

## **Identification and Interpretation of Mammalian Archaeofaunal Specimens Recovered from Las Vegas Contexts in Southwestern Ecuador**

This study presents an analysis of all available mammalian archaeofaunal specimens recovered from excavations of Las Vegas archaeological sites in Santa Elena province, southwestern Ecuador. Analysed assemblages in this study include specimens that had been curated since the 1970s in the collections of the Environmental Archaeology Program of the Florida Museum of Natural History (FLMNH), and specimens that were stored at the field laboratory in Cautivo, Santa Elena Province, Ecuador. The entire assemblage was sorted in Cautivo and at the Archaeological Analytical Research Facility (AARF) of Binghamton University. Fish specimens and herpetological and avian specimens were sent in their original containers with recorded provenience information inside curation-grade boxes to the Musée National d' Histoire Naturelle (MNHN) and Millsaps College, respectively. The mammalian specimens were identified through comparison with the collections at the AARF and additional identifications were undertaken in the Department of Mammology, American Museum of Natural History (AMNH). Upon completion of this study, which was undertaken with funding support from the National Science Foundation (BCS0739602), all materials were repackaged in their original containers with recorded provenience information and returned in labeled curation-grade boxes for permanent storage to the FLMNH. A total of 41,633 specimens from seven archaeological sites were studied and inventoried for this report (Table 1).

**Table 1. Total Number (N=41,633) of Studied Specimens by Site**

<b>Site</b>	<b>Number of Specimens</b>
<b>OGSE-38</b>	244
<b>OGSE-63</b>	717
<b>OGSE-66</b>	162
<b>OGSE-67</b>	2,927
<b>OGSE-78</b>	39
<b>OGSE-80</b>	37,540
<b>OGSE-203</b>	4

The specimen identifications are further listed by taxon, number of identified specimens (NISP) and estimations of the minimum number of individuals (MNI) for each site in the Las Vegas archaeofaunal collection (Tables 2-8). Table 9 lists the names of identified specimens based upon contemporary species distributions (Tirira 2007).

**Table 2. OGSE-80 (n=37,540) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate	11,180		
Indeterminate Mammal	18,413		
<i>Didelphis</i>	74	3	42
<i>Didelphis</i> cf.	2		
<i>Tamandua</i>	12	2	9
<i>Homo</i>	1		
Indeterminate Carnivora	408		
Indeterminate Canidae	3		
<i>Lycalopex</i>	2,699	75	251
<i>Lycalopex</i> cf.	21		
Indeterminate Mustelidae	1		
Indeterminate Felidae	1		
<i>Leopardus</i>	1	1	1
<i>Leopardus</i> cf. <i>pardalis</i>	3	1	2
<i>Leopardus</i> cf. <i>yagouaroundi</i>	2	1	2
Indeterminate Cetacea	1		
Indeterminate Artiodactyla	67		
<i>Tayassu</i>	23	1	20
Indeterminate Cervidae	118		
<i>Mazama</i>	355	8	93
<i>Mazama</i> cf.	1		
<i>Odocoileus</i>	2	1	2
Indeterminate Rodentia	3,125		
<i>Sciurus</i>	5	1	4
<i>Sciurus</i> cf.	6		
Indeterminate Sigmodontinae	3		
Oryzimini	7		
<i>Sigmodon</i>	599	193	243
<i>Dasyprocta</i>	5	1	4
<i>Dasyprocta</i> cf.	3		
<i>Proechimys</i>	61	20	33
<i>Proechimys</i> cf.	64		
<i>Sylvilagus</i>	269	18	87
<i>Sylvilagus</i> cf.	5		

**Table 3. OGSE-66 (n=162) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate	23		
Indeterminate Mammal	119		
Cervidae	5		
<i>Mazama</i>	13	1	1
Indeterminate Rodentia	1		
<i>Sylvilagus</i>	1	1	1

**Table 4. OGSE-67 (n=2,927) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate	1,072		
Indeterminate Mammal	1,513		
<i>Didelphis</i>	12	1	4
<i>Tamandua</i>	1	1	1
Indeterminate Carnivora	6		
<i>Lycalopex</i>	27	2	8
<i>Lycalopex</i> cf.	1		
Indeterminate Artiodactyla	1		
<i>Tayassu</i>	1	1	1
Cervidae	4		
<i>Mazama</i>	21	1	7
Indeterminate Rodentia	197		
<i>Sciurus</i>	2	1	2
<i>Sciurus</i> cf.	1		
Indeterminate Sigmodontinae	1		
<i>Aegialomys</i> cf.	1	1	1
<i>Sigmodon</i>	26	5	16
<i>Proechimys</i>	14	2	3
<i>Sylvilagus</i>	23	2	7
<i>Sylvilagus</i> cf.	3		

**Table 5. OGSE-78 (n=39) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate Mammal	31		
<i>Lycalopex</i>	7	1	1
<i>Mazama</i>	1	1	1

**Table 6. OGSE-203 (n=4) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate Mammal	4		

**Table 7. OGSE-38 (n=244) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate	91		
Indeterminate Mammal	125		
<i>Lycalopex</i>	7	1	2
Indeterminate Artiodactyla	2		
Cervidae	4		
<i>Mazama</i>	13	3	3
Indeterminate Rodentia	2		

**Table 8. OGSE-63 (n=717) Taxonomic List of Identifications with NISP (Number of Identified Specimens) with Minimum (calculated for entire site) and Maximum (calculated for separated archaeological contexts) MNI (Minimum Number of Individuals) estimates for Genus-level Identifications**

Identification	NISP	MNI <sub>Min</sub>	MNI <sub>Max</sub>
Indeterminate	79		
Indeterminate Mammal	564		
Indeterminate Artiodactyla	3		
Cervidae	18		
<i>Mazama</i>	53	3	10

