior of the San Cristóbal inhabitants.

In addition, a survey of several Lower Central American archaeological sites raises a host of questions inviting future research. Four of the questions posed are discussed below in the desire to stimulate thinking:

(1) To what extent have the exploitive activities of the various Lower Central American cultural groups altered native fauna? It appears safe to assume that exploitation of animal species by humans is certain to result in changes in the ecological conditions that existed before human intervention. It is difficult to assess quantitatively or qualitatively the extent of the ecological changes caused by humans. However, some inferences are possible.

(2) What are some of the economic possibilities that are suggested by the faunal exploitation of Lower Central American cultural groups?

(3) Does the physical position of a site within a local ecosystem influence the type and quantities of animals hunted?

(4) Does variation in agricultural systems from one area to another affect hunting systems?

In answer to the first query, I would suggest that if we are interested in understanding the nature of human effect on the landscape we should not ignore the fact that the current environment is a consequence of a long history of human action and behavior. The pioneering work of Cook (1909) demonstrated the effect of humans on the environment (e.g., fires set by aboriginal farmers of Central America). However, the ecological inferences of Cook's study were, for years, almost disregarded. It was not until the research efforts of Parsons (1955) that we could perceive a renewed interest in this and related problems in Central America. Parsons examined the relationships between manmade fires and the pine savannas of Nicaragua and Honduras. In an important study related to the faunal changes caused by man, Bennett (1965) conducted a preliminary examination of modern human effect on the zoogeography of Panamanian isthmus.

However, the issue of prehistoric human-environment interactions are best addressed by a research strategy that recovers parallel archaeological and paleoenvironmental data. One such conjunctive approach was the recent analysis of ancient environmental interactions around a tropical, karstic lake, Laguna Tamarindito, in Guatemala. Laguna Tamarindito is a small lake located in the southwestern portion of the Petén rainforest of Guatemala (Dunning *et al.* 1998:139).

We can see from these examples, whether it be present-day or prehistoric, that human disturbance to the environment has complex and far-reaching consequences on the fauna and flora. Therefore, by integrating a complete range of archaeological, faunal and paleobotanical data we may be able to document environmental conditions and attribute their root causes.

In response to the second matter, societies are generally classified by their subsistence strategies (e.g., agriculturists, horticulturists, hunter-gatherers, or pastoralists) associated with characteristic population structures, settlement patterns, social systems, and technologies. Many of these characteristics echo the way in which animal and plant resources were obtained. A model proposed by Jochim (1976, 1981) is mainly useful for assessing human economic behavior from an ecological viewpoint by way of zooarchaeological data. The model presumes that people do form logical choices to reconcile competing needs but eventually balance consumption of energy and nutrients (Jochim 1976:4-5; 1981:64). Though this model was developed for the study of hunter-gatherer economies, it also is suitable for agricultural, pastoral, and urban systems.

Whenever direct historic analogies or ethnohistoric analogies can be made in prehistoric zooarchaeology, they certainly should be. Similarly, historic records should be consulted when doing historic zooarchaeology. Such comparisons give new perspective to the zooarchaeological record and can be enlightening.

Although one can postulate that variation in the aforementioned faunal assemblages is the result of different hunting strategies in different environments, one must also consider the interrelationship between hunting and agriculture. It is safe to assume that faunal exploitation by the San Cristóbal residents is not unique among other Lower Central American inhabitants in similar ecological and cultural circumstances. Therefore, one may make two assumptions regarding this pattern of faunal use: (1) the diets of Pre-Columbian people at the agricultural level of shifting cultivation included sufficient animal protein derived from utilizing a wide range of native animals, and (2) the resources of the Lower Central American tropics available to produce continued harvests of non-domesticated animal food was relatively high. Furthermore, these two assumptions suggest that attention might well be focussed toward maintaining stocks of indigenous food animals, which then could be harvested under some system of control.

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APPENDIX A

Faunal Samples at Vigilante Alta: Unit 8, Costa Rica (modified from Creamer 1983:399).

	Fragments	MNI	% Contrib. to Diet	Weight of Bone (g)	% of Total
Marine Species					
Ariidae *c.f. Arius dowii* (marine catfish)	327	13	7.15	69.6	17.62
Batrachoididae *c.f. Thalassophryne Reticulata* (toadfish)	15	5	.26	6.9	1.75
Belonidae (needlefish)	55	17	.88	7.6	1.92
Carangidae *c.f. Caranx caballus, c.f. Caranx hippos, c.f. Tachinotus rhodopus, c.f. Vomer declivifrons* (jack)	15	6	3.10	13.0	3.29
Centropomidae *c.f. Centropomus nigrensis* (snook)	125	3	3.34	38.7	9.80
Charcharinidae (shark)	30	1	2.25	9.9	2.50
Dasyatidae *c.f. Dasyatis* (stingray)	2	2	2.34	.8	.20
Eleotridae *c.f. Eleotris picta* (sleeper)	2	2	.79	.2	.05
Lutjanidae *c.f. Lutjanus gutatus* (snapper)	126	3	1.55	11.4	2.89
Myliobatidae *c.f. Aeteobates* (eagle ray)	8	2	1.38	2.3	.58
Pomadasydae *c.f. Lythrulon flavigattatum, c.f. Pomadasys corvinaeformis* (grunt)	21	3	1.55	3.8	.96
Scianidae *c.f. Larimus acclivis, c.f. Cynocion phoxocephalus* (drum or corvina)	7	4	1.70	2.4	.61
Scombridae *c.f. Scomberomorus maculatus* (mackerel and tuna)	10	1	.61	1.3	.33
Serranidae *c.f. Epinephalus analogus, c.f. Cephalopholis acanthistius* (grouper and sea bass)	11	7	9.11	4.0	1.01
Synbranchus (eel)	6	1	.01	.1	.025
Tetradontidae *c.f. Canthigaster puntatissimus* (puffer)	17	8	2.27	13.6	3.44
Unidentified fish	1685	--	7.75	144.4	36.57
Crab	55	28	--	16.2	4.10
Chelonlidae *c.f. Chelonia mydas* (marine turtle)	2	1	32.70	4.0	1.01
Terrestrial Species					
Emydidae *c.f. Kinosternon scorploides* (turtle)	1	1	.04	2.1	.53
Iguanidae *c.f. Iguana iguana* (Iguana)	9	2	2.64	3.0	.76
Rodentia *c.f. Oryzomys talamancae* (rice rat), *c.f. Sigmodon hispidus* (cotton rat)	35	3	.009	3.4	.85
Aves (bird)	11	2	2.89	4.1	1.04
Small mammal *c.f. Procyon lotor* (raccoon)	1	1	1.69	1.1	.025
Large mammal *c.f. Odocoileus virginianus* (white-tailed deer)	2	2	--	.2	.05
TOTAL	2580	159	100.009	394.2	100.535

Faunal Samples at Herramientas: Unit 7, Costa Rica (modified from Creamer 1983:400).

	Frag-ments	MNI	% Contrib. to Diet	Weight of Bone (g)	% of Total
Marine Species					
Ariidae *c.f. Arius dowii* (marine catfish)	134	3	1.97	60.5	12.24
Batrachoididae *c.f. Thalassophryne Reticulata* (toadfish)	8	1	.06	3.6	.73
Belonidae (needlefish)	2	2	.12	1.0	.20
Carangidae *c.f. Caranx caballus, c.f. Caranx hippos, c.f. Tachinotus rhodopus, c.f. Vomer declivifrons* (jack)	5	2	1.23	1.2	.24
Centropomidae *c.f. Centropomus nigrensis* (snook)	125	3	1.33	19.6	3.97
Charcharinidae (shark)	24	1	3.14	5.5	1.11
Lutjanidae *c.f. Lutjanus gutatus* (snapper)	7	1	.52	1.5	.26
Myliobatidae *c.f. Aeteobates* (eagle ray)	2	1	.82	.2	.04
Pomadasydae *c.f. Lythrulon flavigattatum, c.f. Pomadasys corvinaeformis* (grunt)	6	3	1.85	4.7	.95
Scianidae *c.f. Larimus acclivis, c.f. Cynocion phoxocephalus* (drum or corvina)	1	1	.51	.1	.02
Serranidae *c.f. Epinephalus analagus, c.f. Cephalopholis acanthistius* (grouper and sea bass)	2	1	1.55	1.2	.24
Tetradontidae *c.f. Canthigaster puntatissimus* (puffer)	5	3	1.02	3.9	.79
Unidentified fish	148	--	--	41.0	8.30
c.f. Pristis (sawfish)	3	1	1.63	.4	.08
Terrestrial Species					
Bufonidae *c.f. Bufo marinus* (toad)	2	1	.03	.2	.04
Emydidae *c.f. Kinosternon scorploides* (turtle)	53	1	.04	40.0	8.0
c.f. Chrysemmys scripta	7	2	1.92	15.4	3.12
c.f. Pseudemmys scripta (land turtle)	6	1	.96	3.7	.75
Iguanidae *c.f. Iguana iguana* (Iguana)	111	8	12.44	37.6	7.60
Rodentia *c.f. Oryzomys talamancae* (rice rat)	8	2	.007	.9	.18
c.f. Sigmodon hispidus (cotton rat)	17	3	.01	3.2	.65
Aves (bird)	106	2	3.45	63.2	12.79
Small mammal	3	1	2.02	.7	.14
c.f. Procyon lotor (raccoon)	2	1	2.02	3.5	.07
c.f. Potos flavus	5	1	2.02	2.2	.44
c.f. Caluromys or *Philander* (opossum and weasel)	3	1	.40	.3	.06
c.f. Dasypus novemcinctus (armadillo)	7	1	1.96	1.3	.26
Medium mammal	4	1	2.86	2.0	.40
c.f. Dasyprocta punctata (agouti)	5	1	1.02	1.5	.26
c.f. Cuniculus paca (paca)	10	1	2.86	8.4	1.70
Large mammal *c.f. Odocoileus virginianus* (white-tailed deer)	7	1	16.70	8.7	1.76
c.f. Tapirus bairdii	19	1	34.40	156.3	31.63
c.f. Homo sapiens	1	1	--	.7	.14
TOTAL	804	52	99.967	494.2	99.25

Faunal Samples at Herramientas: Unit 12, Costa Rica (modified from Creamer 1983:401).

	Frag- ments	MNI	% Contrib. to Diet	Weight of Bone (g)	% of Total
Marine Species					
Ariidae *c.f. Arius dowii* (marine catfish)	365	16	7.74	160.1	29.24
Batrachoididae *c.f. Thalassophryne Reticulata* (toadfish)	7	4	.18	2.2	.40
Carangidae *c.f. Caranx caballus*, *c.f. Caranx hippos*, *c.f. Tachinotus rhodopus*, *c.f. Vomer declivifrons* (jack)	7	3	1.36	13.9	2.54
Centropomidae *c.f. Centropomus nigrensis* (snook)	119	3	2.94	85.0	15.52
Charcharinidae (shark)	2	1	1.98	11.9	2.17
Lutjanidae *c.f. Lutjanus gutatus* (snapper)	9	2	.91	1.5	.27
Myliobatidae *c.f. Aeteobates* (eagle ray)	7	2	1.21	1.7	.31
Pomadasydae *c.f. Lythrulon flavigattatum*, *c.f. Pomadasys corvinaeformis* (grunt)	6	3	1.36	1.2	.22
Scianidae *c.f. Larimus acclivis*, *c.f. Cynocion phoxocephalus* (drum or corvina)	8	2	.75	2.9	.53
Scombridae *c.f. Scomberomorus maculatus* (mackerel and tuna)	4	1	.53	1.0	.18
Serranidae *c.f. Epinephalus analagus*, *c.f. Cephalopholis acanthistius* (grouper and sea bass)	5	2	2.29	4.1	.75
Synbranchus (eel)	6	1	--	.4	.07
Tetradontidae *c.f. Canthigaster puntatissimus* (puffer)	10	5	1.25	8.6	1.57
Unidentified fish	352	--	--	70.6	12.89
Chelonlidae *c.f. Chelonia mydas* (marine turtle)	1	1	28.76	2.8	.51
Terrestrial Species					
Bufonidae	4	2	.03	.54	.10
c.f. Bufo marinus (toad)	1	1	.01	.1	.02
Ranidae c.f. Leptodactylus pentadactylus (frog)	2	2	.03	.5	.09
Emydidae c.f. Kinosternon leucostoma	5	1	.03	3.2	.58
c.f. Kinosternon scorploides (turtle)	7	1	.03	7.2	13.15
c.f. Rhinoclemmys (land turtle)	2	1	.35	2.4	.44
Iguanidae	4	2	2.29	1.0	.18
c.f. Iguana iguana (Iguana)	34	3	3.44	16.6	3.03
Rodentia *c.f. Sigmodon hispidus* (cotton rat)	20	4	.01	3.3	.60
Aves (bird)	106	5	6.36	72.0	13.15
Small mammal					
c.f. Procyon lotor (raccoon)	4	1	1.49	3.1	.57
c.f. Dasypus novemcinctus (armadillo)	2	1	1.60	2.2	.40
Medium mammal					
c.f. Tayassu tayassu (collared peccary)	15	1	8.48	56.2	10.26
Large mammal	5	1	12.30	9.0	1.64
c.f. Odocoileus virginianus (white-tailed deer)	1	1	12.30	2.3	.42
Unidentified mammal	28	--	--	6.5	1.19
TOTAL	1140	73	100.01	547.54	100.15

Faunal Species of Mammals at Yarumela, Honduras (modified from Colby 1988:92).

Species	# of Pieces (% burnt)	% of Total	MNI	Total Weight of MNI (kg.)	Estim. Weight of Usable Meat (kg.)
Large mammal (unid.)	951 (8)	68.86			
Small mammal (unid.)	278 (16)	20.13			
Tapirella bairdii (tapir)	17+ (47)	1.23	5	1350	675
Odocoileus virginianus (white-tailed deer)	54 (41)	3.91	7	636	317
Tayassu pecari (white-lipped peccary)	1 (0)	.07	1	23	16
Sylvilagus sp. (cottontail rabbit)	71 (46)	5.14	14	22	11
Procyon lotor (raccoon)	1 (burnt)	.07	1	11	8
Didelphis marsupialis (opossum)	1	.07	1	5	4
Dasypus novemcinctus (nine-banded armadillo)	1 (burnt)	.07	1	7	3
Urocyon cinereorgentens (gray fox)	1	.07	1	4	2
Mephitis macroura (hooded skunk)	1	.07	1	3	2
Probably not use for food:					
Rat (species unknown)	1		1		
Gopher (species unknown)	1		1		
Canis familiaris (domesticated dog)	1		1		
Felis sp.	2 (1 burnt)		2		

Terrestrial Fauna from the Vidor Site, Costa Rica (modified from Kerbis 1980:135).

