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Adding Flesth to Bones: Using Zooarchaeology Research to Answer the Big-Picture Questions

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ABSTRACT: Faunal analysis can give clues to the quality of life for the elite and the general population. Many studies have discussed how a general Maya diet was affected by population pressure, but few have looked directly at the archaeological dietary remains. This paper looks at the adaptive responses to the increasing requirements for animal resources at Caracol, Belize, such as importation of animal products, specialization of animal use strategies, and animal management.

KEYWORDS: MAYA, COMPLEX SOCIETY, ZOOARCHAEOLOGICAL METHODS, SUBSISTENCE INTENSIFICATION, POPULATION PRESSURE, ANIMAL USE

RESUMEN: Los análisis faunísticos pueden proporcionar pautas diferenciales acerca de la calidad de vida entre las élites y sus súbditos. Muchos estudios han contemplado los modos por los cuales la dieta-patrón maya pudo haberse visto afectada por la presión demográfica aunque pocos de estos estudios han analizado directamente los restos de estas dietas en el registro arqueológico. Este trabajo considera las respuestas adaptativas al incremento de la demanda de recursos animales en el yacimiento de Caracol, Belize, dentro de los cuales podemos incluir la importación de productos animales, la especialización de las estrategias de uso y la gestión de los recursos animales.

PALABRAS CLAVE: MAYA, SOCIEDADES COMPLEJAS, METODOLOGÍA ZOOARQUEOLÓGICA, INTENSIFICACIÓN, SUBSISTENCIA, PRESIÓN DEMOGRÁFICA, GESTIÓN ANIMAL

INTRODUCTION

Faunal analysis was not a priority of early site excavations in the Maya area. When included in site reports, it generally consisted only of lists of identified taxa (including Woodbury & Trik, 1953; Pollock & Ray, 1957; Olsen, 1972, 1978). Not until excavations undertaken in the late 1970s and early 1980s at Cuello (Wing & Scudder, 1991), Cerros (Carr, 1985), Cozumel Island (Hamblin, 1984), Kichpanha (Shaw & Gibson, 1986) and Colha (Shaw, 1985, 1991) was faunal analysis used for archaeological interpretation. These works demonstrated that zooarchaeology could be used not only to understand Maya subsistence practices, but also to give clues to the quality of life for both the general population and the elite. However, although the use of faunal analysis in Maya studies has been recognized for the last 25 years, even today these analyses often are not integrated into larger archaeological project interpretations and conclusions.

One way to change this trend is to test larger theoretical questions with our own faunal data. Like ceramics, lithics, and other data sets, faunal material provides information ranging from the mundane to the ritual. And because animal products were so necessary to daily life, zooarchaeological remains offer insights into the specifics of daily societal decision making. To demonstrate the possibilities of this process of approaching broader theoretical questions with zooarchaeological data, the faunal analysis that has been undertaken at Caracol, Belize (Teeter, 2001) is used here to look at social adaptive responses to human population pressures.

ADAPTIVE STRATEGIES

How might a city provide animal resources during times of transition from lesser to greater societal complexity and population sizes? If we follow a cultural ecological approach, a limited number of responses can be predicted for humans adapting to any given environment. Th ese responses can include any or all of technological innovations, changes in social organization, and/or subsistence intensification (Sanders & Price, 1968; Ford, 1986; Pyburn, 1996).

Technological innovation and subsistence intensification can be more clearly applied to faunal data using models such as optimal foraging theory as suggested by Ford (1986). In her research Ford (1986) put forth three options for subsistence strategies a society can use to adapt to population pressure. One is to move into unoccupied areas. Another is to intensify production by using already established resources. A third option is to utilize previously unused or underused resources. Of course, the likelihood is that some combination of these three responses was used depending on need. Following Ford's options for adapting to the increased need for animal resources, a society could have: (1) increased hunting distances into unused areas; (2) developed methods of domestication and/or taming, as well as targeted and managed hunting; or (3) used other previously underutilized fauna.

As a caution to these postulates, however, Pyburn (1996) notes that conquest and alliance through politics or trade should be included in the possible adaptive strategies. Following Sanders & Price (1968), Pyburn (1996) warns that "culture – beliefs, knowledge, experience, history – determines whether any particular resource will be made available, used, traded, worshipped, transformed by domestication, made extinct, or simply ignored, regardless of its biological potential." This is an important reminder that a culture's choice cannot be predicted or explained solely on the basis of ecological or biological availability, because individual experience and knowledge will be factors in that choice.

Pyburn's caution reminds us that we must consider other adaptive responses to population pressure, such as shifts in social organization. As part of the balance between the biological and physical environment, a developing city needs an efficient centralized authority and leadership to handle the pressure relating to the needed resources for its inhabitants. Some responses to increasing population pressure in terms of social organization can include the creation of a non-subsistence sector (specialization) and/or the importation of goods (increased interaction in trade alliances) (Brumfiel & Earle, 1987: 2). Specialization with regard to animal resources can take on many forms, from meat distribution to animal management to the production of finished bone products.

Another part of greater social organization is the increased role of leadership in a regional economy, including centralized control over the importation of subsistence goods and exotic items. These imported goods may allow the continuance of a favored diet or the development of new tastes (at least for part of the economy). Control over and access to trade goods and resources give power (Service, 1975; D'Altroy & Earle, 1985). In ancient Maya states, not only did elite families compete internally for control over resources, but also similar sized cities clashed with each other for control over smaller sized cities and for regional control (Webster, 1977; Chase & Chase, 1989, 1998b).

Therefore, in looking at the effect of complex society on animal resources, it is necessary to recognize technological innovations, subsistence intensification, and changes in social organization as possible adaptive responses to population pressure. These responses can also be used as a model for better understanding the zooarchaeological distribution patterns revealed within the Caracol faunal assemblage.