**Table 9. Names of Identified Specimens based upon Contemporary Species Distributions**

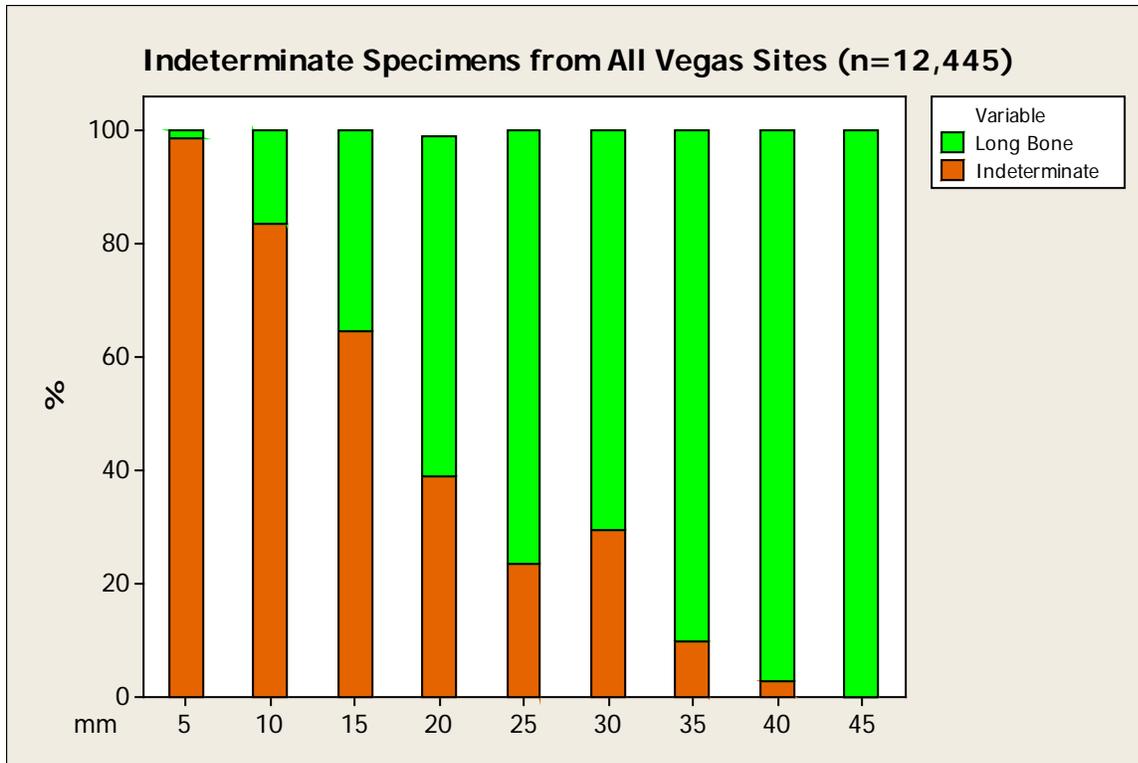
<i>Didelphis marsupialis</i>	Common Opossum	Zarigüeya Común
<i>Tamandua mexicana</i>	Tamandua	Oso Hormiguero de Occidente
Carnivora	Carnivores	Carnívoros
Canidae	Dogs	Perros
<i>Lycalopex sechurae</i>	Sechuran Fox	Perro de Monte de Sechura
Mustelidae	Weasels	Nutrias y Comadreas
Felidae	Cats	Gatos
<i>Leopardus pardalis</i>	Ocelot	Ocelote
<i>Puma (Leopardus) yagouaroundi</i>	Jaguarundi	Yaguarundi
Cetacea	Whales and Dolphins	Ballenas y Delfines
Artiodactyla	Even-toed Ungulates	Ungulados de Dedos Pares
<i>Pecari tajacu</i>	Collared Peccary	Pecarí de Collar
<i>Tayassu pecari</i>	White-lipped Peccary	Pecarí de Labio Blanco
Cervidae	Deer	Venados
<i>Mazama americana</i>	Brocket Deer	Venado Colorado
<i>Odocoileus virginianus</i>	White-tailed Deer	Venado de Cola Blanco

Rodentia	Rodents	Roedores
Sciuridae	Squirrels	Ardillas
Sigmodontinae	New World Rats/Mice	Ratas/Ratones Nuevo Mundo
Oryzomini	Oryzomyine Rodent	Roedor Oryzomyine
<i>Aegialomys xanthesolus</i>	Yellowish Coastal Rat	Rata Costera Amarillenta
<i>Sigmodon peruanus</i>	Cotton Rat	Rata Algodonera Peruana
<i>Dasyprocta punctata</i>	Agouti	Guatusa de la Costa
<i>Proechimys decumanus</i>	Pacific Spiny Rat	Rata Espinosa del Pacífico
<i>Proechimys semispinosus</i>	Spiny Rat	Rata Espinsa de Tomes
<i>Sylvilagus brasiliensis</i>	Rabbit	Conejo Silvestre