Periods and Sample Size	Reptilla MNI (No.)	Aves MNI (No.)	Mammalia MNI (No.)	Total Terrestrial Fauna MNI (No.)
¼ inch Samples				
Early Polychrome	4 (44) iguaninds	1 (1) Currasow	2 (70) deer	15 (132)
	3 (6) snakes		1 (3) peccary	
	2 (5) turtles		1 (1) fox	
			1 (2) raccoon	
Early Middle Polychrome	6 (133) iguaninds	1 (1) *Crax*	1 (1) jaguar	22 (325)
	2 (29) snakes	1 (2) bobwhite	1 (3) rabbit	
	1 (4) turtle		3 (119) deer	
			1 (4) raccoon	
			1 (14) armadillo	
			2 (5) squirrel	
			1 (10) peccary	
			1 (1) opossum	
Late Middle Polychrome	4 (135) iguaninds		1 (160) deer	24 (427)
	1 (1) *Ameiva*		2 (3) opossum	
	3 (40) turtles		2 (4) peccary	
	4 (37) snakes		1 (37) armadillo	
			1 (5) rabbit	
			1 (2) raccoon	
			1 (3) squirrel	
½ inch Samples				
Early Polychrome	1 (7) iguaninds		2 (26) deer	5 (38)
	1 (4) turtles		1 (1) opossum	
Early Middle Polychrome	5 (53) iguaninds		5 (138) deer	19 (236)
	2 (28) turtles		2 (10) peccary	
	1 (1) snake		1 (2) brocket deer	
			1 (1) raccoon	
			1 (2) armadillo	
			1 (1) rabbit	
Late Middle Polychrome	2 (11) iguaninds		3 (110) deer	12 (145)
	1 (3) snake		2 (8) opossum	
	1 (8) turtle		1 (2) peccary	
			1 (2) armadillo	
			1 (1) *Agouti*	
Late Polychrome	1 (1) iguanind		2 (61) deer	5 (64)
			1 (1) peccary	
			1 (1) tapir	

Table 4: Ecological Groupings of Fish Species from the Vidor Site (modified from Kerbis 1980:134)

Pelagic

c.f. Euthynnus lineatus
Auxis sp.

Reef/Rock

Cymnothorax sp.
Epinephelus sp.
Lutjanus argentiventris
Macmulon sp.
Bodianus sp.
Bodianus diplotaenia
Halichoeres sp.
Scarus sp.
Balistidae
Balistes sp.
Pseudobalistes naufragium

Estuary, Brackish Water, Mud Substrate

Bagre sp.
Ariopsis sp.
Lepisosteus tropicus
Eleotridae *c.f. Eleotris picta*
Batrichoididae *c.f. Daector sp.*
Centropomus sp.

Tending towards Estuarine Environments and Inshore Habitats (e.g., Sandy Substrates)

Dasyatis sp.
Negaprion fronto
Carcarhinus leucas
Elops affinis
Siluriformes
Vomer declivifrons
Selene sp.
Lutjanus sp.
Mugil sp.
Sphoeroides sp.

- *Caranx sp.*
  - *Caranx sp.*
  - *Caranx caballus* (inshore and pelagic)
  - *Caranx hippos* (inshore and pelagic)

Miscellaneous

I. Inshore vegetation/sandy substrates
Calamus brachysomus

II. Inshore and pelagic habitats
Belonidae
Tylosurus sp.
Sphyraena sp.
Scomberomorus sierra

III. Inadequate identifications for habitat grouping purposes
Rajiformes
Squaliformes
Diodon sp.
Anisotremus sp.

IV. Tentative identifications
c.f. Acanthuridae
c.f. Gerres cinereus
c.f. Seiene
c.f. Trachurus
c.f. Pogonias
c.f.Scorpaena

The Aquatic Fauna from the La Pitahaya Site in Panama (modified from Wing 1980:213).

Bony Fish Species	Biomass (kg)	%
Serranidae (sea basses/groupers)	0	0
Centropomidae (snooks)	6.48	2.5
Lutjanidae (snappers)	2.00	0.8
Elopidae (tarpons)	0	0
Carangidae (jacks)	7.00	2.7
Sphyraenidae	4.23	1.6
Pomadasyidae (grunts)	2.00	0.8
Diodontidae (porcupine fishes)	9.88	3.8
Scaridae (parrotfishes)	0	0
Sparidae (porgies)	.74	0.3
Sciaenidae (drums or corvinas)	24.17	9.2
Kyphosidae (rudderfishes)	0	0
Batrachoididae (toadfishes)	0	0
Belonidae (needlefishes)	.10	0.04
Albulidae (bonefishes)	0	0
Eleotridae (sleepers)	6.93	2.6
Ariidae (sea catfishes)	158.12	60.1
Scombridae (mackerels & tuna)	23.32	8.9
Tetradontidae (puffers)	17.60	6.7
Holocentridae (squirrel fishes)	.50	0.2
Totals	263.07	100%

Aquatic Fauna from the La Pitahaya Site (IS-3), Panama (modified from Wing 1980:213).

	No.	MNI	Live wt. (kg)	MNI x l.w.	% Usable
BONY FISH					
Ariidae (sea catfish)	830	54	1.245	67.23	.77
Arius spp. or *Ariopsis spp.*	150	60	1.245	74.7	.77
Bagre panamensis	16	13	1.245	16.185	.77
Sciaenidae (drums or corvinas)	51	17	1.11	18.87	.90
Cynoscion spp.	16	6	.826	4.956	.90
Larimus sp.	1	1	.173	.173	.90
Bairdiella sp.	1	1	.173	.173	.90
Scombridae (mackerels & tuna)	44	17	1.372	23.324	.90
Tetradontidae (puffers)					
Lagocephalus spp.	4	3	ca. .55	1.65	.90
Sphoeroides spp.	55	29	ca. .55	15.95	.90
Sphyraenidae (barracuda)					
Sphyraena spp.	15	8	.529	4.23	.90
Diodontidae (porcupine fishes)	35	18	.549	9.882	.90
Eleotridae (sleepers or gobies)	13	9	.77	6.93	.90
Carangidae (jacks)	12	7	1.00	7.00	.90
Centropomidae (snooks)	8	3	2.16	6.48	.90
Lutjanidae (snappers)	2	2	1.00	2.00	.90
Pomadasyidae (grunts)	5	2	1.00	2.00	.90
Sparidae (porgies)	1	1	.738	.738	.90
Holocentridae (squirrel fishes)	1	1	.50	.50	.90
Belonidae (needlefishes)	2	1	ca. .100	.100	.90
CARTILAGINOUS FISH					
Orectolobidae (nurse sharks)					
Ginglymostoma cirratum	2	1	.469	.469	.90
Carcharhinidae (requiem sharks)	186	12	5.087	61.044	.90
Carcharhinu spp. (reef shark)	8	4	5.087	20.348	.90
Galeocerdo cuvieri (tiger shark)	18	6	11.008	66.048	.90
Sphyrnidae (hammerheads)					
Sphyrna spp.	47	16	1.116	17.86	.90
Dasyatidae (stingrays)	1	1	2.653	2.653	.90
Dasyatis spp.	5	4	2.653	10.61	.90
REPTILES					
Iguanidae (probably Iguana)	55	14	4.536	63.504	.60
Cheloniidae (sea turtles)	5	3	57.00	171.00	.35
Chelonia mydas	7	1	90.00	90.00	.40
Emydidae (freshwater turtle)					
Chrysemys scripta	92	2	4.00	8.00	.35
Totals	1688	317			

Terrestrial Mammals from Trenches 1-5, 7 at the La Pitahaya Site (IS-3), Panama (modified from Linares and White 1980:191).

Scientific/Common Names	No.	MNI	%	Live wt. (kg)	MNI x l.w.	% Usable
Dasyprocta punctata Agouti	2	1	.08	2.26	2.26	.66
Cuniculus paca Paca	4	1	.08	6.33	6.33	.66
Sylvilagus sp. Conttontail rabbit	1	1	.08	.79	.79	.63
Tayassu tajacu Collared peccary	1	1	.08	24.00	24.00	.70
Odocoileus virginianus White-tailed deer	254	7	.58	39.32	275.24	.62
Felis concolor Puma	1	1	.08	34.00	34.00	.55

Key:
No. = Number of Elements
MNI = Minimum Number of Individuals
Live wt. = Weight of live animal
MNI x l.w. = Biomass
% Usable = Proportion of animal that is meat

Identified Faunal Remains from Site NMN-2-1, Nicaragua.

Scientific/Common Name	Unit No.	Faunal Material Recovered	Special Features
MAMMALS			
Odocoileus virginianus	G-4	Tibia: proximal end with joint	Rodent gnawed
White-tailed Deer	J-3	Left side of mandible with 1molar	
	I-6	M1 (Molar)	
	I-8	1 Molar	
	I-8	Right Femur	Lateral condyle (burned)
Nasua nasua	H-3	2 Molars	No jaw
Coatimundi			
Lynx rufus			
Bobcat	J-4	P3 (Premolar)	
Dasyprocta punctata	I-4	1 molar	
Agouti	I-5	1 molar	
Canis familiaris	H-6	P4 (Premolar)	
Domesticate dog	F-3	M2 (Molar)	
REPTILES			
Lizards			
Ctenosaura similis	I-8	Section of front left side of maxillae near nasal opening	
Spiny-tailed Iguana	I-6	Premaxillae with teeth	
Heloderm horridum	I-6	Thoracic vertebra	
Mexican beaded lizard			

Caiman: One tooth, pierced on 2 sides, possibly for ornamental purposes.

Turtles: Only bony plates identified and found throughout all levels. However, it is impossible to determine to turtle fragments to genus, with the exception being that soft shelled and hard shelled turtles are represented.

Scientific/Common Name	Unit No.	Faunal Material Recovered	Special Features
Snakes			
Viparid sp.	I-5	2 Thoracic vertebrae	
Probably Colubrid	I-5	Thoracic vertebra	Large specimen (4-6 m)

Plus several small vertebrae of unidentified snakes.

Scientific/Common Name	Unit No.	Faunal Material Recovered	Special Features
AMPHIBIANS			
Rana sp.	I-5	1 Thoracic vertebra	
Unidentified frog			
FISH			
Lepisosteus tropicus	found in every Level of every Unit	Numerous Scales	
Tropical Gar			
Unidentified Catfish sp.		1 Pectoral spine	

Faunal Remains from Cruz Site, Ometepe Island (modified from Pohl and Healy 1980:288).

Species	Phases						
	Alta Gracia		Las Lajas		La Virgen	Apompua	San Roque
	No.	%	No.	%	No.	No.	No.
Mammals							
Homo sapiens							
(human)	1	1	5	7		2	
Urocyon cineoargenteus							
(grey fox)	1	1					
Odocoileus virginianus							
(white-tailed deer)			9	13			
Large mammal							
(probably deer)	1	1	5	7			
Medium mammal	1	1	1	1			
Birds							
Large bird	2	2					
Reptiles							
Kinosternon sp.							
(mud turtle)	4	6	2	3			
Chrysemys sp.							
(pond turtle)	74	88	48	68	1		1
Turtle, unidentified			1	1			
Total	84		71		1	2	1

Faunal Remains from Santa Isabel A Site, Nicaragua (modified from Pohl and Healy 1980:289).

Species	Phases			
	Las Lajas		La Virgen	
	No.	Percentage	No.	Percentage
Mammals				
Homo sapiens (human)	3	4	7	7
Cebidae (monkey)			1	1
Ateles geoffroyi	1	1		
(spider monkey)	(2 matching femora)			
Dasypus novemcinctus				
(nine-banded armadillo)			2	2
Dasyprocta punctata				
(agouti)	1	1	1	1
Procyon lotor				
(raccoon)	1	1		
Nasua narica				
(coati)			1	1
Odocoileus virginianus				
(white-tailed deer)	53	73	56	54
Large mammal				
(probably deer)	4	5	13	13
Medium mammal	1	1		
Reptiles				
Kinosternon sp.				
(mud turtle)	1	1	12	12
Chrysemys sp.				
(pond turtle)	6	8	10	10
Chelonidae				
(sea turtle)	1	1		
Turtle, unidentified	1	1		
Fishes				
Fish, unidentified				
(probably shark)			1	1
Total	73		104	

Note: One additional unprovenienced species: Tayassuidae (peccary)

Fish Species from the Selin Site (H-CN-5) of Honduras (modified from Healy 1983: 41).

Common Name	Scientific Name	E.S.	B.S.	T.S.	Total MNI	% of MNI
Jack	*Caranx hippos*	5	20	30	55	53.39
Snook	*Centropomus sp.*	2	1	5	8	7.76
Snapper	*Lutjanus sp.*	1	2	3	6	5.83
Grouper (sea bass)	Serranidae	1	2	2	5	4.85
Tarpon	*Megalops atlanticus*		3	2	5	4.85
Barracuda	*Sphyraena sp.*		3	2	5	4.85
Houndfish	*Tylosaurus sp.*		1	2	3	2.91
Cartilaginous fish	Chondrichthyes			2	2	1.94
Mullet	*Mugil sp.*			2	2	1.94
Cichlid (mojarra)	*Cichlasoma sp.*			2	2	1.94
Croaker	*Micropogon sp.*		1	1	2	1.94
Marine Mojarra	*Eugerres sp.*		1	1	2	1.94
Shark	Carcharhinidae		1		1	.97
Porcupinefish	*Diodontidae sp.*			1	1	.97
Rays/Skates	Rajiformes			1	1	.97
Sea Catfish	Ariidae			1	1	.97
Porgie (sheepshead)	*Archosargus sp.*			1	1	.97
Puffer	*Spheroides sp.*			1	1	.97
					103	99.96

E.S. = Early Selin Period
B.S. = Basic Selin Period
T.S. = transitional Selin Period

Mammals from the Selin Site (H-CN-5) of Honduras (modified from Healy 1983:41).

Common Name	Scientific Name	E.S.	B.S.	T.S.	Total MNI	% of MNI
Deer (white-tailed)	*Odocoileus virginianus*	2	4	4	13	31.70
(brocket)	*Mazama americana*		2	1		
(sp. unidentified)	Cervidae					
Armadillo	*Dasypus novemcinctus*	1	3	3	7	17.07
Peccary	*Tayassu sp.*	1	2	2	5	12.20
(sp. unidentified)	Artiodactyla					
Manatee	*Trichechus manatus*	1	2	1	4	9.96
Agouti	*Dasyprocta punctata*	1	1	1	3	7.32
Paca (spotted cavy)	*Agouti paca*		1	1	2	4.88
Howler monkey	*Alouatta villosa*			2	2	4.88
Tapir	*Tapirus sp.*		1		1	2.44
Jaguar	*Felis onca*		1		1	2.44
Porcupine	*Coendu sp.*		1		1	2.44
Otter	*Lutra annectens*			1	1	2.44
Sm. unidentified rodent				1	1	2.44
					41	100.01

Reptiles and Amphibians from Selin: H-CN-5 (modified from Healy 1983:42).

Common Name	Scientific Name	E.S.	B.S.	T.S.	Total MNI	% of MNI
Iguana	Iguanidae	1	3	9	13	44.82
Sea turtle	Chelonidae		2	2	4	13.79
Green turtle	*Chelonia mydas*					
Crocodilians	Crocodylia	1	2	1	4	13.79
Crocodile	*Crocodylus sp.*					
Frogs/Toads	Anuran			2	4	13.79
Marine toad	*Bufo marinus*		2			
Mud turtle	*Kinosternon scorpiodes*		2		2	6.89
Pond turtle	*Chrysemys sp.*		2		2	6.89
					29	99.97

Birds from Selin: H-CN-5 (modified from Healy 1983: 42).