THE SETTING

Located within the eastern foothills of the Maya Mountains on the Vaca Plateau, Caracol (so named because of the winding road that traversed the hilly terrain into the site) is approximately 500 m above sea level (Figure 1). The epicenter is situated on a high plateau that falls away into a deep

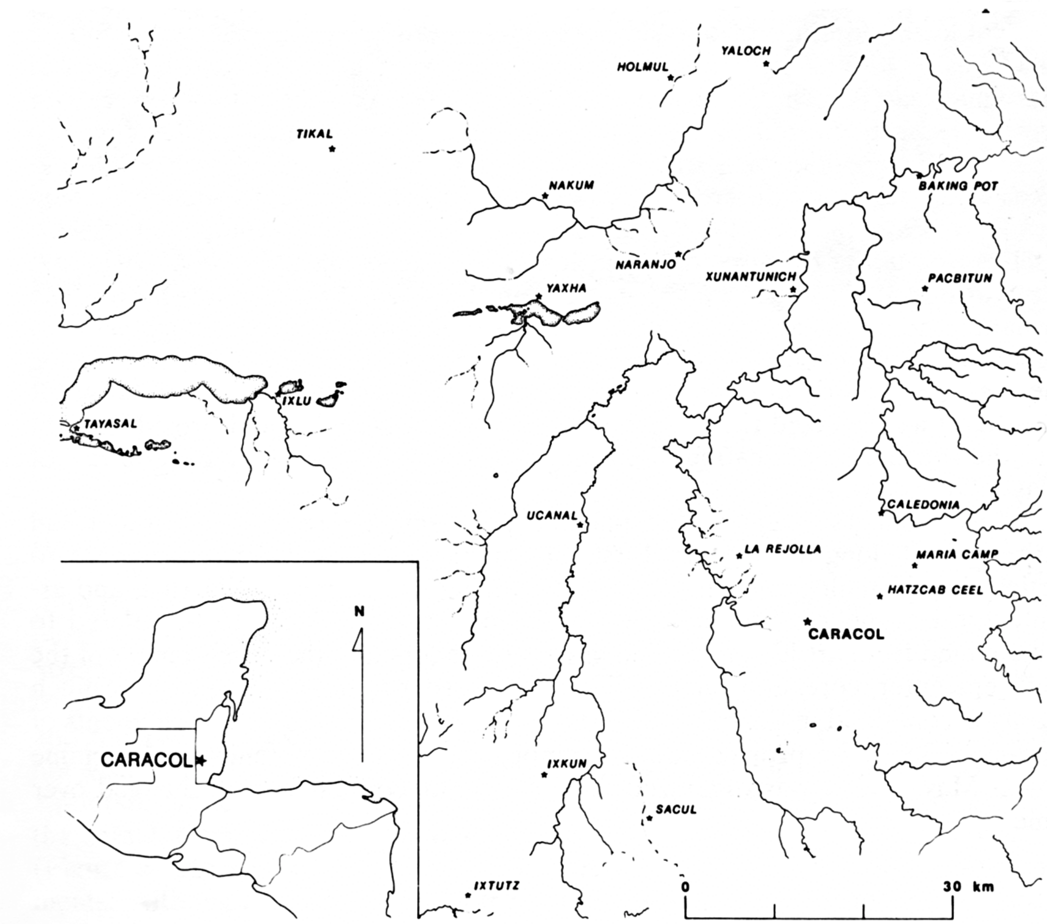


FIGURE 1
Map showing the location of Caracol and other nearby Classic Period sites (from Chase & Chase, 1987: Figure 1).

valley to the northwest and rises into hills to the southeast (Chase & Chase, 1987: 1). The environment today is moist subtropical forest within the Petén Biotic Province and has changed little since the Late Pleistocene (Miller & Miller, 1994: 18). The nearest permanent body of water to the epicenter is the Macal River, located 15 km away. To overcome the lack of permanent water in the region, the Caracol Maya constructed many reservoirs that took advantage of the large amount of yearly rainfall (Chase & Chase, 1987).

The Vaca Plateau was home to many similarly sized villages during the Middle Preclassic (1000 - 400 BC). The earliest known habitation in the center of Caracol is at 300 BC at a structure known as A6, while, farther away, a plaza group nicknamed "Veracruz" was first occupied at about 600 BC. Life continued in these independent villages relatively unchanged through the Early Classic Period (AD 250 - 600). Within Caracol (Figure 2), by AD 70 much of the ceremonial plaza (Group A) and many other elite residences were built (Chase & Chase, 1995). Caana (Maya for "Sky House"), a massive platform with temples, palaces, and other buildings, was first erected to a height of almost 30 m during the second century (Chase & Chase, 1994: 2).

While large architecture and monuments, which require an ability to support specialists and mobilize people, attest to a prominent city with a powerful ruler, indications are that the city was subservient to Tikal, paying tribute during the