## General Description of the Total Las Vegas Archaeofaunal Assemblage Compiled from All Sites

### Indeterminate Specimens

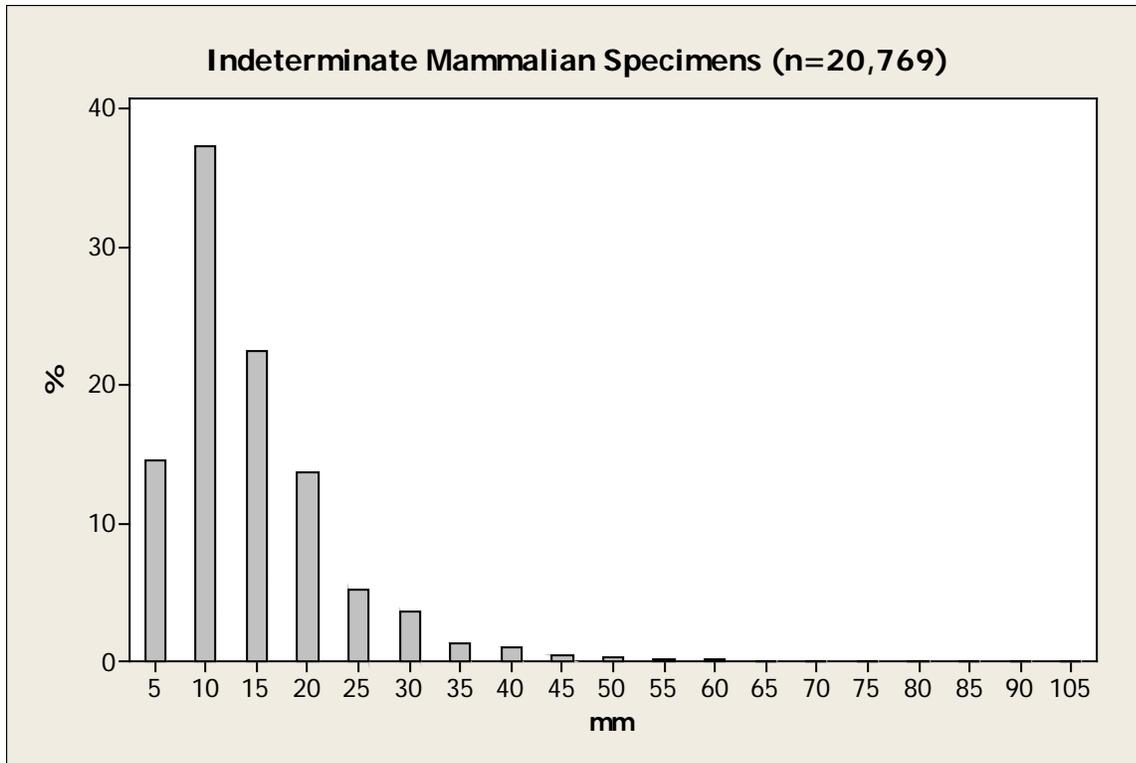
A total of 12,445 specimens (29.9%) in the assemblage from all studied Vegas archaeological sites include indeterminate fragments that could not be reliably identified to the level of zoological class. With the exception of one 20 mm rib shaft specimen, all are either fragments of indeterminate anatomical origin or long bone shafts. Figure 1 graphs the relationship between indeterminate fragments and indeterminate long bone fragments according to maximum size in 5 mm unit increments. Most of the indeterminate specimens (n= 10,491, 84.3%) consist of non-identifiable fragments under 10 mm in maximum size. As expected, the proportion of indeterminate long bone specimens increases with maximum size.



**Figure 1. Relative Proportions of Indeterminate/Long Bone Specimens from all Las Vegas Sites.**

### **Indeterminate Mammalian Specimens**

One half of the entire assemblage (n=20,769, 49.9%) is composed of indeterminate mammalian specimens, the majority of which includes indeterminate and unidentified long bone fragments (n=19,424, 93.5%). These are dominated (n=13,128, 63.2%) by specimens under 15 mm in maximum size (Figure 2). The remaining specimens include fragments of mammalian vertebrae and sterna (n=743), ribs (n=261), crania (n=133), phalanges (n=67), teeth (n=39), and dentary (n=34), and indeterminate fragments of mammalian post cranial elements (n=68) too small to be reliably identified to the level of zoological order.



**Figure 2. Proportionate Size Range of Indeterminate Mammalian Specimens (n=20,769)**

### **Didelphimorphia**

Numerous specimens of a large opossum, identified as *Didelphis* were recovered from OGSE-80 (n= 76) and OGSE-76 (n=12). The large (Head-Body, 324-500mm, Weight, 750-2500g) common opossum (*Didelphis marsupialis*) is ubiquitous in most lowland forests in northwestern South America, but excludes arid and semi-arid habitats from its range (Cerqueira and Tribe 2007). In Ecuador, it is found throughout a wide variety of habitats below 1000 masl, including anthropogenic settings. Solitary and nocturnal, it is an omnivorous opportunist that can feed on a wide range of plant and animal foods (Tirira 2007:69-70). The majority of specimens recovered from Las Vegas contexts consist of highly identifiable vertebrae (n=69, 78.4%), teeth (n=7, 8.7%), elements bearing teeth (n=5, 5.7%), in addition to a few cranial (occipital, n=2) and appendicular (hip, n=2, humerus, n=3, and ulna, n=1) specimens.

### **Pilosa**

A small number (n=13) of specimens identified as Tamandua (*Tamandua mexicana*) were recovered from deposits at OGSE-80 (n=12) and OGSE-67 (n=1). A subspecific form of northern Tamandua, *T. m. punensis*, is recognized for southwestern Ecuador and northwestern Peru, where it is relatively common (Gardner 2007). A medium-sized (Head-Body, 770-1300mm, Weight, 3.2-7.0kg) solitary, diurnal and nocturnal anteater, the Tamandua forages in trees and

on the ground principally for termites, ants, and also bees. It can occupy a variety of habitats including open areas between 0-1800 m throughout the western lowlands (Tirira 2007:110-111). The northern Tamandua has been recorded in evergreen, deciduous tropical forest, mangrove, second-growth forest, savanna, gallery forest, mist forest, and transformed habitats, and although it spends almost half of its time in trees, it can move, feed, and rest on the ground as it passes between arboreal habitats (Navarrete and Ortega 2011:60). The majority of identified specimens in the assemblage include distinctive phalanges (n=9, 69%) in addition to an astragalus (n=1), humerus (n=1) and ulna (n=2).

### **Carnivora**

A sizeable number of recovered medium-sized carnivore specimens (n=414) could not be reliably identified to the level of zoological family or lower. Some incisors, canines and fragmented molars (n=36, 8.7%) are included, but the bulk (n=373, 90.1%) were isolated first to third phalangeal specimens. Although not identified to the level of genus, the latter were factored into survivorship estimations for medium-sized canids at OGSE-80.

**Canidae** Identified specimens in the assemblage are dominated by fragments of a very small dog. Attempts at extracting aDNA from dental elements were unsuccessful due to a lack of any preserved organic fraction. Currently, the endemic Sechuran fox (*Lycalopex sechurae*) is the only native canid in the area. Much smaller than the common páramo fox of the highlands, the Sechuran fox (Head-Body, 445-780 mm, Weight, 2.2-4.2kg) is principally a solitary, nocturnal animal that is also active at dawn and dusk. A highly opportunistic canid, it inhabits dry lowland forests between 0-1800 masl and frequents anthropogenic settings (Tirira 2007:369-370). Today, it is restricted to the coastal areas of southwestern Ecuadorian and northwestern Peruvian between 3 and 12 degrees south latitude, principally in disturbed environments and rural areas with habitats ranging from sandy deserts to dry forests. A generalist omnivore that prefers vertebrate prey and carrion, it can subsist entirely on fruits as well as insects and scorpions (Asa and Cossíos 2004). Its small size, behavior, diet, and ability to survive without drinking is suggestive of adaptation to desertic conditions. Although considered common today on Peru's north coast, its presence in the Santa Elena area is principally established on the basis of preservation in paleontological and archaeological contexts (Cossíos 2010). A total of 2,762 specimens are identified as *Lycalopex* and represent all portions of the skeleton. The sample is dominated by lower limb elements (n=1,265, 45.8%), followed by upper limb elements (n=564, 20.4%), skull and teeth (n=553, 20%), and vertebrae (n=380, 13.8%). Differential skeletal representation at OGSE-80 is detailed below.