Common Name	Scientific Name	E.S.	B.S.	T.S.	Total MNI	% of MNI
Heron	Ardeidae		3	5	10	45
Great blue heron	*Ardea heroidas*			2		
Wood Stork	*Mycteria americana*		4	2	6	27
Turkeylike birds (guan, chachalaca)	Galliformes		2		2	9
Curassow	*Crax sp.*					
Shore birds (plover, Gull, snipe)	Charadriiformes		2		2	9
Cranelike birds (coot, Rail, trumpeter)	Gruiformes			1	1	5
Ducklike birds (duck, Goose, swan)	Anseriformes			1	1	5
					22	100

Unit A Fauna by NISP and Weight Percentages Throughout the Late to Early Polychrome and Zoned Bichrome Deposits at San Cristobal

Taxa	Late Polychrome		Middle Polychrome						Early Polychrome						Zoned Bichrome					
Note Column Units represent NISP % & Weighted % (g) Respectively	A20-30		A30-40		A40-50		A50-60		A60-70		A70-80		A80-90		A90-100		A100-110		A110-120	
Aves																				
Unidentified Bird	16.9	17.2	2.7	1.7			5.4	10.2									4.6	4	3.8	5.9
Caragyps atratus (Black Vulture)																				
Colinus virginianus (Bobwhite)																				
Egretta caerulea (Little Blue Heron)																				
Eudocinus sp. (Ibis)																				
Penelope sp. (Guan)	7.1	27.4							92.9	72.6										
Amphibia																				
Toad																				
Bufo marinus (Marine Toad)							28.6	45.5												
Rana sp. (Bullfrog)																				
Osteichthyes																				
Lepisosteiformes																				
Atractosteus tropicus (Tropical Gar)	8.9	6.9	7.4	4.7			0.4	1.5	8	9.5	2.7	1.5	15.2	22	9.9	9	5.4	5.5	9.3	8.5
Perciformes																				
Caranx hippos (Jackfish)	2.6	3.5	4.8	5			26.2	10.7	12.9	13	1.8	2.1					4.2	5.8	3.3	5.9
Cichlasoma sp. (Cichlid)	1.7	1.2	3.7	3.6			6.6	5.2	0.5	0.4	5	5.7	5.4	6.5	1	0.9	2.4	3.7	2.3	2.5
c.f. Mycteroperca sp. (Grouper)																				
Rachycentron sp. (Cobia)							7.7	11.9												
c.f. Sciaenidae sp. (Drum)			2.5	3			5.8	3.6	8.3	13.9			13.2	12.1			5	5.4	4.1	3.6
Siluriformes																				
c.f. Rhamdia sp. (Catfish)	6.9	7.1	2.3	1.7			4	3.3	2.9	2.8	8	9.7	28	20.6			5.1	6.2		

Taxa	**Late Polychrome**		**Middle Polychrome**						**Early Polychrome**						**Zoned Bichrome**					
Note Column Units represent NISP % & Weighted % (g) Respectively	A20-30		A30-40		A40-50		A50-60		A60-70		A70-80		A80-90		A90-100		A100-110		A110-120	
Reptilia																				
Unidentified Reptile																				
Crocodile																				
c.f. Crocodylus sp. (Am. Crocodile)																				
Iguana																				
Iguana iguana (Green Iguana)	0.8	3.8					20.3	13.2	3	4.8	4.5	2.9	6.8	5			5.3	11	6	9.6
Lizard																				
Ameiva festiva (C.A. Whiptail)																			100	100
Ophisaurus sp. (Glass Lizard)																				
Sceloporus sp. (Spiny Lizard)																	25	44.4	25	5.6
Snake																				
Agkistodon piscivorus (Cotton-mouth Moccasin)									2	2.7	2	2.7	30	30.2					2	3.4
c.f. Drymobius sp. (Racer)																				
Lampropeltis sp. (Tr. King Snake)																				
Natricinae sp. (Water Snake)											42.3	24.5								
Spilotes sp. (Rat Snake)									15.6	22.7	14.1	10.1					6.3	5.3		
Turtle																				
Chelydra sp. (Snapping Turtle)																	100	100		
Chrysemys sp. (Painted Turtle)	5.8	4.7	3.5	1.9	2.3	1.1	2.9	2.5	2.3	3.9	1.2	0.4			2.9	1.6				
Clemmys sp. (Pond Turtle)									1.5	5.7										
Kinosternon sp. (Mud Turtle)	16.3	12.5							8.2	3.6									4.1	1.2
Terrapene sp. (Box Turtle)			0.8	1	0.8	5	4.7	33.3	1.6	2.3	2.4	1.3					24	19.2	1.6	2

Taxa	Late Polychrome		Middle Polychrome						Early Polychrome						Zoned Bichrome					
Note Column Units represent NISP % & Weighted % (g) Respectively	A20-30		A30-40		A40-50		A50-60		A60-70		A70-80		A80-90		A90-100		A100-110		A110-120	
Mammalia																				
Unidentified Large Mammal	8.4	11.9	3.9	23.9			29	9.2	4	8.8	11.7	11.5	0.2	0.4					0.9	2.6
Odocoileus virginianus (W.T. Deer)	10.3	14.5	5.6	6.5	6.4	6.9	13.8	9.4	2.9	1.3			0.8	2.8	0.3	0.5	8.7	7.3	0.5	0.2
Mazama Americana (Rd.Br. Deer)					14.8	15.8														
Unidentified Small Mammal	10.5	13.3	11.8	12.5	6.6	7.9	5.4	6.8	21.9	15.8							4.9	6.9	4.3	5.9
Artiodactyla																				
Tayassu pecari (W.L. Peccary)							33.3	36.7			6.7	2					13.3	16.3		
Tayassu tajacu (Collared Peccary)	7.9	10.3	6.1	36.1					1.8	1.6			3.5	3.6			0.9	4.2		
Carnivora																				
Bassaricyon gabbii (Olingo)																				
Bassariscus astutus (Ringtail)							100	100												
Mustela frenata (L.-tailed Weasel)																	50	33.3		
Nasua narica (Coatimundi)	20.7	39.4					3.5	3.9									24.1	12.8		
Potos flavus (Kinkajou)	14.3	29.4	85.7	70.6																
Procyon lotor (Northern Raccoon)																				
Didelphimorphia																				
Didelphis marsupialis (Opossum)																				
Langomorpha																				
Sylvilagus sp. (Cottontail Rabbit)			7.1	6.1			7.1	6.1	21.4	19.7	7.1	1.5							7.1	4.6
Rodentia																				
Agouti paca (Paca)	20	33.3					80	66.7												
Dasyprocta punctata (C.A. Agouti)	85.7	33.3																		
Oryzomys sp. (Rice Rat)							1.5	1.6									6.1	8.2		
Sciurus sp. (Squirrel)																				
Xenarthra																				
Dasypus novemcinctus (Nine-banded Armadillo)	1.2	0.6	1.2	0.9	0.8	0.4									0.8	0.6	1.2	1.2	1.6	1.4
Mollusc	0.2	0.6													6.4	8.5	18.4	23.6	18.2	30.4
Nephronaias bivalve																				
Euglandina cylindracea																				
Pomacea flagelatta																				
Pachychilus sp.																				

Unit C Fauna by NISP and Weight Percentages Throughout the Late to Early Polychrome and Zoned Bichrome Deposits of San Cristobal

Taxa	Late Polychrome						Middle Polychrome						Early Polychrome				Zoned Bichrome					
Note Column Units represent NISP % & Weighted % (g) Respectively	C0-10		C10-20		C20-30		C30-40		C40-50		C50-60		C60-70		C70-90		C90-100		C100-110		C110-120	
Aves																						
Unidentified Bird									2.7	15.9	4.2	2.7	2.7	7.1	23.4	14.3	0.4	0.9			0.4	0.3
Caragyps atratus (Black Vulture)													100	100								
Colinus virginianus (Bob White)																						
Egretta caerulea (Little Blue Heron)																	42.9	50				
Eudocinus sp. (Ibis)																						
Penelope sp. (Guan)																						
Amphibia																						
Toad																						
Bufo marinus (Marine Toad)																						
Rana sp. (Bullfrog)											50	88.9					50	11.1				
Osteichthyes																						
Lepisosteiformes																						
Atractosteus osseus (Long-nose Gar)							0.4	0.3	1.9	0.9	0.6	4.4	4.7	5.8	2.5	5.0	8.9	9.9	2.1	1.5	0.2	0.2
Perciformes																						
Caranx hippos (Jack Fish)									0.2	0.4	6.1	10.9	4.5	5.3	15	17.2	4.7	7.9	0.6	0.6	1.7	1.9
Cichlasoma sp. (Cichlid Fish)									0.9	0.7	20.9	17.9	9.0	9.5	12.4	13.2	16.2	16.9	4.6	4.5	0.1	0.1
c.f. Mycteroperca sp. (Grouper)															75	75			25	25		
Rachycentron sp. (Cobia)									7.7	6					69.2	59.7	15.4	22.4				
c.f. Sciaenidae sp. (Drum Fish)											13.2	10.2	5	5.4	16.5	18	8.3	7.2	6.6	6.6		
Siluriformes																						
c.f. *Rhamdia sp.* (Cat Fish)											0.6	0.2			33.1	33.6					5.1	3.1

Taxa	Late Polychrome						Middle Polychrome						Early Polychrome				Zoned Bichrome					
Note Column Units represent NISP % & Weighted % (g) Respectively	C0-10		C10-20		C20-30		C30-40		C40-50		C50-60		C60-70		C70-90		C90-100		C100-110		C110-120	
Reptilia																						
Unidentified Reptile																						
Crocodile																						
Crocodylus acutus (American Crocodile)											100	100										
Iguana																						
Iguana iguana (Green Iguana)									1.5	0.8	4.5	1.9	5.3	6.7	18.8	17.5	10.5	9.1			0.8	0.5
Lizard																						
Ameiva festiva (Central American Whiptail)																						
Ophisaurus sp. (Glass Lizard)															100	100						
Scleroporus sp. (Spiny Lizard)									25	5.6	25	44.4										
Snake																						
Agkistodon piscivorus (Cotton-mouth Moccasin)									14	18.1			10	10.8	22	19.5	4	1.3			2	1.3
c.f. Drymobius sp. (Racer)															100	100						
Lampropeltis sp. (Tropical King Snake)															100	100						
Natricinae sp. (Water Snake)															3.9	2.1	53.8	73.4				
Spilotes sp. (Rat Snake)											28.1	24.6			14.1	11.1	9.4	5.8				
Turtle																						
Chelydra sp. (Snapping Turtle)																						
Chrysemys sp. (Painted Turtle)															53.2	75.8	19.1	6.8				
Clemmys sp. (Pond Turtle)													15.9	31.4	20.3	18.1						
Kinosternon sp. (Mud Turtle)									2.0	5.7	12.3	8.9			4.1	5.2			24.5	58.1		
Terrapene sp. (Box Turtle)											7.1	0.8			20.5	8.7	4.7	3.4	9.5	20.5	2.4	4.7

Taxa	**Late Polychrome**						**Middle Polychrome**						**Early Polychrome**				**Zoned Bichrome**					
Note Column Units represent NISP % & Weighted % (g) Respectively	C0-10		C10-20		C20-30		C30-40		C40-50		C50-60		C60-70		C70-90		C90-100		C100-110		C110-120	
Mammalia																						
Unidentified Large Mammal							0.2	0.2	7.1	6.4												
Odocoileus virginianus (White-tailed Deer)							0.5	0.1	2.9	1.9	3.4	4.6	0.8	0.2	28	24.3	9.5	7.4				
Mazama Americana (Red Brocket Deer)											54.8	58.7	20.9	13.3								
Unidentified Small Mammal							0.2	1.1	1.8	1.7	10.4	9.4	0.1	0.1	8.8	9.1	7.1	5.5			0.7	1.4
Artiodactyla																						
Tayassu pecari (White-lipped Peccary)											26.7	4.1			33.3	40.8						
Tayassu tajacu (Collared Peccary)													79.8	47.8								
Carnivora																						
Bassaricyon gabbii (Olingo)															100	100						
Bassariscus astutus (Ringtail)																						
Mustela frenata (Long-tailed Weasel)																						
Nasua narica (Coatimundi)											27.6	21.2			17.2	42.4						
Potos flavus (Kinkajou)																						
Procyon lotor (Northern Raccoon)											100	100										
Didelphimorphia																						
Didelphis marsupialis (Opossum)											50	41.1	25	52.1			25	6.8				
Langomorpha																						
Sylvilagus sp. (Cottontail Rabbit)											21.4	15.2			21.4	33.3	7.1	19.7				
Rodentia																						
Agouti paca (Paca)																						
Dasyprocta punctata (Central American Agouti)																	14.3	66.7				
Oryzomys sp. (Rice Rat)											34.9	32.8										
Sciurus sp. (Squirrel)											50	50										
Xenarthra																						
Dasypus novemcinctus (Nine-banded Armadillo)									2	1.6	1.6	0.2	0.4	3.9	45.5	45.5	33.3	35	2.0	2.6	0.8	0.9
Mollusc													0.9	1.4	1.1	0.4	12.9	8.9	17.8	13.6	5.3	3.2
Nephronaias bivalve																						
Euglandina cylindracea																						
Pomacea flagelatta																						
Pachychilus sp.																						

Unit D Fauna by NISP and Weight Percentages Throughout the Late to Early Polychrome and Zoned Bichrome Deposits of San Cristobal

Taxa	**Late Polychrome**						**Middle Polychrome**						**Early Polychrome**						**Zoned Bichrome**					
Note Column Units represent NISP % and Weighted % (g) Respectively	D0-10		D10-20		D20-30		D30-40		D40-50		D50-60		D60-70		D70-80		D80-90		D90-100		D100-110		D110-120	
Aves																								
Unidentified Bird													21.8	13.2			11.1	6.7						
Caragyps atratus (Black Vulture)																								
Colinus virginianus (Bob White)													100	100										
Egretta caerulea (Little Blue Heron)													57.1	15.4										
Eudocinus sp. (Ibis)													100	100										
Penelope sp. (Guan)																								
Amphibia																								
Toad																								
Bufo marinus (Marine Toad)													14.3	15.9			57.1	38.6						
Rana sp. (Bullfrog)																								
Osteichthyes																								
Lepisosteiformes																								
Lepisosteus osseus (Long-nose Gar)													0.2	0.1			5.6	3.1						
Perciformes																								
Caranx hippos (Jack Fish)													0.6	1.1										
Cichlasoma sp. (Cichlid Fish)																	10.8	8.7						
Mycteroperca sp. (Grouper)																	7.2	7.7						
Rachycentron sp. (Cobia)																								
Sciaenidae sp. (Drum Fish)													8.3	7.8			3.3	3						
Siluriformes																								
Rhamdia sp. (Cat Fish)													0.6	1			3.4	10.6						

Taxa	**Late Polychrome**						**Middle Polychrome**						**Early Polychrome**						**Zoned Bichrome**					
Note Column Units represent NISP % and Weighted % (g) Respectively	D0-10		D10-20		D20-30		D30-40		D40-50		D50-60		D60-70		D70-80		D80-90		D90-100		D100-110		D110-120	
Reptilia																								
Unidentified Reptile													100	100										
Anolis sp. (Anole)													100	100										
Crocodile																								
Crocodylus acutus (American Crocodile)																								
Iguana																								
Iguana iguana (Green Iguana)													4.5	6.2			7.5	7						
Lizard																								
Ameiva festiva (Central American Whiptail)																								
Ophisaurus sp. (Glass Lizard)																								
Scleroporus sp. (Spiny Lizard)																								
Snake																								
Agkistodon piscivorus (Cotton-mouth Moccasin)													6	2.7			6	7.4						
Drymobius sp. (Racer)																								
Lampropeltis sp. (Tropical King Snake)																								
Natricinae sp. (Water Snake)																								
Spilotes sp. (Rat Snake)													1.6	1			11	19.3						
Turtle																								
Chelydra sp. (Snapping Turtle)																								
Chrysemys sp. (Painted Turtle)													5.2	3			1.7	1.2						
Clemmys sp. (Pond Turtle)													15.9	7.6			46.4	37.1						
Kinosternon sp. (Mud Turtle)													28.6	4.8										
Terrapene sp. (Box Turtle)													8.7	7.5			11	15.7						