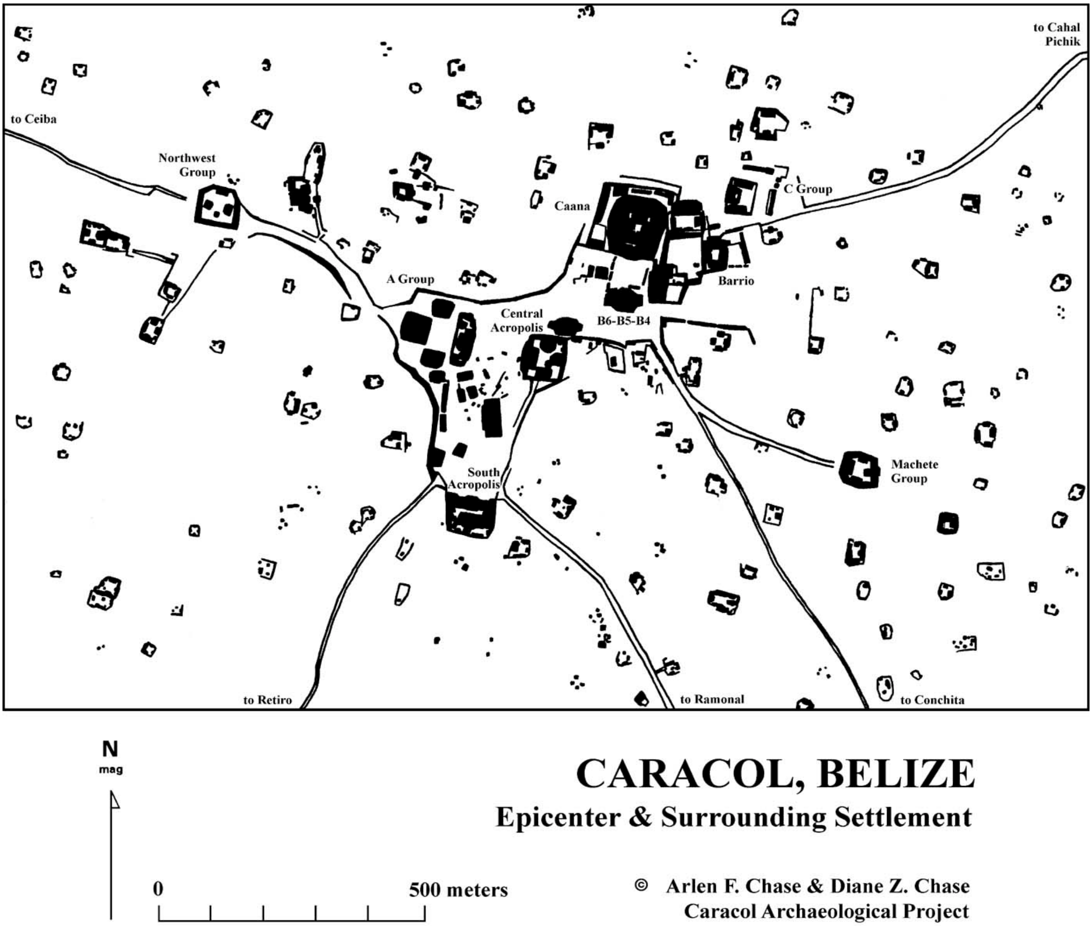


FIGURE 2
Caracol epicentral area causeways (courtesy of Caracol Archaeological Project).

Early Classic Period. Lord Water (Yahaw Te K'i-nich), an Early Classic ruler who took the throne in AD 553, instigated several "events" to gain Caracol's independence. In AD 562 a "Star Wars" event was successful, ushering in a florescence at Caracol, while ending Tikal's domination of the region for at least a hundred years (Chase, 1991).

After Caracol's success, inhabitants from outlying regions (based on the material culture) flocked into the city possibly looking to share in the center's prosperity. The city doubled in size within a few decades, and leaders developed a plan to integrate agricultural terraces around housemound plazas, and built 11 causeways that radiated out of the epicenter to link all parts of the city (Figure 3; Chase & Chase, 1998). The city's layout allowed people to move more easily, but also brought the majority of people through the epicenter, where leaders could have maintained control over the distribution of goods and resources. As the city continued to grow outward from the center, smaller independent villages found themselves subsumed and incorporated into the greater Caracol metropolitan area (Chase & Chase, 1996). They became suburban administrative centers where outlying citizens likely paid their tribute. Caracol continued to grow and prosper, reaching its height of power during the 7th century. The city was approximately 177 km^2 and had a population of more than 115,000 people (Chase & Chase, 1994: 5).

Burned floors and artifacts throughout the epicenter suggest an abrupt abandonment in AD 895 of the city center (Chase & Chase, 2000). Several proposals link this abandonment to ecological and subsistence causes. For instance, some hypothesize that the depletion of primary forest growth would eventually have caused large wild game to migrate to areas where food was more readily available, and that people would have followed (Chase & Chase, 1994: 6; Miller & Miller, 1994: 12; Lee, 1996: 413). Another proposal is that a period of drought engulfed the lowlands at the end of the 9th century, meaning that the larger centers could no longer supply enough food to their citizens (Rosenmeier *et al*., 2002). In any event, even with the center empty, perhaps 25% of the plaza

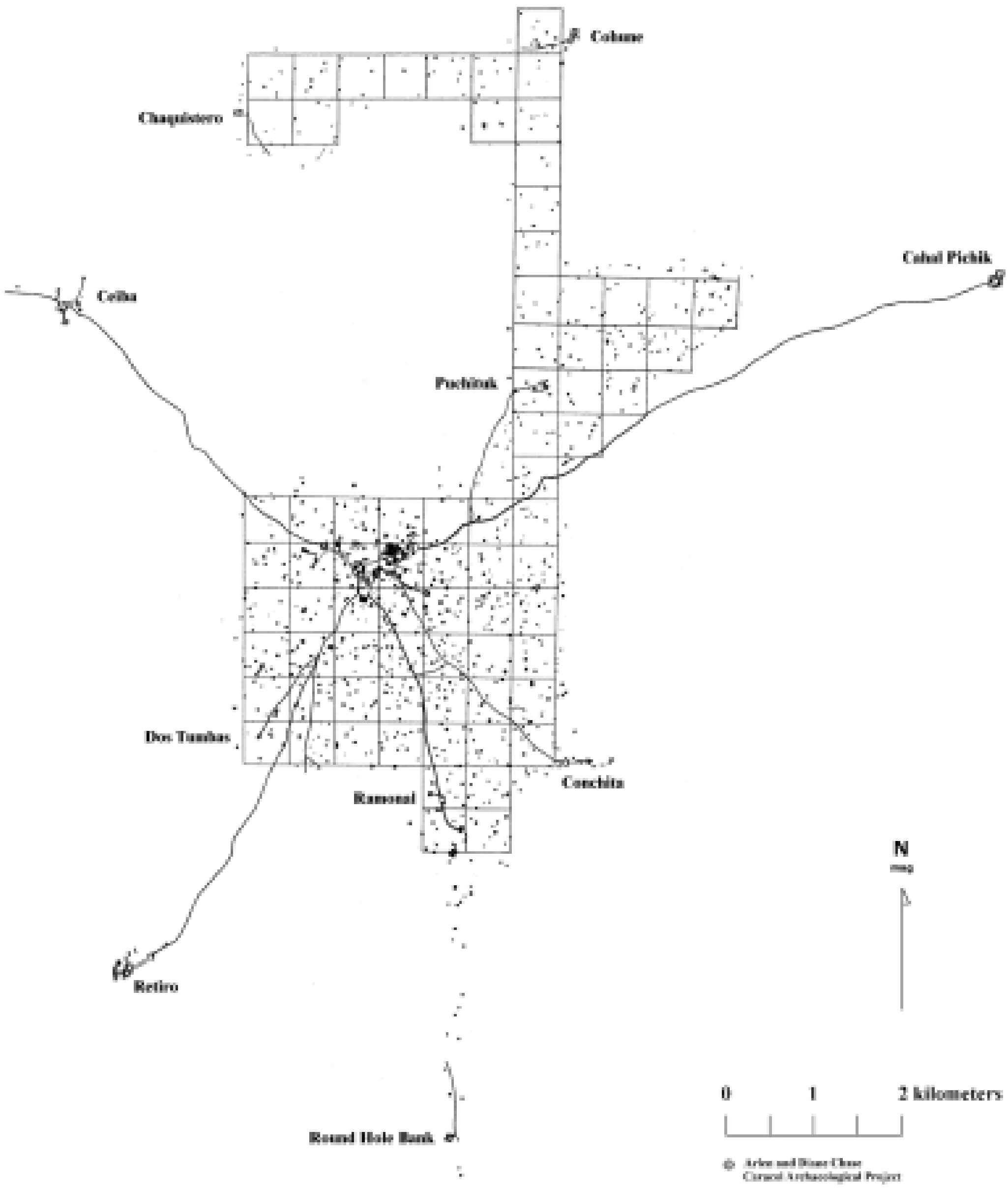


FIGURE 3
Map showing greater Caracol with causeways (courtesy of Caracol Archaeological Project).

groups in the core continued to be occupied, possibly for another half century (Chase & Chase, 2004). Within the epicenter, only the A Group continued to be visited, likely as a ritual pilgrimage site with short-term camping extending into the Early Postclassic (AD 1000-1250) or until around AD 1050 (Chase & Chase, 2000).