**Mustelidae** One distal tibia of an unidentified mustelid was recovered from OGSE-80. This specimen could have originated from any one of a number of native mustelids currently inhabiting southwestern Ecuador, including otter, eiras, and hurons.

**Felidae** A small number (n=7) of felid specimens were recovered from site OGSE-80. All appear to be from medium- to small-size felids. Currently, four smaller cats inhabit the western lowlands. The ocelot (*Leopardus pardalis*) ranges in head-body dimensions between 700-900 mm and weighs between 8-14.5 kg. It is the largest of the smaller cats which also include tigrillo (*L. tigrinus*, Head-Body 452-648, Weight, 1.5-3 kg), margay (*L. weidii*, Head-Body, 501-660, Weight, 3-9 kg.), and jaguarundi (*Puma [Leopardus] yagouaroundi*, Head-Body, 505-645, Weight, 4.5-9.0kg). All are solitary carnivores that feed on smaller vertebrates. With the exception of one complete phalanx, these specimens were tentatively identified through comparison with museum specimens as possible ocelot and jaguarundi. The ocelot is perhaps the least arboreal of the four species, and inhabits dry forests with good vegetational cover from 0-1500 masl. Preferring areas closer to water sources, it is known to utilize human trails (Tirira 2007:359-362). A subspecific form, *L.p. pusaea*, is identified for southwestern Ecuador and northwestern Peru. Although found in a diverse array of habitats, ocelots are strongly associated with vegetational cover which they will utilize as corridors through otherwise open areas. Ocelots will hunt in trees but are most efficient as terrestrial hunters of small vertebrate prey, mainly small mammals (Murray and Gardner 1997). All identified bones are of the lower limb. Two limb bones of a slightly smaller cat, possibly jaguarundi were tentatively identified at OGSE-80. A nocturnal and diurnal cat, the jaguarundi is often most active in early and late daylight hours when it hunts for small vertebrates, mainly small rodents, birds, and reptiles. In Belize, diurnal jaguarundis have been observed, suggesting a possible temporal segregation from potentially competing ocelots. Jaguarundis inhabit all forests between 0-1800 masl and are often found in anthropogenic settings (de Oliveira 1998; Tirira 2007:364-365).

### **Cetacea**

The largest vertebrate specimen (190 mm) recovered in the assemblage is an unidentified fragment that may have been a piece of a large marine mammal dentary. The closest match is to that of a small- to medium-size whale, possibly of the family Ziphiidae or beaked whales. From its appearance, it is possible that this specimen may have originated as a beached specimen which was subsequently scavenged.

### **Artiodactyla**

A total of 73 specimens were identified as fragments of indeterminate artiodactyl (two-toed ungulates) skeletons. Most of these specimens are likely derived from relatively large animals. The majority of indeterminate artiodactyls specimens (n=39, 53.4%) are from the head (cranial, dental, dentary, antler fragments), and mainly include the petrous portion of the temporal bone. The high survivorship of the durable petrous portion is consistent with the density-mediated survivorship of vertebrate bone specimens at OGSE-80 discussed below.

**Tayassuidae.** Currently two genera of peccaries range throughout the western and Amazonian lowlands and montañas of Ecuador in humid and dry forests between 0-1600 masl. Highly adaptable, the smaller collared peccary (*Pecari tajacu*) is abundant and widely distributed in woodlands, tropical dry and rain forests, savannas, and deserts (Bodmer and SOWLS 1993). It typically has head-body ranges from 800-980 mm and weighs between 17-35 kg. A diurnal and crepuscular animal with major activity during early and later hours of the day, the collared peccary is gregarious, ranging in small herds of usually no more than nine individuals, foraging principally on fallen fruits, but incorporating a catholic diet of browse, roots and tubers, mushrooms, invertebrates and small vertebrates. The white-lipped peccary (*Tayassu pecari*) is larger with head-body ranges from 950-1100 mm and weights between 25-45 kg. A principally diurnal animal with similar habitat preferences and diet to that of the collared peccary, it is known to roam around large territories in maximal herds of between 50-300 individuals (Tirira 2007:406-409). Of the 24 specimens identified as peccary, 23 were recovered from OGSE-80. They include: 10 dental (5 canine, 5 molar), 2 dentary, 1 humerus, 1 patella, 1 tibia, 1 magnum, 1 navicular, 1 astragalus, 2 metacarpi, and 4 phalangeal specimens.

**Cervidae.** Currently two monospecific genera of deer, *Mazama* and *Odocoileus*, range into the western lowlands and the Santa Elena peninsula; the remaining genera of native Ecuadorian deer are either highland or Amazonian forms. *Mazama* tend to be of medium-size, however their live dimensions can overlap with smaller *Odocoileus*. All deer specimens, where their state of preservation allowed it, were further identified as either small, medium, or large cervids. A total of 149 cervid specimens were not identified to genus: 75 specimens were identified as deer without a corresponding size category, and most of these consisted of tooth and antler fragments (n=48, 64%); 46 specimens were fragments from various regions of the skeleton of larger cervids; 27 from medium-sized cervids; and one almost complete cervical vertebra of a small deer. All unspecified cervid specimens for which a density scan site could be assigned, are included in the estimations of assemblage preservation for OGSE-80 which are dealt with below.