Taxa	**Late Polychrome**						**Middle Polychrome**						**Early Polychrome**						**Zoned Bichrome**					
Note Column Units represent NISP % and Weighted % (g) Respectively	D0-10		D10-20		D20-30		D30-40		D40-50		D50-60		D60-70		D70-80		D80-90		D90-100		D100-110		D110-120	
Mammalia																								
Unidentified Large Mammal													19.3	21.5			0.5	0.2						
Odocoileus virginianus (White-tailed Deer)													5.2	11.7										
Mazama Americana (Red Brocket Deer)																	9.6	12.2						
Unidentified Small Mammal													2.7	1.9			2.8	1.9						
Artiodactyla																								
Tayassu pecari (White-lipped Peccary)																								
Tayassu tajacu (Collared Peccary)																								
Carnivora																								
Bassaricyon gabbii (Olingo)																								
Bassariscus astutus (Ringtail)																								
Mustela frenata (Long-tailed Weasel)																	50	66.7						
Nasua narica (Coatimundi)																	6.9	15.8						
Potos flavus (Kinkajou)																								
Procyon lotor (Northern Raccoon)																								
Didelphimorphia																								
Didelphis marsupialis (Opossum)																								
Langomorpha																								
Sylvilagus sp. (Cottontail Rabbit)																								
Rodentia																								
Agouti paca (Paca)																								
Dasyprocta punctata (Central American Agouti)																								
Oryzomys sp. (Rice Rat)													12.1	14.8			45.5	42.6						
Sciurus sp. (Squirrel)													50	50										
Xenarthra																								
Dasypus novemcinctus (Nine-banded Armadillo)													0.8	1.2			3.5	3.6						
Mollusc																	2.6	2.9	16.2	6.5				
Nephronaias bivalve																								
Euglandina cylindracea																								
Pomacea flagelatta																								
Pachychilus sp.																								

Unit	Species (Common Name)	Bone	Qty	Wt (g)
A110-120	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebra	1	0.5
A60-70	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebra	1	0.4
A70-80	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebra	1	0.4
A80-90	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebrae Fragments2x Burnt	15	4.5
C110-120	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebra	1	0.2
C40-50	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebrae	7	2.7
C60-70	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebrae	5	1.6
C70-90	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Verterbrae 2xBurnt	11	2.9
C90-100	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertabrae	2	0.2
D60-70	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebrae	3	0.4
D80-90	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Maxilla with Teeth	1	0.7
D80-90	Agkistrodon piscivorus (Cotton-mouth Moccasin)	Vertebrae	2	0.4
A20-30	Agouti paca (Paca)	Phalange 1.3cm	1	0.5
A50-60	Agouti paca (Paca)	Teeth, 2x Mandible	4	1
A110-120	Ameiva festiva (Central American Whiptail)	Vertebrae-distinct wings unlike any other vertebrae in collection	1	1.9
D60-70	Anolis sp. (Anole)	Femur	1	0.1
A100-110	Atractosteus tropicus (Tropical Gar)	Scales	28	6.4
A110-120	Atractosteus tropicus (Tropical Gar)	Vertebra	6	1.6
A110-120	Atractosteus tropicus (Tropical Gar)	Scales	42	8.3
A20-30	Atractosteus tropicus (Tropical Gar)	Left Mandible Fragment	1	0.3
A20-30	Atractosteus tropicus (Tropical Gar)	Scales	15	2.3
A20-30	Atractosteus tropicus (Tropical Gar)	Scales	30	5.5
A30-40	Atractosteus tropicus (Tropical Gar)	Scales	38	5.5
A50-60	Atractosteus tropicus (Tropical Gar)	Mandible Fragments	2	1.7
A60-70	Atractosteus tropicus (Tropical Gar)	Vertebrae	5	3.4
A60-70	Atractosteus tropicus (Tropical Gar)	Scales	36	7.7
A70-80	Atractosteus tropicus (Tropical Gar)	Pharyngeal Arch	14	1.7
A80-90	Atractosteus tropicus (Tropical Gar)	Maxilla	1	1.8
A80-90	Atractosteus tropicus (Tropical Gar)	Mandible	1	6
A80-90	Atractosteus tropicus (Tropical Gar)	Vertebrae	12	6.4
A80-90	Atractosteus tropicus (Tropical Gar)	Scales	64	11.5
A90-100	Atractosteus tropicus (Tropical Gar)	Scales	51	10.5
C100-110	Atractosteus tropicus (Tropical Gar)	Scales	11	1.8
C110-120	Atractosteus tropicus (Tropical Gar)	Vertebra	1	0.2
C30-40	Atractosteus tropicus (Tropical Gar)	Scales	2	0.4

C40-50	Atractosteus tropicus (Tropical Gar)	Scales	10	1.1
C50-60	Atractosteus tropicus (Tropical Gar)	Scales	32	5.1
C60-70	Atractosteus tropicus (Tropical Gar)	Vertebrae	4	1.2
C60-70	Atractosteus tropicus (Tropical Gar)	Vertebrae	5	3.2
C60-70	Atractosteus tropicus (Tropical Gar)	Scales	15	2.4
C70-90	Atractosteus tropicus (Tropical Gar)	Fragment	1	0.3
C70-90	Atractosteus tropicus (Tropical Gar)	Scales	6	0.6
C70-90	Atractosteus tropicus (Tropical Gar)	Vertebrae	6	4.9
C90-100	Atractosteus tropicus (Tropical Gar)	Vertebrae	6	3.9
C90-100	Atractosteus tropicus (Tropical Gar)	Scales	8	1.7
C90-100	Atractosteus tropicus (Tropical Gar)	Scales	15	2.8
C90-100	Atractosteus tropicus (Tropical Gar)	Scales	17	3.2
D60-70	Atractosteus tropicus (Tropical Gar)	Vertebra	1	0.1
D80-90	Atractosteus tropicus (Tropical Gar)	Scales	29	3.6
C70-90	Bassaricyon gabbii (Olingo)	Humerus, Astrogalus, Phalange	3	1.6
A50-60	Bassariscus astutus (Ringtail)	Complete Left Humerus	1	0.6
A100-110	Beads	N/A	7	1.4
A110-120	Beads	N/A	4	0.1
C90-100	Beads	N/A	17	2.2
A50-60	Bufo marinus (Marine Toad)	Pelvis	1	1.8
A50-60	Bufo marinus (Marine Toad)	Vertebra Fragment	1	0.2
D60-70	Bufo marinus (Marine Toad)	Right Mandible Bone Fragment	1	0.7
D80-90	Bufo marinus (Marine Toad)	Fragment	1	0.3
D80-90	Bufo marinus (Marine Toad)	Angular Fragments	3	1.4
C60-70	Caragyps atratus (Black Vulture)	Ulna-Single row of prominent papillae	1	2.2
A100-110	Caranx hippos (Jackfish)	Vertebra	1	0.3
A100-110	Caranx hippos (Jackfish)	Preoperculum	2	0.8
A100-110	Caranx hippos (Jackfish)	Post Temporal	2	0.3
A100-110	Caranx hippos (Jackfish)	Burnt Mandible Fragments With Teeth	2	0.6
A100-110	Caranx hippos (Jackfish)	Maxilla (1 Complete, 1 Burnt)	5	1.5
A100-110	Caranx hippos (Jackfish)	Fragments including Articular	5	2.2
A100-110	Caranx hippos (Jackfish)	Fragments	156	20.7
A110-120	Caranx hippos (Jackfish)	Fragments	64	16.4
A110-120	Caranx hippos (Jackfish)	Vertebrae	74	10.5
A20-30	Caranx hippos (Jackfish)	Fragments	2	1.2
A20-30	Caranx hippos (Jackfish)	Fragments	27	3.5

A20-30	Caranx hippos (Jackfish)	Unidentified Bone Fragments except Pelvic Girdle	80	11
A30-40	Caranx hippos (Jackfish)	Vertebrae	28	3.2
A30-40	Caranx hippos (Jackfish)	Maxilla, Vomer, Fragments	171	19.3
A50-60	Caranx hippos (Jackfish)	Dentary	1	0.1
A50-60	Caranx hippos (Jackfish)	Mandible	1	0.2
A50-60	Caranx hippos (Jackfish)	Vertebrae	8	1.1
A50-60	Caranx hippos (Jackfish)	Fragments	11	2.5
A50-60	Caranx hippos (Jackfish)	Fragments	19	1.5
A50-60	Caranx hippos (Jackfish)	Fragments	1042	43.2
A60-70	Caranx hippos (Jackfish)	Fragments	103	15.1
A60-70	Caranx hippos (Jackfish)	Vertebrae	202	25.3
A60-70	Caranx hippos (Jackfish)	Fragments	230	18.3
A70-80	Caranx hippos (Jackfish)	Vertebra	1	0.4
A70-80	Caranx hippos (Jackfish)	Preoperculum	2	0.6
A70-80	Caranx hippos (Jackfish)	Vomer	3	1.4
A70-80	Caranx hippos (Jackfish)	Premaxilla	11	0.9
A70-80	Caranx hippos (Jackfish)	Post Temporal	14	0.9
A70-80	Caranx hippos (Jackfish)	Lateral Skull Fragment, Maxilla	15	1.5
A70-80	Caranx hippos (Jackfish)	Vomer, Mandible, Premaxilla	27	3.6
C100-110	Caranx hippos (Jackfish)	Vomer	3	0.7
C100-110	Caranx hippos (Jackfish)	Preoperculum	21	1.9
C110-120	Caranx hippos (Jackfish)	Caracoid Fragment	1	0.1
C110-120	Caranx hippos (Jackfish)	Vomer	1	0.4
C110-120	Caranx hippos (Jackfish)	Premaxilla	1	0.3
C110-120	Caranx hippos (Jackfish)	Articular, Angular	2	0.8
C110-120	Caranx hippos (Jackfish)	Quadrate	2	0.5
C110-120	Caranx hippos (Jackfish)	Post Temporal	2	0.2
C110-120	Caranx hippos (Jackfish)	Palatine	2	0.2
C110-120	Caranx hippos (Jackfish)	Dentary	2	0.5
C110-120	Caranx hippos (Jackfish)	Epihyal	2	0.1
C110-120	Caranx hippos (Jackfish)	Maxilla	2	0.1
C110-120	Caranx hippos (Jackfish)	Operculum	3	0.5
C110-120	Caranx hippos (Jackfish)	Spinous Process	5	0.5
C110-120	Caranx hippos (Jackfish)	Vertebrae	5	0.5
C110-120	Caranx hippos (Jackfish)	Fragments	42	4
C40-50	Caranx hippos (Jackfish)	Vertebra	1	1.6

C40-50	Caranx hippos (Jackfish)	Fragments, Mandible with Teeth	5	0.8
C50-60	Caranx hippos (Jackfish)	Premaxilla	3	0.4
C50-60	Caranx hippos (Jackfish)	Fragments	8	0.9
C50-60	Caranx hippos (Jackfish)	Premaxilla, Fragments	9	1.7
C50-60	Caranx hippos (Jackfish)	Fragments	234	46.5
C60-70	Caranx hippos (Jackfish)	Dentary, Vomer, Fragments	186	23.8
C70-90	Caranx hippos (Jackfish)	Mandible Fragments	4	1.2
C70-90	Caranx hippos (Jackfish)	Maxilla, Vomers, Fragments	13	1.6
C70-90	Caranx hippos (Jackfish)	Vertebrae	81	16.9
C70-90	Caranx hippos (Jackfish)	Fragments	522	58.2
C90-100	Caranx hippos (Jackfish)	Dentary	1	0.2
C90-100	Caranx hippos (Jackfish)	Vertebrae	20	9.4
C90-100	Caranx hippos (Jackfish)	Assorted	57	8
C90-100	Caranx hippos (Jackfish)	Mandible, Fragments	117	18
D60-70	Caranx hippos (Jackfish)	Vomer	1	0.4
D60-70	Caranx hippos (Jackfish)	Fragments	7	2
D60-70	Caranx hippos (Jackfish)	Fragments	15	2.5
D80-90	Caranx hippos (Jackfish)	Vomer	1	0.1
D80-90	Caranx hippos (Jackfish)	Angular	1	0.5
D80-90	Caranx hippos (Jackfish)	Lachrymal	1	0.2
D80-90	Caranx hippos (Jackfish)	Operculum	2	0.2
D80-90	Caranx hippos (Jackfish)	Maxilla	4	0.6
D80-90	Caranx hippos (Jackfish)	Articular	4	0.5
D80-90	Caranx hippos (Jackfish)	Quadrate	4	1
D80-90	Caranx hippos (Jackfish)	Mandible	5	1
D80-90	Caranx hippos (Jackfish)	Premaxilla	31	4.3
D80-90	Caranx hippos (Jackfish)	Fragment	89	7.8
D80-90	Caranx hippos (Jackfish)	Fragments, Vomer	306	23.6
A30-40	Ceramic	Fragments	2	
A100-110	Chelydra sp. (Snapping Turtle)	Vertebra	1	1.4
A20-30	Chrysemys sp. (Painted Turtle)	Carapace	10	3.7
A30-40	Chrysemys sp. (Painted Turtle)	Carapace	6	3.6
A40-50	Chrysemys sp. (Painted Turtle)	Carapace	4	2.1
A50-60	Chrysemys sp. (Painted Turtle)	Carapace	5	4.7
A60-70	Chrysemys sp. (Painted Turtle)	Carapace	4	7.4
A70-80	Chrysemys sp. (Painted Turtle)	Carapace	2	0.7