METHODS

The data for this zooarchaeological analysis come from excavations conducted from 1985 through 1998. These 13 field seasons under the direction of Arlen and Diane Chase of the University of Central Florida provide data from 596 unique excavations (including test pits, trenches, and horizontal clearings) from the city's epicenter to household complexes 6 km away from the site's epicenter. During these excavations Caracol yielded 84,763 pieces of animal bone from trowel excavations, and matrices were screened using 1/4-inch mesh, or a finer 1/8-inch mesh when special deposits were identified. The faunal material also reflects a variety of behaviors, as it has been recovered from burials, caches, floors, garbage scatters, and construction fill. Identifications by Teeter are based on comparisons with specimens from the UCLA Cotsen Institute of Archaeology Zooarchaeology Laboratory, UCLA Dickey Collection, and the Florida Museum of Natural History (see Table 1 for a list of identified taxa). Calculations are presented as number of identified specimens (NISP) although elements have been refitted where possible.

Such a large quantity of bone allows particular consideration to be given to context. Therefore, the results can be well grounded both temporally and spatially. Bones with secondary provenance (fill, collapse, and surface contexts) are excluded from this analysis (N = 17,498 specimens; weight = 5,070.24 g), except when the bone is modified or identified as fish. These two exceptions are based on the necessity for human intervention for their disposition into the archaeological record. One other context was removed from the data analysis: excavations into trash deposited on the room floors of Structure A6 (N = 59,167 specimens; weight = 4,039.68 g).

This context dates to after AD 890 with a build-up of faunal remains and trash due to owl and human contributions. The human component consists of a trash deposit almost a meter thick including burnt rabbit, deer, and other mammal remains; however the bone considered here is from only the basal 15 cm to the floor, a reasonable assignment of primary floor debris. In the second part of this deposit are the remains of a large number of small animals, including rodents, shrews, bats, lizards, and frogs. The skeletal part representation (nearly complete skeletons) and age structure (a high percentage of juveniles) suggest that their presence is likely the result of owl roosting, not human activity in the building.

To answer questions concerning the socio-economic use of animals, the faunal assemblage is divided between the epicenter (the central locus of administrative and ceremonial activities), the core (residential in nature and outside of the administrative and royal structural complexes), and the termini areas at the end of the causeways (large administrative plazas). Causeway termini, approximately 6 km to 8 km away from the epicenter, are not residential in function, but probably served as regional administrative centers for the area (Chase & Chase, 1996). On the basis of architectural investment alone, the epicenter and the causeway termini can be classified as elite, possibly royal, whereas the core contains households of all socio-economic strata and will be more difficult to discuss in broad trends of socio-economic activity.

Table 2 highlights the fact that most of the faunal remains were recovered from the epicenter. This is significant since, although only 26% of the total 147 discrete excavation areas or operations were located in the epicenter, bone from the epicenter represents 88% of the total site faunal assemblage. In contrast, although over 90 core residential groups have been excavated to various degrees, only 37 groups produced evidence of faunal material, and that material makes up only 10 percent of the total assemblage. It is therefore unlikely that excavation strategies are responsible for the discrepancy in quantities recovered. It is more likely that the differences are due to socio-economic access or variability in preservational conditions in the recovery contexts.

CARACOL FAUNAL DATA

A general overview of findings from Caracol is in order before delving into specifics. Tables 3 and 4 (a and b) provide a corrected distribution (wit-

Taxon		Common Name
Dasyatidae		Stingray – Unid.
Ariidae		Sea Catfish Family
Epinephelus striatus		Grouper - Nassau
Caranx latus		Jack - Horse-eye
Lutjanus sp.		Snapper – Unid.
Haemulon sciurus		Grunt - Blue Striped
Sphyraena sp.		Barracuda – Unid.
Sparisoma viride		Parrotfish - Stoplight
Total Fish	**197**	**54.90g**
Rhinophrynus dorsalis		Frog - Mexican Burrowing (Uo)
Bufo sp.		Toad - Unid
Rana sp.		Frog - Unid
Total Amphibian	**2716**	**64.14g**
Dermatemys mawii		River Turtle - Central America
Kinosternidae		Mud, Musk Turtle Family
Rhinoclemmys areolata		Turtle - Furrowed Wood
Gekkonidae		Gecko Family
Basiliscus vittatus		Basilisk - Striped
Ctenosaura similis		Iguana - Spiny-tailed
Anolis sp.		Anole – Unid.
Ameiva festiva		Lagartija Parda
Lepidophyma flavimaculatum		Night Lizard - Yellow-spotted
Boa constrictor		Boa Constrictor
Colubridae		Colubrid Family
Bothrops asper		Fer De Lance
Total Reptile	**1006**	**284.22g**
Buteo sp.		Hawk – Unid.
Micrastur semitorquatus		Falcon - Collared Forest
Meleagris ocellata		Ocellated Turkey
Gallus gallus		Chicken - Domestic
Odontophoridae		Quail – Unid.
Columba flavirostris		Pigeon - Red-billed
Zenaida sp.		Dove – Unid
Amazona sp.		Parrot - Unid
Tyto alba		Barn-Owl - Common
Strigidae		Owl Family
Momotus momota		Motmot - Blue-crowned
Ramphastos sulfuratus		Keel-billed Toucan