Ecuadorian Brouck Deer (*M. americana*) are of medium size with Head-Body ranges from 900-1400 mm and weights between 12-48 kg. Adult males differ skeletally from *Odocoileus* in the possession of short and erect, non-branching antlers. A solitary and terrestrial browser, red brouckets are mainly active in the evening and at night when they browse principally on trees, bushes and fruit. Built for denser vegetation, they seek refuge in areas of denser undergrowth and are found in dry tropical forests, including primary, secondary, and gallery formations, but are rarely seen in open areas (Tirira 2007:414-416). In Suriname, white-tailed deer inhabit coastal marshes and savannas, whereas red broucket deer are found in interior forests where they subsist principally on reproductive plant parts like flowers and fruits that fall from the midstory canopy (Branan et al. 1985). Skeletal specimens identified as deriving from a medium

cervid skeleton, likely that of *Mazama* (n=457), are dominated by lower limb elements (n=317, 69.4%), predominantly phalanges (n=146, 31.9%), and to a lesser extent skull and tooth specimens (n=74, 16.2%), upper limb specimens (n=47, 10.3%), and vertebral and sternal specimens (n=19, 4.1%). Differential skeletal representation at OGSE-80 will be detailed later.

Two large specimens, a right upper molar, and a right distal tibia were provisionally identified as white-tailed deer (*Odocoileus*). Contemporary *O. peruvianus* are of relatively large size with Head-Body measurements ranging from 1130-2260 mm and weights between 50-120 kg. Coastal populations are separated from their highland congeners, where they inhabit dry tropical forests in the southwest between 0-1000 masl. Although young males can carry non-branching antlers, mature males are the only Ecuadorian cervid with multiple branching antlers. The usually solitary white-tailed deer is active both day night and can browse and graze principally in open areas, frequently seeking refuge in vegetation (Tirira 2007:418-419). White-tailed deer in regularly inundated Venezuelan savannas incorporate seasonally available browse and grasses into their diets (Brokx and Andressen 1970). Savannas are their primary habitat in South America, yet white-tailed deer benefit significantly from mosaics of second-growth forests, openings, and agricultural lands which mimic natural disturbances. Particularly in and around areas of human disturbance they can become less crepuscular; however, their distribution and density in less forested areas are directly related to local abundance of riparian and woody cover (Smith 1991).

## **Rodentia**

Most non-tooth bearing specimens of small- (n= 3,232) to medium-size (n= 93) rodents were not identified to categories zoological lower than order. The assemblage of indeterminate small- to medium-sized rodents is dominated by elements of the hind limb and head (Table 10), a pattern that will be investigated in further detail at OGSE-80 below.

**Table 10. Indeterminate small- to medium-sized rodent specimens by body region**

Skull	34
Dentary	346
Teeth	146 (Incisors=144, Molar=2)
Vertebra	67
Scapula	3
Humerus	131
Radius	3
Ulna	27
Metapodium	9
Phalange	4
Sacrum	1
Hip	278
Femur	1808
Astragalus	23
Calcaneum	39
Tibia	406

**Sciuridae.** A few (n=14) specimens from OGSE-67 and OGSE-80 are identified as preserved fragments of medium- and large-sized sciurid rodents. Currently, the only squirrel inhabiting the western lowlands is the Guayaquil squirrel (*Sciurus stramineus*). A medium- to large-size rodent (Head-Body, 180-320 mm, Weight, 470 g), its major habitat includes dry forests in central and southern coastal areas of Ecuador but it is also present in various forest formations. Population levels can be particularly high in cultivated areas where it can become an agricultural pest (Tirira 2007:148). In northern Peru, the Guayaquil squirrel is a primary prey item of the Sechuran fox, where it is also found in association with white-tailed deer, collared peccary, puma, tayra, ocelot and jaguar. Diurnal and arboreal, it persists in cities and anthropogenically fragmented landscapes. Introduced populations in Lima have catholic diets including reproductive plant parts, stalks, sap, insects, and mushrooms (Merrick et al. 2012).

**Cricetidae.** A number of fragments were identified as preserved specimens of rodents; however, their state of preservation inhibited identification to the level of genus. These include specimens (n= 4) tentatively identified as indeterminate sigmodontinae, one of three subfamilies of the New World rats and mice (Cricetidae). A few poorly preserved teeth (n=7), some still in their sockets, were identified as oryzomyine rodents, a tribe of the sigmodontinae which has undergone extensive revision (Weksler 2006; Weksler et al. 2006). One preserved dentary with first molar from OGSE-67 compared favorably with examples of yellowish coastal rat (*Aegialomys xanthaeolus*). This medium-sized oryzomyine rodent currently inhabits the central and southwestern coast from 0-1600 m; however, little is known other than it is a

solitary, nocturnal, and terrestrial species. It is present in a range of primary, secondary and disturbed, arid, dry, and humid forests with undergrowth (Tirira 2007:154-155). The cotton rat (*Sigmodon peruanus*) is the most abundant rodent genus in the assemblage (n= 625). Identified almost exclusively on the basis of isolated teeth and tooth-bearing bones, there is a particularly large number of identifiably *Sigmodon* specimens at site OGSE-80, and these also appear in marked spatial concentrations. This point will be explored below. Cotton rats are medium-sized rodents (Head-Body, 109-172 mm, Weight, 72g) that inhabit the western coastal lowlands mainly below 600 masl in central and southern Ecuador. They are present in a variety of forests, gallery formations and forest borders, with a preference for habitats around small rivers (Tirira 2007:190-191). They are often associated with xeric, semiarid and deforested landscapes (Voss 1992:34).

**Dasyproctidae** A small number (n= 8) of specimens recovered from OGSE-80 are identified as agouti (*Dasyprocta punctata*), including the following elements: occipital (n=1), hip (n=3), tibia (n=3), and calcaneum (n=1). The large (Head-Body, 450-600 mm, Weight, 3-5 kg) coastal agouti currently inhabits the dry and humid forests of western lowland Ecuador, usually below 1000 masl. Found in different forest formations as well as in borders and agricultural habitats, it is generally diurnal and terrestrial, feeding principally on seeds and fruits, especially palms (Tirira 2007:216-217). Agoutis are the principal prey of ocelots and jaguarundis in central Panamá, where mated pairs occupy approximately two hectare territories that usually include a length of creek bed and fruiting trees. Agouti have been known to follow arboreal monkey troops in search of falling fruit, and are functionally important seed dispersers through their scatter hoarding. Potential competition over resources is achieved through the temporal partitioning of activity patterns between diurnal agoutis and collared peccary, and nocturnal opossum, pacas, spiny rats and tapir (Smythe 1978).