A90-100	Chrysemys sp. (Painted Turtle)	Carapace	5	3.1
C70-90	Chrysemys sp. (Painted Turtle)	Carapace	4	1.5
C70-90	Chrysemys sp. (Painted Turtle)	Long Bone Fragments	10	1.5
C70-90	Chrysemys sp. (Painted Turtle)	Carapace	78	140.2
C90-100	Chrysemys sp. (Painted Turtle)	Carapace	6	5.1
C90-100	Chrysemys sp. (Painted Turtle)	Carapace	7	3
C90-100	Chrysemys sp. (Painted Turtle)	Long Bones, Pubis, Scapula Fragment	20	4.8
D60-70	Chrysemys sp. (Painted Turtle)	Carapace	9	5.7
D80-90	Chrysemys sp. (Painted Turtle)	Carapace	3	2.2
A100-110	Cichlasoma sp. (Cichlid)	Dorsal Spines	2	0.1
A100-110	Cichlasoma sp. (Cichlid)	Spinous Process	42	3.7
A100-110	Cichlasoma sp. (Cichlid)	Vertebrae	141	24.4
A110-120	Cichlasoma sp. (Cichlid)	Maxilla	8	1.4
A110-120	Cichlasoma sp. (Cichlid)	Dorsal Spines	55	5.2
A110-120	Cichlasoma sp. (Cichlid)	Premaxilla, Fragments, Vomer	119	12.2
A20-30	Cichlasoma sp. (Cichlid)	Lachrymal	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Angular	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Parietal	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Epihyal	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Post Frontal	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Hyomandibular	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Hypohyal	1	0.1
A20-30	Cichlasoma sp. (Cichlid)	Parasphenoid	2	0.3
A20-30	Cichlasoma sp. (Cichlid)	Frontal	2	0.1
A20-30	Cichlasoma sp. (Cichlid)	Premaxilla	2	0.1
A20-30	Cichlasoma sp. (Cichlid)	Fragments	2	0.1
A20-30	Cichlasoma sp. (Cichlid)	Sqamosal	3	0.2
A20-30	Cichlasoma sp. (Cichlid)	Post Temporal	3	0.1
A20-30	Cichlasoma sp. (Cichlid)	Mandible Fragment With Teeth	3	0.4
A20-30	Cichlasoma sp. (Cichlid)	Operculum	4	0.2
A20-30	Cichlasoma sp. (Cichlid)	Unidentified Bone Fragments	15	0.3
A20-30	Cichlasoma sp. (Cichlid)	Dorsal Spines	16	1
A20-30	Cichlasoma sp. (Cichlid)	Vertebrae	20	1.1
A20-30	Cichlasoma sp. (Cichlid)	Dorsal Spines	55	4.2
A30-40	Cichlasoma sp. (Cichlid)	Vomer	6	0.6
A30-40	Cichlasoma sp. (Cichlid)	Dorsal Spines	8	0.7

A30-40	Cichlasoma sp. (Cichlid)	Spinous Process	44	3.7
A30-40	Cichlasoma sp. (Cichlid)	Vertebrae	228	22
A50-60	Cichlasoma sp. (Cichlid)	Dentary	1	0.1
A50-60	Cichlasoma sp. (Cichlid)	Basibranchiostegal	1	0.1
A50-60	Cichlasoma sp. (Cichlid)	Quadrate	1	0.1
A50-60	Cichlasoma sp. (Cichlid)	Lateral Skull Fragment	1	0.1
A50-60	Cichlasoma sp. (Cichlid)	Parasphenoid	3	0.3
A50-60	Cichlasoma sp. (Cichlid)	Pharyngeal Arches	3	0.2
A50-60	Cichlasoma sp. (Cichlid)	Preoperculum	4	0.2
A50-60	Cichlasoma sp. (Cichlid)	Operculum	4	0.2
A50-60	Cichlasoma sp. (Cichlid)	Dorsal Spines	5	0.2
A50-60	Cichlasoma sp. (Cichlid)	Dorsal Spines	11	0.8
A50-60	Cichlasoma sp. (Cichlid)	Vertebrae	478	37.1
A60-70	Cichlasoma sp. (Cichlid)	Dorsal Spines	37	3
A70-80	Cichlasoma sp. (Cichlid)	Dorsal Spines	4	0.6
A70-80	Cichlasoma sp. (Cichlid)	Dorsal Spines	5	0.3
A70-80	Cichlasoma sp. (Cichlid)	Spinous Process	88	7.3
A70-80	Cichlasoma sp. (Cichlid)	Vertebrae	295	34.6
A80-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	17	1.1
A80-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	57	5.5
A80-90	Cichlasoma sp. (Cichlid)	Vertebrae	342	41.8
A90-100	Cichlasoma sp. (Cichlid)	Dorsal Spines	79	6.9
C100-110	Cichlasoma sp. (Cichlid)	Dorsal Spines	12	0.8
C100-110	Cichlasoma sp. (Cichlid)	Spinous Process	96	6.8
C100-110	Cichlasoma sp. (Cichlid)	Dorsal Spines	96	6.9
C100-110	Cichlasoma sp. (Cichlid)	Vertebrae	157	19.2
C110-120	Cichlasoma sp. (Cichlid)	Dorsal Spines	11	0.9
C40-50	Cichlasoma sp. (Cichlid)	Spinous Process	3	0.2
C40-50	Cichlasoma sp. (Cichlid)	Fragments, Pharyngeal Arch	5	0.6
C40-50	Cichlasoma sp. (Cichlid)	Vertebrae	63	4.2
C50-60	Cichlasoma sp. (Cichlid)	Dorsal Spines	18	1.2
C50-60	Cichlasoma sp. (Cichlid)	Spinous Process	130	9.7
C50-60	Cichlasoma sp. (Cichlid)	Vertebrae	732	61.8
C50-60	Cichlasoma sp. (Cichlid)	Vertebrae	749	62.1
C60-70	Cichlasoma sp. (Cichlid)	Vomer, Dorsal Spines	15	1.1
C60-70	Cichlasoma sp. (Cichlid)	Spinous Process	67	5.5

C60-70	Cichlasoma sp. (Cichlid)	Vertebrae	306	32.2
C60-70	Cichlasoma sp. (Cichlid)	Vertebrae	313	33.1
C70-90	Cichlasoma sp. (Cichlid)	Mandibular	7	1.2
C70-90	Cichlasoma sp. (Cichlid)	Fragments including Vomer and Mandible	10	2.6
C70-90	Cichlasoma sp. (Cichlid)	Spinous Process	44	3
C70-90	Cichlasoma sp. (Cichlid)	Dorsal Spines, Fragments	58	4.2
C70-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	61	14
C70-90	Cichlasoma sp. (Cichlid)	Vertebrae	787	74.8
C90-100	Cichlasoma sp. (Cichlid)	Vomer	14	2
C90-100	Cichlasoma sp. (Cichlid)	Dorsal Spines, Mandible	15	1.6
C90-100	Cichlasoma sp. (Cichlid)	Dorsal Spines	21	0.8
C90-100	Cichlasoma sp. (Cichlid)	Spinous Process	173	13.7
C90-100	Cichlasoma sp. (Cichlid)	Dorsal Spines	176	13.8
C90-100	Cichlasoma sp. (Cichlid)	Vertebrae	430	47.6
C90-100	Cichlasoma sp. (Cichlid)	Vertebrae	431	47.7
D80-90	Cichlasoma sp. (Cichlid)	Post Temporal	1	0.2
D80-90	Cichlasoma sp. (Cichlid)	Preoperculum	1	0.2
D80-90	Cichlasoma sp. (Cichlid)	Vertebra	1	0.1
D80-90	Cichlasoma sp. (Cichlid)	Mandible	2	0.4
D80-90	Cichlasoma sp. (Cichlid)	Lachrymal	2	0.1
D80-90	Cichlasoma sp. (Cichlid)	Mandible	2	0.2
D80-90	Cichlasoma sp. (Cichlid)	Articular	3	0.1
D80-90	Cichlasoma sp. (Cichlid)	Premaxilla	4	0.3
D80-90	Cichlasoma sp. (Cichlid)	Operculum	5	0.8
D80-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	6	0.6
D80-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	9	0.6
D80-90	Cichlasoma sp. (Cichlid)	Parietal	17	1.1
D80-90	Cichlasoma sp. (Cichlid)	Dorsal Spines	23	1.2
D80-90	Cichlasoma sp. (Cichlid)	Fragment	25	1.8
D80-90	Cichlasoma sp. (Cichlid)	Vertebrae	457	50.4
A60-70	Clemmys sp. (Pond Turtle)	Beak Fragment	1	0.6
C60-70	Clemmys sp. (Pond Turtle)	Fragments	5	2
C60-70	Clemmys sp. (Pond Turtle)	Carapace	6	1.3
C70-90	Clemmys sp. (Pond Turtle)	Vertebrae	14	1.9
D60-70	Clemmys sp. (Pond Turtle)	Innominate Bone	1	0.1
D60-70	Clemmys sp. (Pond Turtle)	Phalanges	10	0.7

D80-90	Clemmys sp. (Pond Turtle)	Carapace	1	0.1
D80-90	Clemmys sp. (Pond Turtle)	Carapace	2	0.4
D80-90	Clemmys sp. (Pond Turtle)	Skull Bone Fragments	4	1
D80-90	Clemmys sp. (Pond Turtle)	Vertebrae	6	0.8
D80-90	Clemmys sp. (Pond Turtle)	Fragments	6	0.6
D80-90	Clemmys sp. (Pond Turtle)	Long Bones	13	1
D60-70	Colinus virginianus (BobWhite)	Caracoid Fragment	1	0.2
C90-100	Crab Claw	Claw	1	0.2
C50-60	Crocodylus acutus (American Crocodile)	Dermal Scute Fragment	1	0.5
A20-30	Dasyprocta punctata (Central American Agouti)	Fragments	6	0.2
C90-100	Dasyprocta punctata (Central American Agouti)	Right Ulna	1	0.4
A100-110	Dasypus novemcinctus (Nine-banded Armadillo)	Osteoderms	3	0.8
A110-120	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderm	1	0.3
A110-120	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	3	0.7
A20-30	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	3	0.4
A30-40	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	3	0.6
A40-50	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	2	0.3
A90-100	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	2	0.4
C100-110	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	5	1.8
C110-120	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	2	0.6
C40-50	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	5	1.1
C50-60	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	4	0.6
C60-70	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	10	2.7
C70-90	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	9	2.1
C70-90	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	35	9.6
C70-90	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	36	9.9
C70-90	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	36	10
C90-100	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	3	0.4
C90-100	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	41	11.9
C90-100	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	41	12
D60-70	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	2	0.8
D80-90	Dasypus novemcinctus (Nine-banded Armadillo)	Imbricating Osteoderms	9	2.5
C50-60	Didelphis marsupialis (Opossum)	Maxilla	1	2.3
C50-60	Didelphis marsupialis (Opossum)	Scapula	1	0.7
C60-70	Didelphis marsupialis (Opossum)	Maxilla	1	3.8
C90-100	Didelphis marsupialis (Opossum)	Partial Maxilla	1	0.5

C70-90	Drymobius sp. (Racer Snakes)	Vertebrae	7	1.8
C90-100	Egretta caerulea (Little Blue Heron)	Tibiotarsus	3	1.3
D60-70	Egretta caerulea (Little Blue Heron)	Tibiotarsus	1	0.3
D60-70	Egretta caerulea (Little Blue Heron)	Tarsometatarsus	3	1
D60-70	Eudocimus sp. (Ibis)	Tarsometatarsus	2	0.2
D60-70	Eudocimus sp. (Ibis)	Tibiotarsus	3	0.4
A100-110	Iguana iguana (Green Iguana)	Left Maxilla	1	0.4
A100-110	Iguana iguana (Green Iguana)	Parietal	1	0.3
A100-110	Iguana iguana (Green Iguana)	Right Mandible with Teeth	1	2.2
A100-110	Iguana iguana (Green Iguana)	Vertebrae	4	1.7
A110-120	Iguana iguana (Green Iguana)	Vertebrae	1	0.5
A110-120	Iguana iguana (Green Iguana)	Vertebra, Maxilla with Teeth	3	2.6
A110-120	Iguana iguana (Green Iguana)	Vertebrae	4	0.9
A20-30	Iguana iguana (Green Iguana)	Right Mandible with Teeth	1	1.6
A50-60	Iguana iguana (Green Iguana)	Vertebrae	27	5.5
A60-70	Iguana iguana (Green Iguana)	Vertebrae	1	1.3
A60-70	Iguana iguana (Green Iguana)	Parietal, Vertebrae	3	0.7
A70-80	Iguana iguana (Green Iguana)	Vertebrae	6	1.2
A80-90	Iguana iguana (Green Iguana)	Vertebrae	2	0.3
A80-90	Iguana iguana (Green Iguana)	Vertebrae	3	1.1
A80-90	Iguana iguana (Green Iguana)	Maxilla, Mandibular	4	0.7
C110-120	Iguana iguana (Green Iguana)	Vertebra	1	0.2
C40-50	Iguana iguana (Green Iguana)	Vertebrae	2	0.3
C50-60	Iguana iguana (Green Iguana)	Vertebra	1	0.1
C50-60	Iguana iguana (Green Iguana)	Left Maxilla Fragment	1	0.2
C50-60	Iguana iguana (Green Iguana)	Vertebrae Fragments	4	0.5
C60-70	Iguana iguana (Green Iguana)	Long Bone	1	0.4
C60-70	Iguana iguana (Green Iguana)	Maxilla	3	0.6
C60-70	Iguana iguana (Green Iguana)	Vertebrae	3	1.8
C70-90	Iguana iguana (Green Iguana)	Left Mandible with Teeth	1	0.5
C70-90	Iguana iguana (Green Iguana)	Maxilla	2	0.2
C70-90	Iguana iguana (Green Iguana)	Parietal, Postorbital	3	1
C70-90	Iguana iguana (Green Iguana)	Vertebrae	19	5.6
C90-100	Iguana iguana (Green Iguana)	Vertebra Fragment	1	0.7
C90-100	Iguana iguana (Green Iguana)	Frontal	1	0.2
C90-100	Iguana iguana (Green Iguana)	Mandibular	2	0.7

C90-100	Iguana iguana (Green Iguana)	Long Bone	3	0.6
C90-100	Iguana iguana (Green Iguana)	Mandible, Vertebrae	7	1.6
D60-70	Iguana iguana (Green Iguana)	Left Mandible	1	1.7
D60-70	Iguana iguana (Green Iguana)	Vertebrae	5	0.9
D80-90	Iguana iguana (Green Iguana)	Vertebrae	5	2.1
D80-90	Iguana iguana (Green Iguana)	Mandible and Maxilla Fragments	5	0.8
A110-120	Kinosternon sp. (Mud Turtle)	Vertebrae	2	0.3
A20-30	Kinosternon sp. (Mud Turtle)	Carapace	1	2
A20-30	Kinosternon sp. (Mud Turtle)	Long Bones	7	1.1
A60-70	Kinosternon sp. (Mud Turtle)	Long Bone Fragments	4	0.9
C100-110	Kinosternon sp. (Mud Turtle)	Carapace	12	14.4
C40-50	Kinosternon sp. (Mud Turtle)	Carapace	1	1.4
C50-60	Kinosternon sp. (Mud Turtle)	Carapace	6	2.2
C70-90	Kinosternon sp. (Mud Turtle)	Plastron	1	1.2
C70-90	Kinosternon sp. (Mud Turtle)	Vertebra	1	0.1
D60-70	Kinosternon sp. (Mud Turtle)	Innominate Bone Fragment	1	0.1
D60-70	Kinosternon sp. (Mud Turtle)	Beak Fragment	1	0.1
D60-70	Kinosternon sp. (Mud Turtle)	Ulnas	2	0.1
D60-70	Kinosternon sp. (Mud Turtle)	Long Bones	10	0.9
C70-90	Lampropeltis sp. (Tropical King Snake)	Vertebrae	2	0.6
C30-40	Lithic	N/A	2	
A40-50	Mazama americana (Red Brocket Deer)	Fragments	17	16.6
C50-60	Mazama americana (Red Brocket Deer)	Modified Ribs, Fragments	63	61.9
C60-70	Mazama americana (Red Brocket Deer)	First Phalange, Fragments	24	14
D80-90	Mazama americana (Red Brocket Deer)	Phalange	1	1.5
D80-90	Mazama americana (Red Brocket Deer)	Fragments	10	11.4
A100-110	Mustela frenata (Long-tailed Weasle)	Ulna	1	0.1
D80-90	Mustela frenata (Long-tailed Weasle)	Tooth	1	0.2
C100-110	Mycteroperca sp. (Grouper)	Large Vertebra	1	3.1
C70-90	Mycteroperca sp. (Grouper)	Vertebrae	3	9.3
A100-110	Nasua narica (Coatimundi)	Premolar	1	0.3
A100-110	Nasua narica (Coatimundi)	Fragments including Phalanges and Humerus	6	2.3
A20-30	Nasua narica (Coatimundi)	Carpal Bone	1	0.4
A20-30	Nasua narica (Coatimundi)	Claws and Teeth	5	0.4
A50-60	Nasua narica (Coatimundi)	Ulna	1	0.8
C50-60	Nasua narica (Coatimundi)	Upper Dentition	8	4.3