Taxon		Common Name
Cotinga amabilis		Lovely Cotinga
Cyanocorax yncas		Jay - Green
Cyanocorax morio		Jay - Brown
Total Bird	**4079**	**255.17g**
Didelphis sp.		Opossum – Unid.
Philander opossum		Opossum - Gray Four-eyed
Chironectes minimus		Opossum - Water
Marmosa robinsoni		Opossum - Robinson's Mouse
Caluromys derbianus		Opossum - C. Am. Woolly
Cryptotis sp.		Shrew – Unid.
Micronycteris megalotis		Bat - Brazilian Small-eared
Carollia brevicauda		Bat - Short-tailed
Sturnira lilium		Bat - Yellow-shouldered
Artibeus lituratus		Bat - Big Fruit-eating
Centurio senex		Bat - Wrinkle-faced
Natalus stramineus		Bat - Mexican Funnel-eared
Dasypus novemcinctus		Armadillo - Nine-banded
Sylvilagus sp.		Rabbit – Unid.
Sciurus sp.		Squirrel
Orthogeomys hispidus		Pocket Gopher – Hispid
Heteromys desmarestianus		Mouse - Desmarest's Spiny Pocket
Ototylomys phyllotis		Rat - Big-eared Climbing
Sigmodon hispidus		Rat - Hispid Cotton
Agouti paca		Paca
Dasyprocta punctata		Agouti - Central American
Urocyon cinereoargenteus		Fox - Gray
Canis familiaris		Dog - Domestic
Procyon lotor		Raccoon
Nasua narica		Coati - White-nosed
Puma concolor		Mountain Lion (Puma, Cougar)
Lepardus pardalis		Ocelot
Lepardus wiedii		Margay
Panthera onca		Jaguar
Tapirus bairdii		Tapir - Baird's
Tayassu pecari		Peccary - White-Lipped
Odocoileus virginianus		Deer - White-tailed
Mazama americana		Deer - Red Brocket
Total Mammal	**59,925**	**7,790.46**

TABLE 1

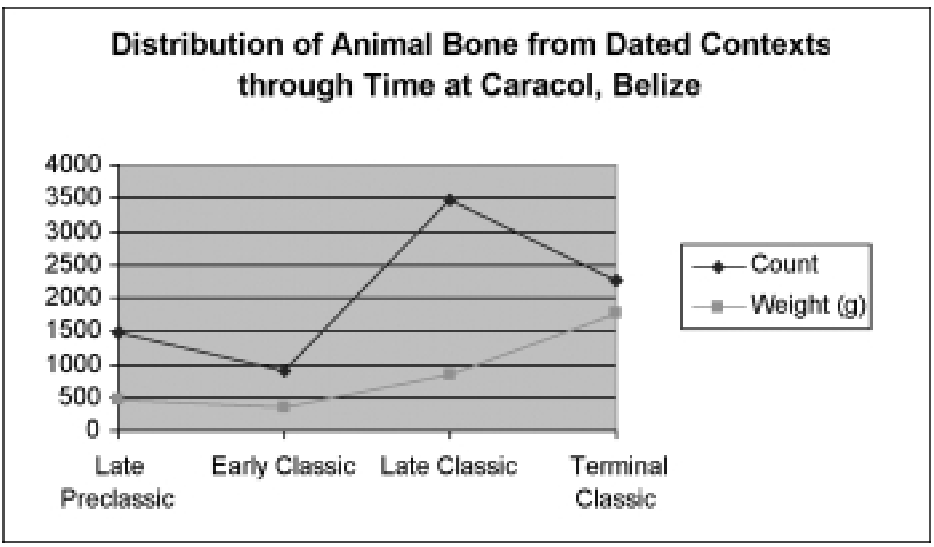
List of identified vertebrate species from Caracol, Belize.

	Epicenter		Core		Terminus		Total	
Context	**Count**	**Weight**	**Count**	**Weight**	**Count**	**Weight**	**Count**	**Weight**
Burial	2286	661.84	2631	866.12	506	208.59	5423	1736.55
Floor	61685	6380.98	59	15.23	0	0.00	61744	6396.21
Cache	510	43.86	62	7.5	0	0.00	572	51.36
Other	160	136.13	18	115	6	13.64	184	264.77
Total	**64641**	**7222.81**	**2770**	**1003.85**	**512**	**222.23**	**67923**	**8448.89**

TABLE 2
Distribution of bone by site area and context.

hout the secondary and A6 material) of the Caracol faunal assemblage counts (NISP) and weights by dated contexts. The quantity and diversity of represented animals indicate that Caracol residents were able to acquire meat for households throughout the city and import products such as marine fish by as early as the Late Preclassic Period. Similar findings at nearby cities dating to the Middle Preclassic, such as Cahal Pech (Powis *et al*., 1999) imply that marine products may have been available even earlier.

The overall trends of faunal remains from dated contexts (Figure 4) at Caracol present interesting results as they are compared with population growth and reduction at the site. While recovered bones do not correlate with the vast quantity of meat that may have been consumed through Caracol's history, we hope that a general reflection of



Time Period	Count (NISP)	Weight (g)
Late Preclassic	1479(18.2%)	451.51
Early Classic	888(11.0%)	338.95
Late Classic	3471(42.9%)	841.56
Terminal Classic	2260(27.9%)	1759.05
SITE TOTAL	**8098(100%)**	**3391.07**

FIGURE 4
Corrected distribution of caracol fauna by dated contexts.

how animal resources were utilized can be discussed. For example, the lower quantities of bone in Early Classic deposits offer several possible explanations: a decline in the use of meat, the use of the bone after meat consumption, or a bias of the data sample. For instance, if more structures are excavated from the Late Preclassic than from the Early Classic, then the dataset could reflect this in the total amount of bone recovered. Or if the disposed animal remains from the Early Classic were reused as fill in the many Late Classic constructions at Caracol, then it would be difficult to correctly date this material, meaning that the overall temporal patterning at the site would be skewed. However, data from other cultural materials and archaeological contexts can be used to help determine the most logical explanation. In this instance, only a few Early Classic structures have been excavated at Caracol, limiting our knowledge and the data sample for this time period.

The spike from Early to Late Classic is logical given the increase in population levels by this point. The hieroglyphically recorded defeat of Tikal initiated a florescence at Caracol that saw the construction of most of the residential groups, causeways, and terraces throughout the city (Chase & Chase, 1989, 1998a). The increase in all faunal material shows the continuance of Caracol's ability to acquire both terrestrial large game and imports from the sea. An apparent increase during the Terminal Classic reflects the large amount of sheet trash recovered from the last occupants leaving the city.