**Echimyidae** Various specimens of spiny rat are identified in the assemblages from OGSE-80 (n= 125) and OGSE-67 (n= 14). They include the following preserved specimens: maxilla (n=3), dentary (n=32), molar (n=10), humerus (n=26), radius (n=1), ulna (n=1), hip (n=3), femur (n=52), and tibia (n=11). Currently, two species of spiny rat are recognized in western Ecuador, the Pacific spiny rat (*Proechimys decumanus*) of the southwestern lowlands, and a spiny rat (*Proechimys semispinosus*) with broader distribution throughout the western lowlands. Both tend to be found at elevations below 700-800 masl. The former is generally smaller (Head-Body, 161-245 mm, Weight, 120-450 g) than the latter (Head-Body, 221-279 mm, Weight, 320-536g). The better known *P. semispinosus* feeds on seeds and fruits, is highly adaptable in cultivated settings, and prefers areas closer to rivers. It is known to be docile and easy to manage in captivity (Tirira 2007:232-234). Spiny rats are often the most abundant and widely distributed frugivores and granivores wherever they range, and along with agoutis are implicated in seed predation and dispersal (Adler and Kestell 1998).

## Lagomorpha

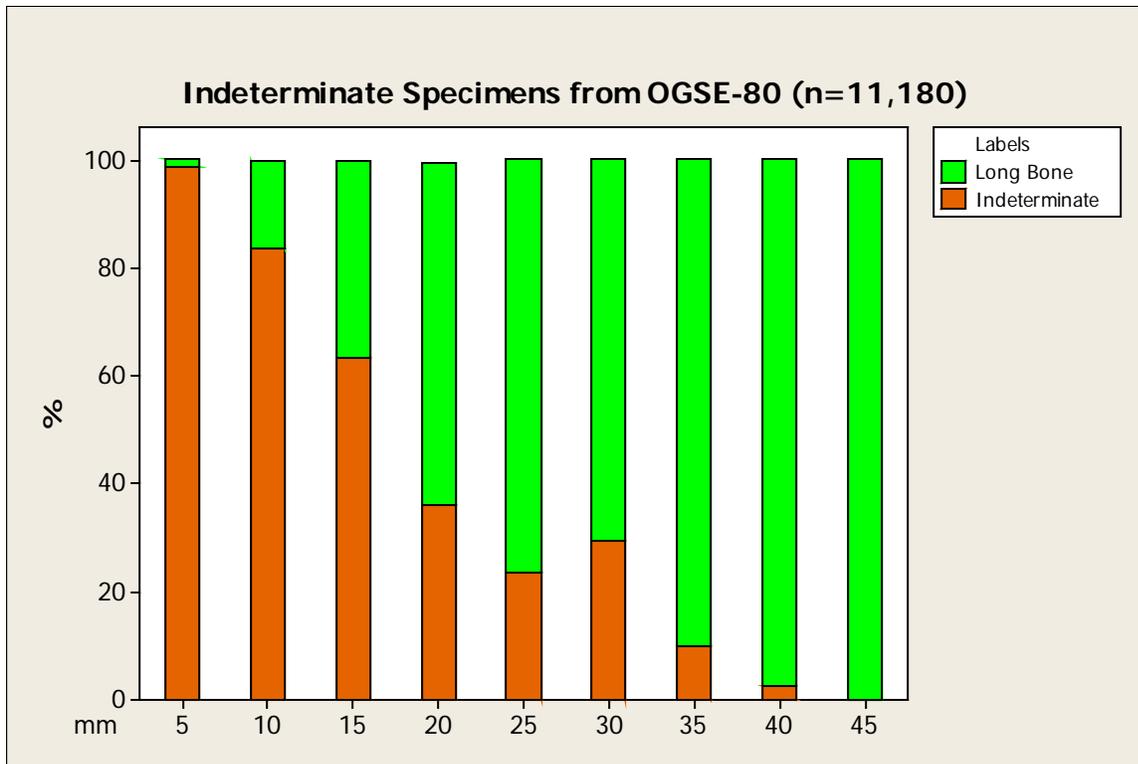
The medium-sized (Head-Body 268-400 mm, Weight, 680-1250 g) forest rabbit (*Sylvilagus brasiliensis*) is found throughout Ecuador, reportedly in a variety of habitats from 0-4800 masl. Principally nocturnal, it is also active during twilight hours, when it browses on vegetation (Tirira 2007:236-237). Forest rabbits live in a variety of habitats throughout their range, except for high altitudes above the snow line. They appear to survive well in second growth and pastures, yet their relative abundance declines through deforestation. In northern South America, their ranges are mutually exclusive of eastern cottontail rabbits, which are replacing forest rabbits as grasslands are created through forest modification (Chapman and Ceballos 1990). A relatively large number (n= 301) of specimens have been identified in the assemblages from three sites (OGSE-66, 67, 80), including: skull (n= 25), teeth (n= 6), dentary (n= 59), scapula (n= 20), humerus (n= 40), radius (n= 6), ulna (n= 4), metapodium (n= 15), phalange (n= 3), vertebra (n= 12), hip (n= 29), femur (n= 35), tibia (n= 24), astragalus (n= 3), and calcaneum (n= 20). An analysis of rabbit specimens is treated separately below.

### **Spatial Distribution, Differential Preservation, and Accumulation of Mammalian Specimens at OGSE-80**

A total of 11,180 specimens (29.8%) in the assemblage from site OGSE-80 are indeterminate fragments that could not be reliably identified to the zoological level of class. With the exception of one 20 mm rib shaft specimen and one 10 mm unidentifiable phalanx fragment, the majority of these specimens are either of indeterminate anatomical origin or long bone shaft fragments (Table 11). The inability to identify the bulk (89.4%) of indeterminate specimens to any anatomical origin is linked to specimen size which is directly associated with degree of fragmentation (Figure 3). Extensive fragmentation typifies the entire Vegas archaeofaunal collection (Figure 1) and is a common characteristic of bone preservation throughout southwestern Ecuador.