C70-90	Nasua narica (Coatimundi)	Claw	1	0.3
C70-90	Nasua narica (Coatimundi)	Tibia	1	1.6
C70-90	Nasua narica (Coatimundi)	Right Femur	1	3.8
C70-90	Nasua narica (Coatimundi)	Humerus, Phalange	2	2.9
D80-90	Nasua narica (Coatimundi)	Vertebra	1	1.9
D80-90	Nasua narica (Coatimundi)	Femoral Head	1	1.3
A70-80	Natricinae sp. (Water Snake)	Vertebrae	11	2.3
C70-90	Natricinae sp. (Water Snake)	Vertebra	1	0.2
C90-100	Natricinae sp. (Water Snake)	Vertebrae	14	6.9
A100-110	Obsidian	N/A	9	5
A110-120	Obsidian	Fragments	2	
C100-110	Obsidian	Fragments	4	
C90-100	Obsidian	N/A	16	15
C90-100	Obsidian	Fragments	16	
A90-100	Obsidian Flakes	N/A	10	3.9
A20-30	Odocoileus virginianus (White Tailed Deer)	Tooth Fragment	1	0.2
A20-30	Odocoileus virginianus (White Tailed Deer)	Left Astragalus	1	8
A20-30	Odocoileus virginianus (White Tailed Deer)	Left Tibia	2	3.7
A100-110	Odocoileus virginianus (White-Tailed Deer)	Unciform	1	1.4
A100-110	Odocoileus virginianus (White-Tailed Deer)	Calcaneum Fragment	1	1.9
A100-110	Odocoileus virginianus (White-Tailed Deer)	Second Phalange	1	0.6
A100-110	Odocoileus virginianus (White-Tailed Deer)	Right Femur Fragment	1	15.7
A100-110	Odocoileus virginianus (White-Tailed Deer)	Premolar	2	1.1
A100-110	Odocoileus virginianus (White-Tailed Deer)	Teeth	2	3.9
A100-110	Odocoileus virginianus (White-Tailed Deer)	Fragments	2	13
A100-110	Odocoileus virginianus (White-Tailed Deer)	Modified and Polished Long Bone Fragments	4	5.8
A100-110	Odocoileus virginianus (White-Tailed Deer)	Fragments	4	6.4
A100-110	Odocoileus virginianus (White-Tailed Deer)	Fragments	15	23.3
A110-120	Odocoileus virginianus (White-Tailed Deer)	Phalange	1	1.8
A110-120	Odocoileus virginianus (White-Tailed Deer)	Tooth	1	0.4
A20-30	Odocoileus virginianus (White-Tailed Deer)	Calcaneum Fragment	1	6
A20-30	Odocoileus virginianus (White-Tailed Deer)	Humerus	1	3.5
A20-30	Odocoileus virginianus (White-Tailed Deer)	Left Femur	1	4.2
A20-30	Odocoileus virginianus (White-Tailed Deer)	Cuboid Fragment	1	1.2
A20-30	Odocoileus virginianus (White-Tailed Deer)	Innominate	1	9.9
A20-30	Odocoileus virginianus (White-Tailed Deer)	Radius	2	18.1

A20-30	Odocoileus virginianus (White-Tailed Deer)	Right Tibia Fragment	2	8.2
A20-30	Odocoileus virginianus (White-Tailed Deer)	Phalanges	3	10.6
A20-30	Odocoileus virginianus (White-Tailed Deer)	Antler	4	6.2
A20-30	Odocoileus virginianus (White-Tailed Deer)	Antler Fragments	4	16.1
A20-30	Odocoileus virginianus (White-Tailed Deer)	Long Bone Fragments	15	50.4
A30-40	Odocoileus virginianus (White-Tailed Deer)	Antler Fragment	1	3.4
A30-40	Odocoileus virginianus (White-Tailed Deer)	Scapula Fragment	1	2
A30-40	Odocoileus virginianus (White-Tailed Deer)	Scaphoid Carpal Bone	1	2.1
A30-40	Odocoileus virginianus (White-Tailed Deer)	Antler Fragment	2	4.2
A30-40	Odocoileus virginianus (White-Tailed Deer)	Left Metatarsal Fragments, Phalange	4	7.4
A30-40	Odocoileus virginianus (White-Tailed Deer)	Teeth	5	7
A30-40	Odocoileus virginianus (White-Tailed Deer)	Long Bone Fragments	7	39.7
A40-50	Odocoileus virginianus (White-Tailed Deer)	Rib Fragment	1	1.5
A40-50	Odocoileus virginianus (White-Tailed Deer)	Metatarsus	1	4.9
A40-50	Odocoileus virginianus (White-Tailed Deer)	Fragment	1	6.1
A40-50	Odocoileus virginianus (White-Tailed Deer)	Right Humerus Fragment	1	6.4
A40-50	Odocoileus virginianus (White-Tailed Deer)	Left Phalanges	1	1.2
A40-50	Odocoileus virginianus (White-Tailed Deer)	Tooth	1	0.4
A40-50	Odocoileus virginianus (White-Tailed Deer)	Left Metatarsus	2	3.3
A40-50	Odocoileus virginianus (White-Tailed Deer)	Phalanges	2	5
A40-50	Odocoileus virginianus (White-Tailed Deer)	Innominate	4	2.3
A40-50	Odocoileus virginianus (White-Tailed Deer)	Long Bone Fragments	10	38.4
A50-60	Odocoileus virginianus (White-Tailed Deer)	Tooth	1	0.7
A50-60	Odocoileus virginianus (White-Tailed Deer)	Right Humerus Fragment	1	4.3
A50-60	Odocoileus virginianus (White-Tailed Deer)	Phalange	1	1.4
A50-60	Odocoileus virginianus (White-Tailed Deer)	Left Scapula Fragment	1	7.2
A50-60	Odocoileus virginianus (White-Tailed Deer)	Right Radius Fragment	1	5.5
A50-60	Odocoileus virginianus (White-Tailed Deer)	Metatarsus Fragments	2	3.7
A50-60	Odocoileus virginianus (White-Tailed Deer)	Antler	11	6.7
A50-60	Odocoileus virginianus (White-Tailed Deer)	Fragments	13	32.2
A50-60	Odocoileus virginianus (White-Tailed Deer)	Fragments	21	33
A60-70	Odocoileus virginianus (White-Tailed Deer)	Fragments	11	13.4
A80-90	Odocoileus virginianus (White-Tailed Deer)	Rib	1	2.6
A80-90	Odocoileus virginianus (White-Tailed Deer)	Femur	1	7
A80-90	Odocoileus virginianus (White-Tailed Deer)	Calcaneum	1	18.3
A90-100	Odocoileus virginianus (White-Tailed Deer)	Right Calcaneum Fragment	1	5.4

C30-40	Odocoileus virginianus (White-Tailed Deer)	Phalange	1	1.2
C30-40	Odocoileus virginianus (White-Tailed Deer)	Modified and Polished Long Bone Fragment	1	1.6
C40-50	Odocoileus virginianus (White-Tailed Deer)	Metatarsus	1	1
C40-50	Odocoileus virginianus (White-Tailed Deer)	Fragments	10	18.2
C50-60	Odocoileus virginianus (White-Tailed Deer)	Rib	1	1.8
C50-60	Odocoileus virginianus (White-Tailed Deer)	Tibia	1	3.7
C50-60	Odocoileus virginianus (White-Tailed Deer)	R. Radius	1	11.2
C50-60	Odocoileus virginianus (White-Tailed Deer)	Metatarsus	1	1.2
C50-60	Odocoileus virginianus (White-Tailed Deer)	L. Metatarsus	2	6.2
C50-60	Odocoileus virginianus (White-Tailed Deer)	Antler	3	9
C50-60	Odocoileus virginianus (White-Tailed Deer)	Modified Fragments	4	12.9
C60-70	Odocoileus virginianus (White-Tailed Deer)	Phalange	1	0.8
C60-70	Odocoileus virginianus (White-Tailed Deer)	Dentary Fragments	2	0.7
C70-90	Odocoileus virginianus (White-Tailed Deer)	Tooth Fragment	1	0.2
C70-90	Odocoileus virginianus (White-Tailed Deer)	Disiform carpal	1	0.8
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Metatarsus	1	3.1
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Humerus Fragment	1	3.2
C70-90	Odocoileus virginianus (White-Tailed Deer)	Right Femur	1	33.9
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Astragalus Fragment	1	12.3
C70-90	Odocoileus virginianus (White-Tailed Deer)	Right Calcaneum Fragment	1	11.1
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Calcaneum Fragment	1	7.7
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Tibia	1	7.8
C70-90	Odocoileus virginianus (White-Tailed Deer)	Humerus Fragment	1	3.2
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Humerus Fragment	1	11
C70-90	Odocoileus virginianus (White-Tailed Deer)	Vertebrae	2	5.7
C70-90	Odocoileus virginianus (White-Tailed Deer)	Phalanges	3	9.9
C70-90	Odocoileus virginianus (White-Tailed Deer)	Left Phalanges	3	9.5
C70-90	Odocoileus virginianus (White-Tailed Deer)	Teeth Fragments	3	0.9
C70-90	Odocoileus virginianus (White-Tailed Deer)	Modified Long Bone Fragments Polished	8	40.7
C70-90	Odocoileus virginianus (White-Tailed Deer)	Fragments	76	83.5
C90-100	Odocoileus virginianus (White-Tailed Deer)	Left Radius	1	13.5
C90-100	Odocoileus virginianus (White-Tailed Deer)	Vertebrae	2	11.2
C90-100	Odocoileus virginianus (White-Tailed Deer)	Teeth	2	1.2
C90-100	Odocoileus virginianus (White-Tailed Deer)	Fragments	10	24.8
C90-100	Odocoileus virginianus (White-Tailed Deer)	Fragments	21	23.3
D60-70	Odocoileus virginianus (White-Tailed Deer)	Large Left Femur Fragment	1	17.4

D60-70	Odocoileus virginianus (White-Tailed Deer)	Right Phalange	1	3
D60-70	Odocoileus virginianus (White-Tailed Deer)	Maxillary Fragment With Embedded Tooth Roots	1	9.2
D60-70	Odocoileus virginianus (White-Tailed Deer)	Long Bone Fragments	2	34
D60-70	Odocoileus virginianus (White-Tailed Deer)	Antler Fragment	2	2
D60-70	Odocoileus virginianus (White-Tailed Deer)	Sacrum, Fragments	2	5.7
D60-70	Odocoileus virginianus (White-Tailed Deer)	Antler Fragments	10	46.7
D80-90	Odocoileus virginianus (White-Tailed Deer)	Antler Fragment	2	2.2
C70-90	Ophisaurus sp. (Glass Lizard)	Vertebra	1	0.5
A100-110	Oryzomys sp. (Rice Rat)	Hind Limb	1	0.2
A100-110	Oryzomys sp. (Rice Rat)	Vertebrae	3	0.3
A50-60	Oryzomys sp. (Rice Rat)	Tooth	1	0.1
C50-60	Oryzomys sp. (Rice Rat)	Maxilla with Teeth	3	0.4
C50-60	Oryzomys sp. (Rice Rat)	Fragments, Ribs	20	1.6
D60-70	Oryzomys sp. (Rice Rat)	Ribs	8	0.9
D80-90	Oryzomys sp. (Rice Rat)	Ribs	8	0.1
D80-90	Oryzomys sp. (Rice Rat)	Phalanges, Rib, Fragments	22	2.5
A20-30	Penelope sp. (Guan)	Sternum	1	2.6
A60-70	Penelope sp. (Guan)	Tibia	13	6.9
A20-30	Potos flavus (Kinkajou)	Right Humerus Fragment	1	1
A30-40	Potos flavus (Kinkajou)	Dentary	6	2.4
C50-60	Procyon lotor (Northern Raccoon)	Caudal Vertebra, Long Bones	4	1
A50-60	Rachycentron sp. (Cobia)	Articular	1	0.8
C40-50	Rachycentron sp. (Cobia)	Articular	1	0.4
C70-90	Rachycentron sp. (Cobia)	Articular, Fragments	9	4
C90-100	Rachycentron sp. (Cobia)	Articular	2	1.5
C50-60	Rana sp. (Bullfrog)	Vertebra	1	0.8
C90-100	Rana sp. (Bullfrog)	Pterygoid	1	0.1
A100-110	Rhamdia sp. (Catfish)	Maxilla with Teeth, Fragments	9	2.6
A20-30	Rhamdia sp. (Catfish)	Pelvic Girdle	1	0.3
A20-30	Rhamdia sp. (Catfish)	Mandible	1	0.3
A20-30	Rhamdia sp. (Catfish)	Operculum	2	0.3
A20-30	Rhamdia sp. (Catfish)	Lachrymal	3	0.3
A20-30	Rhamdia sp. (Catfish)	Fragments	5	1.8
A30-40	Rhamdia sp. (Catfish)	Mandible, Fragments	4	0.7
A50-60	Rhamdia sp. (Catfish)	Dentary	1	0.1
A50-60	Rhamdia sp. (Catfish)	Pectoral Spine	1	0.2

A50-60	Rhamdia sp. (Catfish)	Fragments	2	0.6
A50-60	Rhamdia sp. (Catfish)	Fragments	3	0.5
A60-70	Rhamdia sp. (Catfish)	Vertebrae	5	1.2
A70-80	Rhamdia sp. (Catfish)	Pectoral Spine	1	0.3
A70-80	Rhamdia sp. (Catfish)	Parasphenoid	4	1.4
A70-80	Rhamdia sp. (Catfish)	Fragments	9	2.4
A80-90	Rhamdia sp. (Catfish)	Dentary	10	3.1
A80-90	Rhamdia sp. (Catfish)	Preoperculum	39	5.6
C110-120	Rhamdia sp. (Catfish)	Vertebrae	9	1.4
C50-60	Rhamdia sp. (Catfish)	Premaxilla	1	0.1
C70-90	Rhamdia sp. (Catfish)	Fragment	1	0.2
C70-90	Rhamdia sp. (Catfish)	Vertebrae	57	14
D60-70	Rhamdia sp. (Catfish)	Vertebra	1	0.4
D80-90	Rhamdia sp. (Catfish)	Ultimate Vertebra	1	3.6
D80-90	Rhamdia sp. (Catfish)	Fragments	5	0.9
A100-110	Sceloporus sp. (Spiny Lizard)	Vertebra	1	0.8
A110-120	Sceloporus sp. (Spiny Lizard)	Vertebra	1	0.1
C40-50	Sceloporus sp. (Spiny Lizard)	Vertebra Fragment	1	0.1
C50-60	Sceloporus sp. (Spiny Lizard)	Vertebra	1	0.8
A100-110	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	6	0.9
A110-120	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	2	0.2
A110-120	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	3	0.4
A30-40	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	3	0.5
A50-60	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	7	0.6
A60-70	Sciaenidae sp. (Drum Fish)	Vomer, Parasphenoid, Pharyngeal Arches,Post temporal, Maxilla	10	2.3
A80-90	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	8	1
A80-90	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	8	1
C100-110	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	8	1.1
C50-60	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	16	1.7
C60-70	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	6	0.9
C70-90	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	20	3
C90-100	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	10	1.2
D60-70	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	10	1.3
D80-90	Sciaenidae sp. (Drum Fish)	Pharyngeal Arches	4	0.5
C50-60	Sciurus sp. (Squirrel)	Tibia	1	0.1
D60-70	Sciurus sp. (Squirrel)	Mandible Fragment	1	0.1