The Caracol faunal assemblage counts can also be used to provide information on the relative distribution of animal remains across the site. Tables 2 and 3 provide an overview of the distribution of faunal remains by site area. The results show more bone in the epicenter, where the site's elite lived. However, more than twice as many excavations have been conducted in the outlying core of Caracol than in its epicenter. Although differential access to meat may explain this distributional pattern, Christine White's stable isotope analysis on Caracol human remains showed that the percentage of meat in the diet was not significantly different across socio-economic groups (Chase *et al*., 1998). It is likely that bone preservation between the Caracol epicenter and the outlying residential core settlement may be a contributing cause.

Differential preservation is likely due to differences in architecture between the epicenter and residential core. Epicentral buildings are usually well-constructed stone structures covered with stucco and plaster coats; a similar architectural situation is also found in some of Caracol's causeway termini. These lime coatings, even when they have fallen off the buildings and covered on-floor deposits, effectively prevent some water percolation and vegetation growth, meaning that there is better preservation in such buildings. Buildings in the residential core were not as well constructed nor as well coated. Thus bone in such areas generally is unprotected from environmental degradation, except when it occurs inside protected architectural spaces such as plaster-capped or covered burials, caches, and fill.

These architectural differences do not prevent conclusions from being drawn from the data, however, especially once the possible contextual biases are recognized. For instance, it is interesting that, while Caracol's epicenter follows the larger trend of faunal use through time, a more even distribution is found in the residential core. In fact a larger percentage of bone is recovered from core contexts dated to the Early Classic than to the Late Preclassic (Table 3). Possibly this pattern results from the occupation of the epicenter before the growth of the core of the city. Clearly, by the Early Classic Period people had begun to inhabit more parts of the city, moving into unoccupied areas.

ANIMAL USE: RESPONSES TO POPULATION PRESSURE

So what does the Caracol faunal assemblage suggest concerning strategies for coping with stresses on environmental resources?

Subsistence Intensification

Landa said that the Maya called the Yucatan the land of turkey and deer (cited in Wing, 1981: 26). Caracol was certainly a land of deer; the excavated assemblage shows deer to be the largest contributor of meat. In fact, deer increases in use proportionally with human occupation over time (Teeter, 2001). Research at cities such as Seibal, Zacaleu, Mayapan, Altar de Sacrificios, Dzibilchaltun, Lubaantun, Tikal, and Macanche has also reported deer as the most important animal in food and ceremony (Woodbury & Trik, 1953; Pollock & Ray, 1957; Olsen, 1972; Wing, 1975; Olsen, 1978;

	Epicenter		Core		Terminus	
Time Period	**Count**	**Weight**	**Count**	**Weight**	**Count**	**Weight**
Late Preclassic	1459	446.10	20	5.41		
Early Classic	10	66.76	878	272.19		
Late Classic	2134	274.38	834	359.30	503	207.88
Terminal Classic	1538	1643.48	722	115.57		
SITE TOTAL	**5141**	**2430.72**	**2454**	**752.47**	**503**	**207.88**

TABLE 3

Corrected distribution of Caracol fauna by site area.

Time Period	*Fish*		*Amphibian*		*Reptiles*	
	Count	*Weight (g)*	*Count*	*Weight (g)*	*Count*	*Weight (g)*
Late Preclassic	60 (31.6%)	10.58	7 (8.4%)	1.34	3 (0.4%)	10.32
Early Classic	14 (7.4%)	4.15	12 (14.5%)	0.53	21 (3.2%)	2.84
Late Classic	91 (47.9%)	22.12	17 (20.5%)	1.90	528 (80.4%)	129.50
Terminal Classic	25 (13.1%)	6.07	47 (56.6%)	1.65	105 (16.0%)	76.76
Total	*190 (100%)*	*42.92*	*83 (100%)*	*5.42*	*657 (100 %)*	*219.42*

TABLE 4a

Dated contexts associated with fish, amphibian, and reptiles.

Time Period	*Birds*		*Mammals*	
	Count	*Weight (g)*	*Count*	*Weight (g)*
Late Preclassic	139 (8.5%)	4.29	1238 (26.3%)	425.88
Early Classic	9 (0.6%)	1.95	837 (17.8%)	331.87
Late Classic	1445 (88.8%)	106.47	1395 (29.6%)	583.38
Terminal Classic	35 (2.1%)	25.26	1238 (26.3%)	1562.87
Total	*1628 (100%)*	*137.97*	*4708 (100%)*	*2904.00*

TABLE 4b

Dated contexts associated with birds and mammals.

Wing & Steadman, 1980; Pohl, 1989: 7; Moholy-Nagy, 1997: 7; Emery, 1999). Exceptions, however, include Cozumel Island, Cerros, Colha, Kichpanha, Lamanai, and Laguna de On, where coastal and riverine habitats provided the main source of food during different time periods (Hamblin, 1984: 138; Shaw, 1985: 3; Carr, 1986: 7; Shaw & Gibson, 1986: 6; Masson, 1995: 2; Emery, 1999). Pohl (1989: 168) hypothesized that residents of inland sites may have prepared deer carcasses to trade with the coastal cities, most likely for marine products. This idea is supported by the fact that deer are restricted primarily to elite contexts at many of the coastal cities just mentioned. As well, Carr (1985) has suggested that Late Preclassic specialists at Cerros were preparing fish for trade inland.

Some researchers believe that, as human population sizes climbed and spread out, eventually the deer ran out of cover and food, forcing the Maya to diversify their diet and manage the remaining deer (Thompson, 1969: 223; Pohl, 1976: 9; Shaw, 1985: 8; Sharer, 1994: 440). The Maya may have developed management strategies that included herding and taming the deer (Carr, 1996). Sex and age distribution profiles can show human selection processes (Klein & Cruz-Uribe, 1984). Although it was impossible in the Caracol assemblage to determine the sex of deer specimens, of the 15% that could be assigned an age, 84% (N = 131) were subadult. Whether this finding was the result of hunting or herding selection cannot be determined with confidence on such a small portion of the overall sample, but it is interesting that there was a general increase in the representation of subadult deer remains through time (Table 5).

Time Period	**Count**	**Weight**
Late Preclassic	2	5.28
Early Classic	**lt Deer**9	2.78
Late Classic	10	2.45
Terminal Classic	93	123.42
SITE TOTAL	**114**	**133.93**

TABLE 5
Distribution of subadult deer through time.