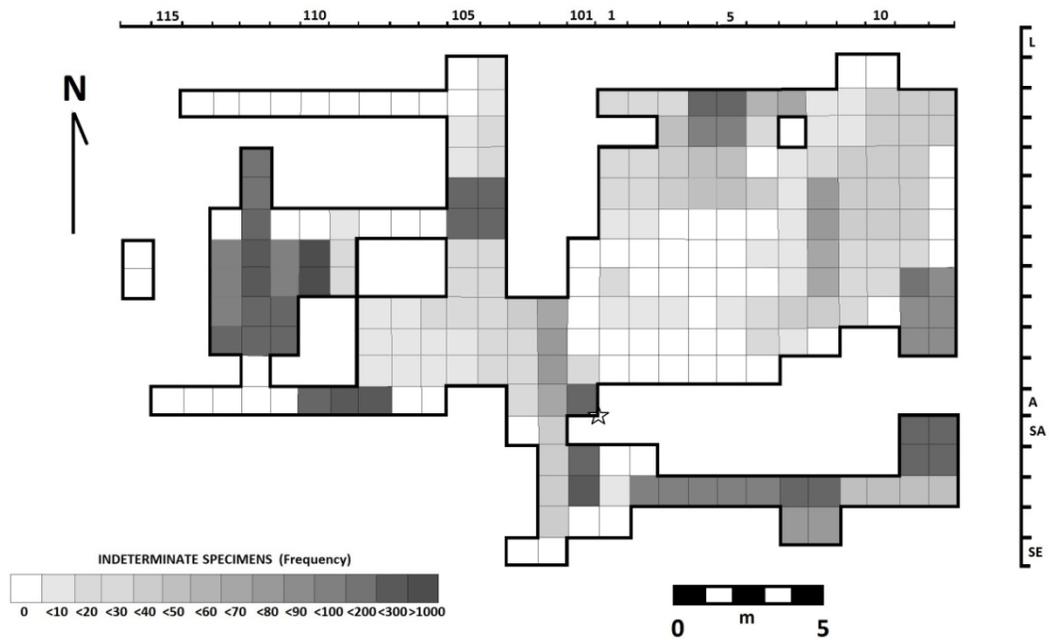
**Table 11. Indeterminate specimen preservation at OGSE-80**

mm	Indeterminate	Long Bone
5	6671	94
10	2681	532
15	548	317
20	72	127
25	16	55
30	5	12
35	1	9
40	1	36
45	0	1



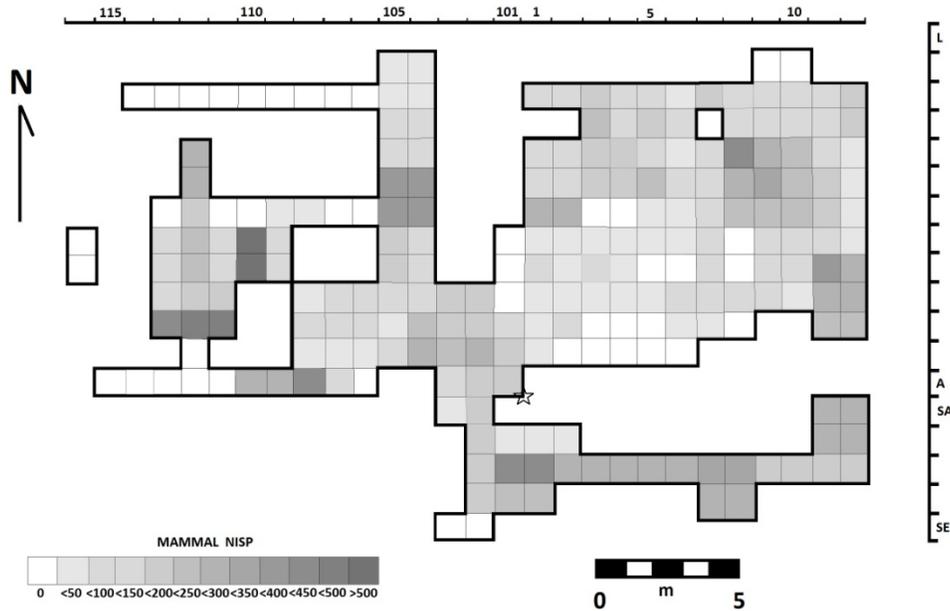
**Figure 3. Relative Proportions of Indeterminate/Long Bone Specimens from OGSE-80.**

The spatial distributions of indeterminate specimens recovered from the main excavation area of OGSE-80 are plotted in Figure 4. The distribution of indeterminate specimens, and by implication increased fragmentation of specimens, appears to be concentrated in certain areas of the central excavation unit. Dense concentrations of intensive fragmentation are particularly pronounced in the western portion of the excavation units between coordinates C-H north and 108-113 west of datum, and units A-SD south of datum (Figure 4) .



**Figure 4. Spatial Distribution of Indeterminate Specimens at OGSE-80**

The spatial distribution of all archaeofaunal specimens recovered from OGSE-80 that could be reasonably identified as of mammalian origin is presented in Figure 5. They represent the bulk of archaeofaunal specimens reported here from OGSE-80 (n= 26,270, 70.1%). Subsequent spatial distributions will explore specific subsets of this archaeofaunal subassemblage in order to examine issues of specimen preservation and accumulation at OGSE-80.



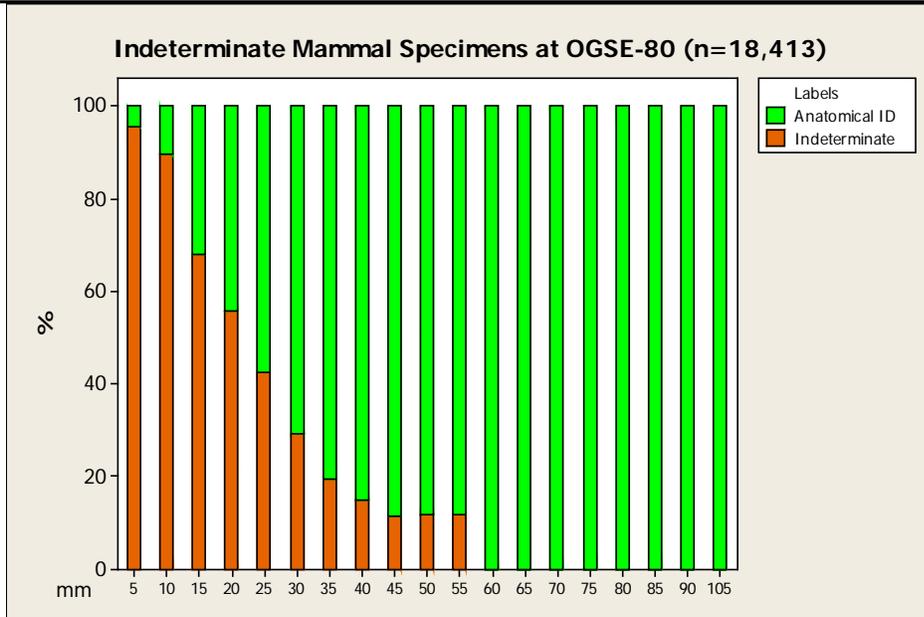
**Figure 5. Spatial Distribution of Mammal Specimens at OGSE-80**