A100-110	Shell	Nephronaias Bivavle	1	0.8
A100-110	Shell	N/A	20	3.8
A100-110	Shell	N/A	63	44.4
A110-120	Shell	N/A	7	11.8
A110-120	Shell	N/A	56	48.1
A20-30	Shell	Nephronaias Bivavle	1	1.3
C100-110	Shell	N/A	40	7.8
C110-120	Shell	N/A	24	6.6
C60-70	Shell	N/A	4	3
C90-100	Shell	Nephronaias Bivavle	11	1.4
C90-100	Shell	N/A	48	17.1
D80-90	Shell	Nephronaias Bivavle	2	0.2
D80-90	Shell	N/A	10	5.8
D90-100	Shell	N/A	74	13.6
A110-120	Shells	N/A	20	3.3
A90-100	Shells	N/A	29	17.6
C100-110	Shells	N/A	41	20.5
C70-90	Shells	Nephronaias Bivavle	5	0.9
A100-110	Spilotes sp. (Rat Snake)	Vertebrae	4	1.1
A60-70	Spilotes sp. (Rat Snake)	Vertebrae	10	4.7
A70-80	Spilotes sp. (Rat Snake)	Vertebrae	9	2.1
C50-60	Spilotes sp. (Rat Snake)	Vertebrae	18	5.1
C70-90	Spilotes sp. (Rat Snake)	Vertebrae	9	2.3
C90-100	Spilotes sp. (Rat Snake)	Vertebrae	6	1.2
D60-70	Spilotes sp. (Rat Snake)	Vertebra	1	0.2
D80-90	Spilotes sp. (Rat Snake)	Quadrate	1	1
D80-90	Spilotes sp. (Rat Snake)	Vertebrae	6	3
A110-120	Sylvilagus sp. (Cottontail Rabbit)	Left Mandible with Teeth	1	0.3
A30-40	Sylvilagus sp. (Cottontail Rabbit)	Pelvis Fragment	1	0.4
A50-60	Sylvilagus sp. (Cottontail Rabbit)	Pelvis	1	
A60-70	Sylvilagus sp. (Cottontail Rabbit)	Sacrum, Fragments	1	0.8
A60-70	Sylvilagus sp. (Cottontail Rabbit)	Mandible & Phalange	2	0.5
A70-80	Sylvilagus sp. (Cottontail Rabbit)	Tooth	1	0.1
C50-60	Sylvilagus sp. (Cottontail Rabbit)	Scapula, Calcaneum, Long Bone	3	1
C70-90	Sylvilagus sp. (Cottontail Rabbit)	Maxilla	1	0.6
C70-90	Sylvilagus sp. (Cottontail Rabbit)	Innominate, Humerus	2	1.6

C90-100	Sylvilagus sp. (Cottontail Rabbit)	Pelvis Fragment	1	1.3
A100-110	Tayassu pecari (White Lipped Peccary)	Patella	2	0.8
A50-60	Tayassu pecari (White Lipped Peccary)	Teeth	3	1.8
A70-80	Tayassu pecari (White Lipped Peccary)	Tooth	1	0.1
C50-60	Tayassu pecari (White Lipped Peccary)	Teeth	4	0.2
C70-90	Tayassu pecari (White Lipped Peccary)	Tooth	1	0.1
C70-90	Tayassu pecari (White Lipped Peccary)	Teeth	4	1.9
A100-110	Tayassu tajacu (Collared Peccary)	Molar	1	1.8
A20-30	Tayassu tajacu (Collared Peccary)	Teeth	3	2.6
A20-30	Tayassu tajacu (Collared Peccary)	Teeth	6	1.8
A30-40	Tayassu tajacu (Collared Peccary)	Long Bone Fragments	7	15.4
A60-70	Tayassu tajacu (Collared Peccary)	Incisors	2	0.7
A80-90	Tayassu tajacu (Collared Peccary)	Teeth	4	
C60-70	Tayassu tajacu (Collared Peccary)	Postemporal, Fragments	91	20.4
A100-110	Terrapene sp. (Box Turtle)	Parietal Bone	1	0.5
A100-110	Terrapene sp. (Box Turtle)	Skull Fragment	1	0.2
A100-110	Terrapene sp. (Box Turtle)	Vertebra	1	0.3
A100-110	Terrapene sp. (Box Turtle)	Vertebrae	6	0.8
A100-110	Terrapene sp. (Box Turtle)	Carapace	10	10.4
A100-110	Terrapene sp. (Box Turtle)	Long Bone Fragments including the Humerus	12	1.4
A110-120	Terrapene sp. (Box Turtle)	Carapace	2	1.4
A30-40	Terrapene sp. (Box Turtle)	Carapace	1	0.7
A40-50	Terrapene sp. (Box Turtle)	Carapace	1	3.5
A50-60	Terrapene sp. (Box Turtle)	Carapace	1	1.2
A50-60	Terrapene sp. (Box Turtle)	Carapace, Caracoid, Innominate	5	0.9
A60-70	Terrapene sp. (Box Turtle)	Carapace	2	1.6
A70-80	Terrapene sp. (Box Turtle)	Intact Beak, Long Bones	3	0.9
C100-110	Terrapene sp. (Box Turtle)	Carapace	12	14.5
C110-120	Terrapene sp. (Box Turtle)	Carapace	3	3.3
C50-60	Terrapene sp. (Box Turtle)	Vertebra	1	0.5
C50-60	Terrapene sp. (Box Turtle)	Carapace	4	2.7
C50-60	Terrapene sp. (Box Turtle)	Vertebrae	4	1
C70-90	Terrapene sp. (Box Turtle)	Carapace	1	1.7
C70-90	Terrapene sp. (Box Turtle)	Carapace, Long Bones	25	4.4
C90-100	Terrapene sp. (Box Turtle)	Vertebra	1	0.2
C90-100	Terrapene sp. (Box Turtle)	Fragments	5	2.2

D60-70	Terrapene sp. (Box Turtle)	Vertebra	1	0.2
D60-70	Terrapene sp. (Box Turtle)	Scapula	1	0.1
D60-70	Terrapene sp. (Box Turtle)	Metatarsals	2	0.3
D60-70	Terrapene sp. (Box Turtle)	Vertebrae	3	0.4
D60-70	Terrapene sp. (Box Turtle)	Carapace	4	4.3
D80-90	Terrapene sp. (Box Turtle)	Vertebra Fragment	1	0.6
D80-90	Terrapene sp. (Box Turtle)	Long Bones	5	4.2
D80-90	Terrapene sp. (Box Turtle)	Carapace	8	6.3
A100-110	Unidentified Bird	Ulna	1	0.2
A100-110	Unidentified Bird	Humerus	1	0.7
A100-110	Unidentified Bird	Femur	1	0.3
A100-110	Unidentified Bird	Long Bone	1	0.2
A100-110	Unidentified Bird	Tarsometatarsus	3	0.9
A100-110	Unidentified Bird	Fragments	5	0.8
A110-120	Unidentified Bird	Fragments	10	4.6
A20-30	Unidentified Bird	Fragments	7	1
A20-30	Unidentified Bird	Fragments	37	12.4
A30-40	Unidentified Bird	Fragments	7	1.3
A50-60	Unidentified Bird	Fragment	1	0.1
A50-60	Unidentified Bird	Fragments	13	7.8
C110-120	Unidentified Bird	Fragment	1	0.2
C40-50	Unidentified Bird	Long Bone Fragments	2	2.4
C40-50	Unidentified Bird	Fragments	5	10
C50-60	Unidentified Bird	Fragments	11	2.1
C60-70	Unidentified Bird	Ulna Modified Into Sewing Needle	1	0.4
C60-70	Unidentified Bird	Fragments	6	5.1
C70-90	Unidentified Bird	Fragments	28	3.6
C70-90	Unidentified Bird	Fragments	33	7.5
C90-100	Unidentified Bird	Long Bone Fragment	1	0.7
D60-70	Unidentified Bird	Fibula	1	0.1
D60-70	Unidentified Bird	Lumbar Vertebra	1	0.2
D60-70	Unidentified Bird	Pubis	1	0.5
D60-70	Unidentified Bird	Femur	2	1.5
D60-70	Unidentified Bird	Fragments	2	0.8
D60-70	Unidentified Bird	Long Bone Fragments	50	7.2
D80-90	Unidentified Bird	Fragment	4	0.3

D80-90	Unidentified Bird	Fragments, Caracoid	25	4.9
A110-120	Unidentified Large Mammal	Fragments	6	10.6
A20-30	Unidentified Large Mammal	Fragments	10	5.5
A20-30	Unidentified Large Mammal	Fragments	21	15.4
A20-30	Unidentified Large Mammal	Fragments	23	27.5
A30-40	Unidentified Large Mammal	Fragments	27	18.3
A30-40	Unidentified Large Mammal	Fragmented and Modified	34	48.2
A30-40	Unidentified Large Mammal	Fragments	64	30.8
A50-60	Unidentified Large Mammal	Fragments	79	37.4
A50-60	Unidentified Large Mammal	Fragments	108	16.4
A70-80	Unidentified Large Mammal	Fragments	75	46.6
C30-40	Unidentified Large Mammal	Fragment	1	1
C40-50	Unidentified Large Mammal	Manipulated Fragments	3	1.7
C40-50	Unidentified Large Mammal	Fragments	43	24.2
D60-70	Unidentified Large Mammal	Fragmented	26	50.6
D60-70	Unidentified Large Mammal	Fragments	98	36.6
A60-70	Unidentified Large Mammal	Unidentified Bone Fragments	26	35.6
A80-90	Unidentified Large Mammal (possibly Deer)	Femur	1	1.7
D60-70	Unidentified Reptile	Innominate	1	2
A100-110	Unidentified Small Mammal	Fragments	3	0.4
A100-110	Unidentified Small Mammal	Fragments	57	23.8
A110-120	Unidentified Small Mammal	Fragments	12	7.7
A110-120	Unidentified Small Mammal	Fragments	41	13
A20-30	Unidentified Small Mammal	Modified Fragments	2	0.8
A20-30	Unidentified Small Mammal	Fragments Modified into Sewing Needles	2	0.3
A20-30	Unidentified Small Mammal	Fragments	28	9.8
A20-30	Unidentified Small Mammal	Fragments	98	35.9
A30-40	Unidentified Small Mammal	Fragments	48	15
A30-40	Unidentified Small Mammal	Fragments	98	28.8
A40-50	Unidentified Small Mammal	Fragments	81	27.6
A50-60	Unidentified Small Mammal	Fragments	67	23.8
A60-70	Unidentified Small Mammal	Fragments	2	1.7
A60-70	Unidentified Small Mammal	Fragments	268	54
C110-120	Unidentified Small Mammal	Fragments, Astragalus, Phalange	8	4.8
C30-40	Unidentified Small Mammal	Fragments	2	0.4
C40-50	Unidentified Small Mammal	Long Bone Fragment	1	0.6

C40-50	Unidentified Small Mammal	Fragments	21	5.2
C50-60	Unidentified Small Mammal	Maxilla	1	0.1
C50-60	Unidentified Small Mammal	Phalanges, Fragments	127	32.9
C60-70	Unidentified Small Mammal	Maxilla	1	0.2
C70-90	Unidentified Small Mammal	Tooth and Mandible	1	0.1
C70-90	Unidentified Small Mammal	Tibia Fragments	2	1.1
C70-90	Unidentified Small Mammal	Ribs	6	0.3
C70-90	Unidentified Small Mammal	Fragments	34	9.8
C70-90	Unidentified Small Mammal	Fragments	66	20.8
C90-100	Unidentified Small Mammal	Fragments	43	14.1
C90-100	Unidentified Small Mammal	Fragments	45	5.2
D60-70	Unidentified Small Mammal	Fragments	33	6.8
D80-90	Unidentified Small Mammal	Tooth	1	0.1
D80-90	Unidentified Small Mammal	Fragments	34	6.6
A90-100	Wooden Beads	N/A	9	1.2

Unit	Diagnostic Features Coincide with Prior Species Data (Units Follow the Diagnostic Features as a Reference Point)
A110-120	
A60-70	
A70-80	
A80-90	2x Burnt
C110-120	
C40-50	
C60-70	2x Burnt
C70-90	
C90-100	
D60-70	
D80-90	
D80-90	
A20-30	Phalange size=1.3 cm
A50-60	2x Mandible
A110-120	Distinct wings unlike any other vertebrae in collection
D60-70	
A100-110	18x Burnt
A110-120	1x Modified Vertebra
A110-120	7x Burnt
A20-30	
A20-30	
A20-30	1x Burnt
A30-40	
A50-60	
A60-70	
A60-70	
A70-80	
A80-90	Fragmented, no teeth present
A80-90	Fragmented, no teeth present
A80-90	
A80-90	
A90-100	18x Burnt
C100-110	
C110-120	
C30-40	

C40-50	
C50-60	
C60-70	
C60-70	2x Burnt
C60-70	4x Burnt
C70-90	
C70-90	1x Burnt
C70-90	
C90-100	1x Burnt
C90-100	4x Burnt
C90-100	5x Burnt
C90-100	
D60-70	
D80-90	11x Burnt
C70-90	
A50-60	
A100-110	
A110-120	
C90-100	
A50-60	
A50-60	
D60-70	
D80-90	
D80-90	
C60-70	Single row of prominent papillae
A100-110	
A100-110	
A100-110	
A100-110	Both Fragments Burnt
A100-110	1x Complete, 1x Burnt
A100-110	
A100-110	
A110-120	11x Burnt
A110-120	19 Burnt
A20-30	
A20-30	

A20-30	
A30-40	
A30-40	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A60-70	
A60-70	
A60-70	
A70-80	
A70-80	
A70-80	
A70-80	Premaxilla-Lateral Skull Bones, Maxilla
A70-80	
A70-80	Maxilla mesial and lateral bones
A70-80	
C100-110	
C100-110	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C110-120	
C40-50	

C40-50	3x Mandibles, 1 Burnt Fragment
C50-60	
C50-60	
C50-60	2x Premaxilla
C50-60	
C60-70	4x Dentary, 5x Vomer
C70-90	
C70-90	1x Maxilla, 2x Vomers, 10 Fragments
C70-90	
C70-90	
C90-100	
C90-100	
C90-100	
C90-100	2x Mandible
D60-70	
D60-70	
D60-70	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	6x Vomer
A30-40	
A100-110	
A20-30	1x Burnt
A30-40	
A40-50	
A50-60	3x Burnt
A60-70	
A70-80	1x Burnt