Some evidence for taming does come from the Motul dictionary, which has a term to describe a little deer raised in a house: *ah may* (Pohl & Feldman, 1982: 305). Emery *et al*. (2000) did stable isotope tests on recovered deer remains from the Petexbatun region, but although results showed that corn was included in the diet of deer, the amount of corn in deer diets did not change over time. Thus either deer were constantly fed corn from the very earliest occupation (which Emery believes is doubtful) or they were opportunistically browsing in cornfields. Certainly the extent of the agricultural terraces at Caracol would have been attractive to deer, and the size of the human population would have kept their animal predators to a minimum. Some management of meat distribution seems to have been carried out at Caracol, with mammals such as rabbit, dog, and deer being generally restricted to the epicenter (Table 6).

	Epicenter		**Core**		**Terminus**	
Dog	446	406.36	14	17.84		
Deer	823	1178.42	55	121.72	4	42.16
Rabbit	110	41.44	70	29.81	28	11.92

TABLE 6
Distribution of certain mammals by site area.

	NISP	**# of Taxa**
Late Preclassic	487	14
Early Classic	1004	35
Late Classic	3502	61
Terminal Classic	54,344	66

TABLE 7
Identification of taxa and bone counts through time.

Access to a diversity of animal resources continued and even increased from the Late Preclassic through the final occupation of Caracol during the Terminal Classic (Table 7; Teeter, 2001). Far from being squatting refugees in the ruins of a once great city, the final Caracol residents imported snapper and other marine fish, as well as river turtle; they also had ready access to animals such as peccary, dog, turkey, and deer (Figure 5). Many of the animals could have been imported from farther lands as the city of Caracol grew; however, since

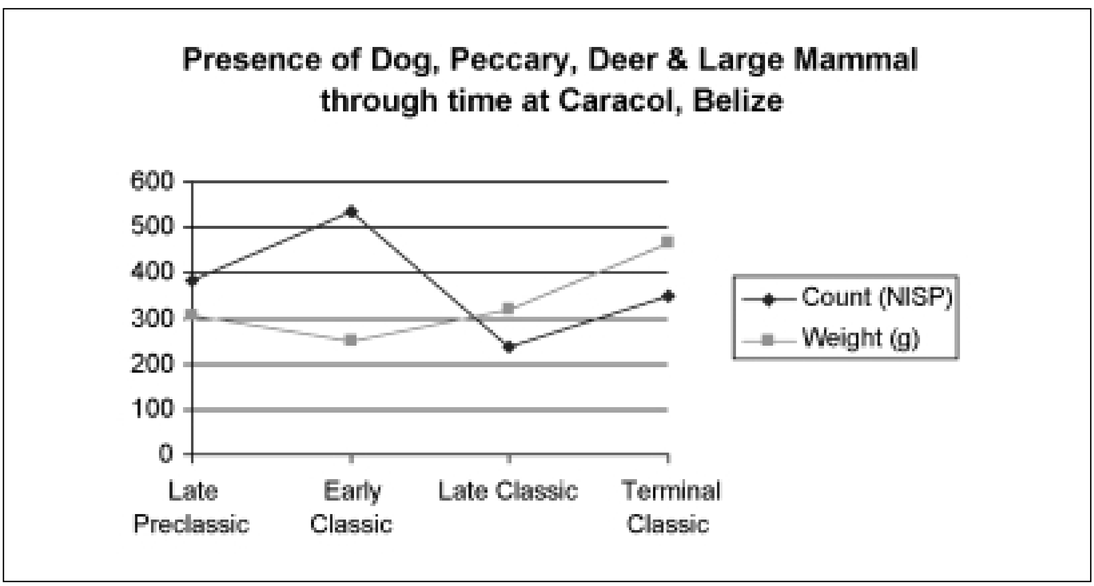


FIGURE 5
Distribution of large mammals from dated contexts.

the resources exploited remained largely the same animals that Caracol residents had always enjoyed, it is hard to know their place of origin. It is always possible that hunting specialists arose to provide meat for the city. Caracol did not rely on commensal animals, although many, such as dog and turkey, contributed to the diet. Reef fish provided the only meat that can be definitively characterized as an import, and while its presence did slightly increase over time, stable isotopic research shows that there was not an increase in dietary contribution for this product (Chase *et al.*, 1998).

Trade

During the Preclassic, Belizean coastal sites such as Cerros, Colha, and Kichpanha exploited a diversity of fish that mirrors Caracol's (Carr, 1985; Shaw, 1985, 1986). Reef fish were most frequently utilized at these sites, even though the sites are at least 20 km away from the reefs. Places such as Ambergris Caye provided initiation trade points to the coast, at least during the Late and Terminal Classic (Guderjan & Garber, 1995: 186). In return, the island and coastal cities received more inland goods and terrestrial animals. For instance, on Ambergris Caye Guatemalan obsidian was recovered (Guderjan & Garber, 1995).

Fish use at Caracol provides a good example of specific environmental exploitation. For example, while the Macal River lies 15 Km away from the city epicenter (Figure 1) and would have provided an abundance of fish, no river fish have yet been recovered from excavations at Caracol. However, evidence for the importation of fish from the Belizean coast has been modest but intriguing. Most of these fish derived from coral reef areas, and their importation would have required logistical planning. Since their presence at Caracol begins in the Late Preclassic, a well-developed trade network must have been in place by this point. Other inland cities benefited from this trade in the Middle Preclassic, such as Cerros (Carr, 1985), and in Late Preclassic, Tikal (Pohl, 1985:110). Although only a few fish remains were recovered in Caracol, their presence is not incidental; the stable isotope analysis on human remains shows the presence of fish in the diet of elite residents (Chase *et al*., 1998). The largest presence of fish remains dates to the Late Classic, not surprisingly, given that period as the apex of Caracol's power, when the larger population would more likely be providing the demand for its importation and wielding increased power over trade routes. A significant drop is seen in the presence of fish in Caracol during the Terminal Classic Period, although fish was still available to the site's epicentral elite.

Other imported items were brought into cities as raw material and then were worked into finished products by specialists for further export and local consumption (Chase & Chase, 1996). For example, at Caracol marine shell was imported from the Belizean coast and made into finished goods at workshops for local and export consumption (Cobos, 1994). It is through specialization that social organization was involved in subsistence intensification.

Specialization

Robert Sharer (1994: 510), along with many others (see Chase & Chase, 1992), believes that, as the Maya became more complex, many different socio-economic groups developed. The increase in specialization put a large middle class between the "haves" and the "have-nots." These included occupational groups, such as scribes, craftsmen in bone, shell, or stone, and agriculturists, as well as warriors, servants, bureaucrats, merchants, bearers, architects, and artists, and other administrative and elite supporting groups (Sharer, 1994: 510). Demonstrating the exact differences among these socio-economic groups is difficult archaeologically. At Caracol, "elite" material markers, such as tombs, inlaid teeth, jadeite, and shell ornaments, are found throughout the city in places that would appear to be otherwise unremarkable (Chase, 1992).

Archaeological and hieroglyphic evidence has shown a complex Maya society that developed a long list of socio-economic groupings for its people. Access to exotic products and resources further divided segments of society and even cities from one another. While shell and lithic workshops have been identified, faunal research at Caracol (Teeter, 2001) has identified animal and meat distribution and management, as well as the optimization of the production of animal by-product goods (tools, ornaments, and musical instruments for example), thus demonstrating the more efficient use of available resources.

Through the distribution of different types of artifacts and debitage, a series of bone-working areas or workshops at Caracol have been distinguished. Identification of workshop areas requires

Bone Type	**A6**	**B34**	**Barrio**	**C Group**	**Central Ac.**	**Walled**	**Total**	**Site Total**
	#	#	#	#	#	#	#	#
Awl	1	2	7	2	3	7	**22**	**44**
Needle		3	4	1	1	1	**10**	**21**
Scraper		2	1		18	1	**22**	**25**
Work. antler	1						**1**	**5**
Press. flaker			2	1			**3**	**5**
Pin/hairpin	6	4	4	21	5	8	**48**	**40**
Tube	6	1	2	6		3	**18**	**26**
Whistle			1	1			**2**	**9**
Pendant	6		4	1	3	3	**17**	**24**
Engraver					5		**5**	**8**
Drilled		380	1			34	**415**	**418**
Carved				1		4	**5**	**14**
Worked	2				1	1	**4**	**8**
Ornament				1			**1**	**3**
Detritus	8	2	6	9		4	**29**	**37**
Total	**30**	**394**	**32**	**44**	**36**	**66**	**602**	**687**

TABLE 8

Types of modified bone in workshop areas.

that a variety of manufacturing evidence be present, depending on the formalization of the production process. Artifacts that are likely to be present at any workshop include "raw materials, partially finished artifacts, mistakes" and "debris, and any special tools or facilities needed for production" (Sharer & Ashmore, 1987: 411).

The most readily visible evidence of manufacturing at Caracol is the debitage from bone working. Although it might seem that bone would be a readily available material that could be processed and manufactured within each household, archaeological evidence recovered from the city has not supported this idea. It is always possible that household manufacturing took place, but the evidence has not survived the archaeological record. However, it is also likely that, as specialization and complexity increased at Caracol, production in bone also was specialized into a few areas of the city. Of all the bone recovered at Caracol, only 37 fragments show signs of the manufacturing process (Teeter, 2001), a very tiny fraction (5%) of the worked bone and an even smaller portion of the entire bone sample recovered from the city. Nine clusters of manufacturing debris have been found, of which all but three are in the northeast area of the city's center.

In the northeast part of Caracol's epicenter, there is significant evidence to support bone-workshop activities (Table 8). An abundant amount of unworked fragmentary bone was found as well as a relatively large number of complete and fragmentary bone objects. The recovered debitage further designates these areas as workshops. The specialized tools that were used in making the bone artifacts are difficult to isolate in the archaeological record. String saws with sand abrasives are possible tools, but, unfortunately, would not likely reach the archaeological record in the tropical environment. Chert and obsidian blades could have been used to score the bone for breakage, but they are too abundant at Caracol to separate bone working from the other activities these types of artifacts served. Future ethnoarchaeological studies may help to elucidate information on a bone-working tool kit.

Caracol's bone artifacts show socio-economic preferences and trends through time, as well as hinting at cultural practices. The distribution of finished goods, such as jewellery and other miscellaneous non-tool bone objects, indicates that the bulk of consumption of worked bone was by the upper middle class (Teeter, 2001). Since the majority (28.6%) of recovered worked bone dates to the Late Classic era, it is likely that the specialization of bone working coincided with the rise in complexity and population after Caracol's successful war campaigns. The variety and quality of bone artifacts attest both to the skill of the workers and to the importance of bone as a raw material at

Caracol. Bone would provide a steady and available resource for the increasing populations that entered Caracol. However, clear lines seem to have existed between socio-economic groups, as evidenced in the distribution of both finished and unfinished bone.

CONCLUSIONS

Responses to growing populations and increasing societal complexity within a city can be recognized archaeologically through the appearance of adaptive mechanisms related to social organization. These focus on technological innovation, subsistence intensification, and/or increased socio-economic differentiation. More complex social organization arises from the need to better manage and utilize stressed resources with increased population levels (Gall & Saxe, 1977; Price, 1977; Hassan, 1981: 250-251; Ford, 1986: 11; Zeder, 1991). From such a situation, a powerful centralized leadership usually emerges to effectively manage the specialization and exchange within the economy (Brumfiel & Earle, 1987: 2; Schwartz, 1994). Specialization with regard to animal resources can take on many forms, from meat distribution to animal management to the production of finished bone products. Specialization is a common solution when natural resources are unevenly distributed or when the production process involves some gradually acquired skills or is embedded in significant economies of scale (Brumfiel & Earle, 1987: 5). Specialization optimizes these services while preserving the skill needed to fulfill these roles (Zeder, 1991). Clearly, bone workshops with specialist workers arose by the Late Classic, suggesting that, for the general populace, the time needed to make bone tools and jewellery was better spent on other tasks.

Given the human population levels known for Caracol, some form of management had to take place. The evidence from this research that Caracol's political and economic systems were sufficiently complex to achieve some form of stasis with the environment – so that animal resources could be provided to Caracol residents and so that trade networks could be maintained with the Belizean coast – testifies to the site's efficient management and social organization through time.

What is recognizable in the analysis of the Caracol faunal material is the increased presence of animal imports, differentiation in animal distribution, and specialization of bone working. The faunal remains from Caracol affirm a high level of social organization from the Late Preclassic through the Terminal Classic era, as well as the continued existence of a trade network that fully articulated with Belizean coastal sites. These remains also highlight the adaptive mechanisms that were put into place in order for animal resources to be provided to a fast-growing and vibrant community during the Late Classic. Finally, the analysis of Caracol's faunal remains attests to the availability of resources and imports during the Terminal Classic era, when the Lowland Maya are often portrayed as being in extreme societal decline.

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