A90-100	4x Burnt
C70-90	
C70-90	
C70-90	
C90-100	
C90-100	
C90-100	
D60-70	4x Burnt
D80-90	
A100-110	
A100-110	
A100-110	
A110-120	2x Burnt
A110-120	6x Burnt
A110-120	8x Premaxilla, 23 Burnt Fragments, 3 Burnt Vomers
A20-30	
A20-30	
A20-30	Fragmented
A20-30	Fragmented
A20-30	Fragmented
A20-30	Fragmented
A20-30	Fragmented
A20-30	
A20-30	Fragmented
A20-30	Fragmented
A20-30	
A20-30	
A20-30	Fragmented
A20-30	Fragmented
A20-30	
A20-30	
A20-30	
A20-30	
A20-30	2x Burnt
A30-40	
A30-40	

A30-40	
A30-40	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A50-60	
A60-70	2x Burnt
A70-80	
A70-80	
A70-80	
A70-80	
A80-90	
A80-90	5x Burnt
A80-90	
A90-100	9x Burnt
C100-110	
C100-110	
C100-110	9x Burnt
C100-110	
C110-120	
C40-50	
C40-50	
C40-50	
C50-60	1x Modified into a bead
C50-60	
C50-60	187x Burnt
C50-60	
C60-70	2x Vomer
C60-70	

C60-70	78xBurnt
C60-70	
C70-90	
C70-90	1x Vomer, 1x Mandible
C70-90	
C70-90	19x Fragments, 35x Dorsal Spines
C70-90	
C70-90	
C90-100	2x Burnt
C90-100	
C90-100	2x Burnt
C90-100	
C90-100	17x Burnt
C90-100	93x Burnt
C90-100	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	1x Burnt
D80-90	
D80-90	145x Burnt
A60-70	
C60-70	
C60-70	
C70-90	
D60-70	
D60-70	

D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D80-90	
D60-70	
C90-100	
C50-60	
A20-30	
C90-100	
A100-110	2x imbricating Osteoderms, 1x burnt fragment
A110-120	
A110-120	1x Burnt
A20-30	
A30-40	
A40-50	
A90-100	1x Burnt
C100-110	
C110-120	1x fragment shows evidence of burning
C40-50	
C50-60	3x fragments, 1x burnt fragment
C60-70	1x Burnt
C70-90	5x Burnt
C70-90	
C70-90	3x fragments are burnt
C70-90	2x Burnt
C90-100	2x Burnt
C90-100	
C90-100	4x Burnt
D60-70	1x Slightly Burnt
D80-90	3x Burnt
C50-60	
C50-60	
C60-70	L. Maxilla, occlusal view shows no teeth
C90-100	P5 and P4 teeth present, right portion of maxilla fractured

C70-90	
C90-100	
D60-70	
D60-70	
D60-70	
D60-70	
A100-110	
A100-110	
A100-110	Incomplete
A100-110	3x Burnt
A110-120	
A110-120	Burnt Vertebra
A110-120	3x Burnt
A20-30	Incomplete
A50-60	
A60-70	
A60-70	1x Parietal, 2x Vertebrae
A70-80	
A80-90	
A80-90	1x Burnt
A80-90	2x Left Mandible Fragments with 1x Burnt, 2x Right Maxilla Fragments
C110-120	
C40-50	
C50-60	
C50-60	
C50-60	
C60-70	
C60-70	
C60-70	
C70-90	Burnt
C70-90	
C70-90	2x Parietal
C70-90	
C90-100	
C90-100	
C90-100	With Teeth

C90-100	
C90-100	1x Mandible
D60-70	
D60-70	
D80-90	
D80-90	
A110-120	1x Burnt
A20-30	
A20-30	
A60-70	Fragmented
C100-110	
C40-50	
C50-60	
C70-90	
C70-90	
D60-70	
D60-70	
D60-70	
D60-70	
C70-90	
C30-40	
A40-50	
C50-60	1x Rib with Cut Marks, 2x Fragments with Cut Marks, 1x Fragments with Gnawing
C60-70	1x First Phalange
D80-90	2cm
D80-90	
A100-110	2 cm Length bone that includes the proximal end with the familiar crescent wrench shape
D80-90	Cusp
C100-110	
C70-90	Large 15mm diameter
A100-110	P2
A100-110	
A20-30	
A20-30	1x M2, 1x P3, 3xClaws
A50-60	
C50-60	1x M3, 3x M2, 2x M1

C70-90	
C70-90	
C70-90	Fragmented
C70-90	
D80-90	
D80-90	
A70-80	
C70-90	
C90-100	2x Burnt
A100-110	
A110-120	
C100-110	
C90-100	
C90-100	
A90-100	
A20-30	Possibly M2
A20-30	
A20-30	Proximal end of fragment
A100-110	
A100-110	
A100-110	Proximal End
A100-110	Proximal Fragment Completely-Caput femoris complete-Missing Trochanter major
A100-110	P4 Fragment
A100-110	Mandibular Dentition-M1, M2
A100-110	Long Bone Shaft Fragments
A100-110	1x Burnt, 1x Evidence of Red Ochre, Modified and polished
A100-110	
A100-110	7x Burnt
A110-120	P3 Phalange
A110-120	Position unidentifiable due to fragmentation
A20-30	Left Calcaneum Fragment
A20-30	Distal end of Humerus Condylar Fragment
A20-30	Distal end, Medial side of Fragment
A20-30	
A20-30	Acetabulos fossa present, Fragmented Iliac Crest
A20-30	1x L. distal end fragmented with evidence of cut or gnaw marks and trace of Red Ochre. 1x L. distal fragment completely fused.

A20-30	
A20-30	1x R. phalange complete proximal fusion (burnt), another R. phalange, 1x R. phalange not fused & missing proximal end
A20-30	Fragmented
A20-30	1x Burnt
A20-30	Gnawing on 3 Fragments,1 possible Fibular shaft fragment with cut marks and 6 fragments with traces of Red Ochre
A30-40	
A30-40	
A30-40	
A30-40	
A30-40	Left Metatarsal Fragments from Distal end:1x fused, 1 Burnt Phalange
A30-40	M3, M2, M1, P3, M2-Cheek Teeth
A30-40	2x gnawed, 1x Burnt, 2x Red Ochre
A40-50	Burnt
A40-50	Red Ochre Residue Present, but cannot side due to fragment
A40-50	Slight Burning
A40-50	Identification based on Location of Lateral side of Nutrient Foramen
A40-50	P4 proximal end
A40-50	Possibly M2
A40-50	1x Burnt
A40-50	P3 Phalange completely fused at Proximal End
A40-50	
A40-50	2x Fragments show gnawing, 1x Fragment show cut marks
A50-60	P4 Fragment
A50-60	Fragmented on Medial Side of Distal End
A50-60	Proximal End Missing, Burnt
A50-60	Acromion Process highly Burnt
A50-60	
A50-60	1x Very Fragmented, 1x Burnt with Lime on Medial Side-Both are Distal Metatarsus, possibly LEFT
A50-60	
A50-60	2x Evidence of gnawing, 2x Burnt
A50-60	
A60-70	
A80-90	Right proximal fragment of immature deer
A80-90	Proximal fragment of L. Femur missing Trochanter major, Epiphysis highly fused, Complete Caput femoris
A80-90	Lime deposits on left portion
A90-100	Fragmented on Lateral Side

C30-40	
C30-40	Modified and Polished
C40-50	Fragmented on Proximal End
C40-50	
C50-60	Front of Proximal Shaft
C50-60	Shaft fragment modified into tool, smoothed & polished, with evidence of Red Ochre (posterior & anterior sides)
C50-60	Olecranon facies articularis medialis S. ventralis, Facies articularis lateralis S. dorsalis and Red Ochre present
C50-60	
C50-60	1x fusion complete:distal, Other only distal fragment, evidence of burning
C50-60	
C50-60	1x Polished and modified, 2x Burnt
C60-70	Only distal end of R. Phalange (Unable to side)
C60-70	With Teeth
C70-90	
C70-90	
C70-90	Large Adult because proximal end is fused
C70-90	Distal End
C70-90	Distal Fragment Burnt, especially on Large Distal Condyles
C70-90	Fragmented medial View (Upper Medial Half)
C70-90	Distal end
C70-90	Proximal End
C70-90	Distal End Not Fragmented
C70-90	Unable to side due to size of fragment at distal end
C70-90	Heavily pitted on medial side of distal fragment
C70-90	Caudal
C70-90	1x L. distal end, medial side missing fragment, 1x R., 1x proximal end missing
C70-90	1x Burnt Adult Fused P3, 1x Fragment Missing Proximal End P3, 1x P4 unfused
C70-90	1x Burnt, No Identifiable Tooth Position
C70-90	1x polished and modified Tibia, 1x Bone modified into a scoop, 1x modified Radius
C70-90	
C90-100	Proximal end of fragment burnt
C90-100	
C90-100	
C90-100	
C90-100	
D60-70	Cut marks on medial side

D60-70	P3
D60-70	Highly Burnt, With Embedded Tooth Roots
D60-70	Red Ochre Residue Present
D60-70	
D60-70	Fragmented due to gnawing
D60-70	
D80-90	
C70-90	
A100-110	
A100-110	
A50-60	
C50-60	
C50-60	4x Ribs
D60-70	
D80-90	
D80-90	
A20-30	Fragmented
A60-70	2x Burnt, 1x showed gnaw marks
A20-30	Distal portion
A30-40	
C50-60	
A50-60	
C40-50	
C70-90	
C90-100	
C50-60	
C90-100	
A100-110	4x Maxilla with Teeth, 5x Fragments
A20-30	
A20-30	
A20-30	
A20-30	
A20-30	
A30-40	
A50-60	
A50-60	

A50-60	
A50-60	
A60-70	
A70-80	
A70-80	
A70-80	
A80-90	
A80-90	
C110-120	
C50-60	
C70-90	
C70-90	
D60-70	
D80-90	
D80-90	
A100-110	
A110-120	
C40-50	
C50-60	
A100-110	1x Burnt
A110-120	
A110-120	
A30-40	
A50-60	1x Burnt
A60-70	3x burnt Vomer, 1x Parasphenoid, 2x Maxilla, 1x Post temporal, 3x Pharyngeal Arches
A80-90	
A80-90	
C100-110	
C50-60	2x Burnt
C60-70	
C70-90	2x Burnt
C90-100	
D60-70	1x Burnt
D80-90	
C50-60	
D60-70	

A100-110	
A100-110	13x Pomacea flagellata, 7x Nephronaias bivalve
A100-110	58x Pomacea flagellata, 5x Nephronaias bivalve
A110-120	4x Nephronaias bivavle (Fresh Water Clam), 2x Large Pomacea flagellata, 1x Rare & Very Large Euglandina cylindracea Shell
A110-120	50x Pomacea flagellata, 2x Nephronaias bivalve and 4x Jute Snail (Pachychilus)
A20-30	
C100-110	32x Pomacea flagellata, 6x Nephronaias bivalve, 2x Jute Snail (Pachychilus)
C110-120	18x Pomacea flagellata, 5x Nephronaias bivalve, 1x Jute Snails (Pachychilus)
C60-70	Pomacea flagellata
C90-100	
C90-100	40x Pomacea flagellata, 9x Nephronaias bivalve
D80-90	
D80-90	8x Pomacea flagellata, 2x Nephronaias bivalve
D90-100	23x Nephronaias bivalve, 35x Pomacea flagellata, 16x Jute Snail (Pachychilus)
A110-120	11x Pomacea flagellata, 7x Nephronaias bivalve, 2x Jute Snails (Pachychilus)
A90-100	27x Pomacea flagellata, 1x Nephronaias bivalve and 1x Jute Snail (Pachychilus)
C100-110	34x Pomacea flagellata, 3x Nephronaias bivalve, 4x Jute Snails (Pachychilus)
C70-90	
A100-110	
A60-70	
A70-80	
C50-60	
C70-90	
C90-100	
D60-70	
D80-90	
D80-90	
A110-120	
A30-40	
A50-60	
A60-70	
A60-70	1x Mandibular Fragment, 1 Phalange
A70-80	Molar
C50-60	
C70-90	
C70-90	

C90-100	Missing Obturator foramen and pubic spine at pubis, Burnt
A100-110	
A50-60	d1, d2, dp2
A70-80	
C50-60	
C70-90	
C70-90	
A100-110	M2
A20-30	M2 Complete, Fragmented Incisor and P3
A20-30	Incisor Fragment-3, 1x P1, 2x Deciduous-dp2
A30-40	
A60-70	
A80-90	3x Incisors, 1x P2
C60-70	1x Postemporal
A100-110	Burnt
A100-110	
A100-110	
A100-110	
A100-110	6x Burnt
A100-110	
A110-120	
A30-40	
A40-50	Extremely Thick-0.4mm
A50-60	
A50-60	2x Caracoid, 2x Carapace, 1x Innominate
A60-70	
A70-80	1x Intact Beak
C100-110	4x Burnt, 1x Modified with a Hole
C110-120	2x Burnt
C50-60	1x Burnt
C50-60	
C50-60	
C70-90	Modified With Hole
C70-90	
C90-100	Missing Dorsal Side
C90-100	

D60-70	
D60-70	
D60-70	
D60-70	
D60-70	Evidence of Burning on Two Fragments
D80-90	
D80-90	
D80-90	7x Burnt
A100-110	Burnt
A100-110	
A100-110	
A100-110	
A100-110	
A100-110	
A110-120	All Bone Fragments Hollow, 1x Burnt
A20-30	All Bone Fragments Hollow
A20-30	15x Burnt, 3x Gnawing
A30-40	
A50-60	
A50-60	
C110-120	
C40-50	
C40-50	Includes partial Humerus at distal end
C50-60	
C60-70	
C60-70	
C70-90	
C70-90	
C90-100	
D60-70	
D60-70	
D60-70	
D60-70	
D60-70	
D60-70	
D80-90	

D80-90	
A110-120	5x burnt fragments
A20-30	1x Burnt Vertebra
A20-30	9x Burnt
A20-30	White residue on 12 burnt fragments
A30-40	1x Burnt
A30-40	3x gnawing, 17x burnt, 4x Red Ochre and 1 fragment modified into a highly polished tool
A30-40	
A50-60	
A50-60	
A70-80	
C30-40	Burnt
C40-50	1x with gnawing or butchery marks, 2x Burnt
C40-50	
D60-70	9x Burnt
D60-70	
A60-70	5x burnt fragments
A80-90	Fragment of Tibia articular surface
D60-70	Bone with 2 puncture marks
A100-110	
A100-110	18x Burnt
A110-120	4x Burnt
A110-120	16x Burnt
A20-30	Both fragments contained gnawing or cut marks
A20-30	1x Burnt, Modified into Sewing Needles
A20-30	1x Mandible, 9x Burnt, 1x Humerus
A20-30	
A30-40	
A30-40	
A40-50	
A50-60	
A60-70	Burnt
A60-70	
C110-120	1x Burnt Astragalus, 1x Burnt Phalange, 3x Burnt Fragments
C30-40	
C40-50	

C40-50	1x partial femoral head, 1x phalange
C50-60	
C50-60	
C60-70	
C70-90	
C70-90	
C70-90	
C70-90	
C70-90	
C90-100	
C90-100	
D60-70	
D80-90	Canine
D80-90	
A90-100	