Almost one half ( $n=18,430$ , 49%) of the recovered specimens from site OGSE-80 are fragments identified as indeterminate mammals that could not be reliably assigned to a zoological level lower than class. The bulk of these specimens are recorded as indeterminate fragments ( $n=13,645$ , 74.1%); otherwise, the remaining fraction consists mainly of indeterminate mammal long bone shaft fragments ( $n=3,492$ , 19%). Other indeterminate mammal fragments that are anatomically identifiable consist mainly of small cranial, dental, rib, vertebral, and phalangeal fragments, yet their identification is zoologically indeterminate to the ordinal level (Table 12). The inability to assign indeterminate mammal specimens to zoological identifications lower than the level of class, and the inability to identify the majority of indeterminate mammal specimens to anatomical origin is linked to specimen size and associated degree of fragmentation (Figure 6). The spatial distributions of indeterminate mammal specimens recovered from the main excavation area of OGSE-80 are plotted in Figure 7. The distribution of indeterminate mammal specimens, and by implication specimen fragmentation, appears to be somewhat less concentrated than for indeterminate specimens and is most noticeable in units

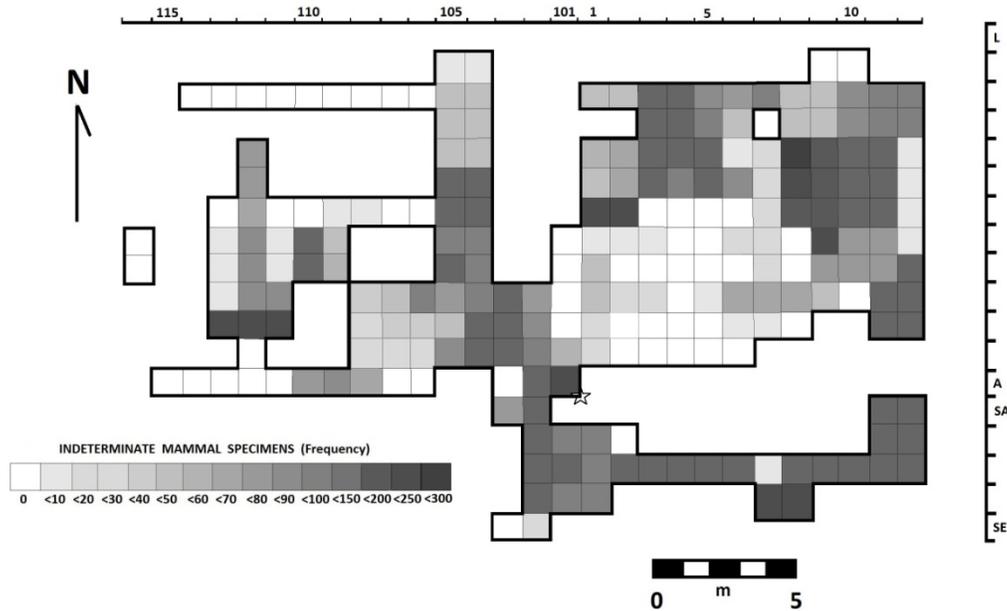
to the south of datum, units F-J in the northeastern sector of the main excavations, and in central portions between units 102-105 west of datum.

**Table 12. Indeterminate mammal specimen preservation at OGSE-80**

mm	Indeterminate	Anatomical Identification
5	2528	123
10	6259	723
15	2765	1213
20	1407	1111
25	402	541
30	194	465
35	45	187
40	31	177
45	8	62
50	6	45
55	0	14
60	0	13
65	0	3
70	0	3
75	0	1
80	0	1
85	0	1
90	0	1
105	0	1



**Figure 6. Relative Proportions of Indeterminate/Anatomically Identified Specimens from OGSE-80.**



**Figure 7. Spatial Distribution of Indeterminate Mammal Specimens at OGSE-80**

Higher resolution specimen identifications in the OGSE-80 assemblage are dominated by a restricted range of taxa, including cricetids or small rodents ( $n= 3,652$ ), small canids which are likely all desert fox ( $n= 2,723$ ), cervids or deer ( $n= 476$ ), leporids or rabbits ( $n= 274$ ), and echimyids or spiny rats ( $n= 125$ ). Table 13 presents the relative ubiquity of specimens identified to the level of zoological family in the excavated deposits of OGSE-80. The number of identified specimens for each family is positively and statistically correlated with the number of separate excavation contexts from which they were recovered at the site ( $r= 0.99$ ,  $p= 0.00$ ); the greater the number of specimens recovered, the greater the number of site contexts from which they were recovered. Table 13 also lists the relative percentage of contexts from which specimens of each family were recovered as well as the average number of specimens that were recovered from each context at OGSE-80. Small canid and small rodent specimens were recovered from over half of excavated deposits, and the average number of specimens in each context are markedly greater than all the other taxa, followed by deer, rabbit, and spiny rat specimens. The remainder of the mammalian taxa recovered from site contexts at OGSE-80 are generally characterized by relatively isolated specimens that are found in a few, scattered deposits.

**Table 13. Ubiquity of Specimens Identified to the Family Level at OGSE-80**

Family	NISP	Number of Contexts	% of Total Contexts	NISP/Contexts
Didelphidae	76	42	16.3	1.8
Myrmecophagidae	12	9	3.5	1.3
Sciuridae	11	9	3.5	1.2
Cricetidae (S. Rodents)	3652	151	58.8	24.2
Dasyproctidae	8	5	1.9	1.6
Echimyidae	125	47	18.3	2.7
Felidae	7	5	1.9	1.4
Canidae	2723	173	67.3	15.7
Mustelidae	1	1	0.4	1
Cervidae	476	113	43.9	4.2
Tayassuidae	23	21	8.2	1.1
Leporidae	274	84	32.7	3.3

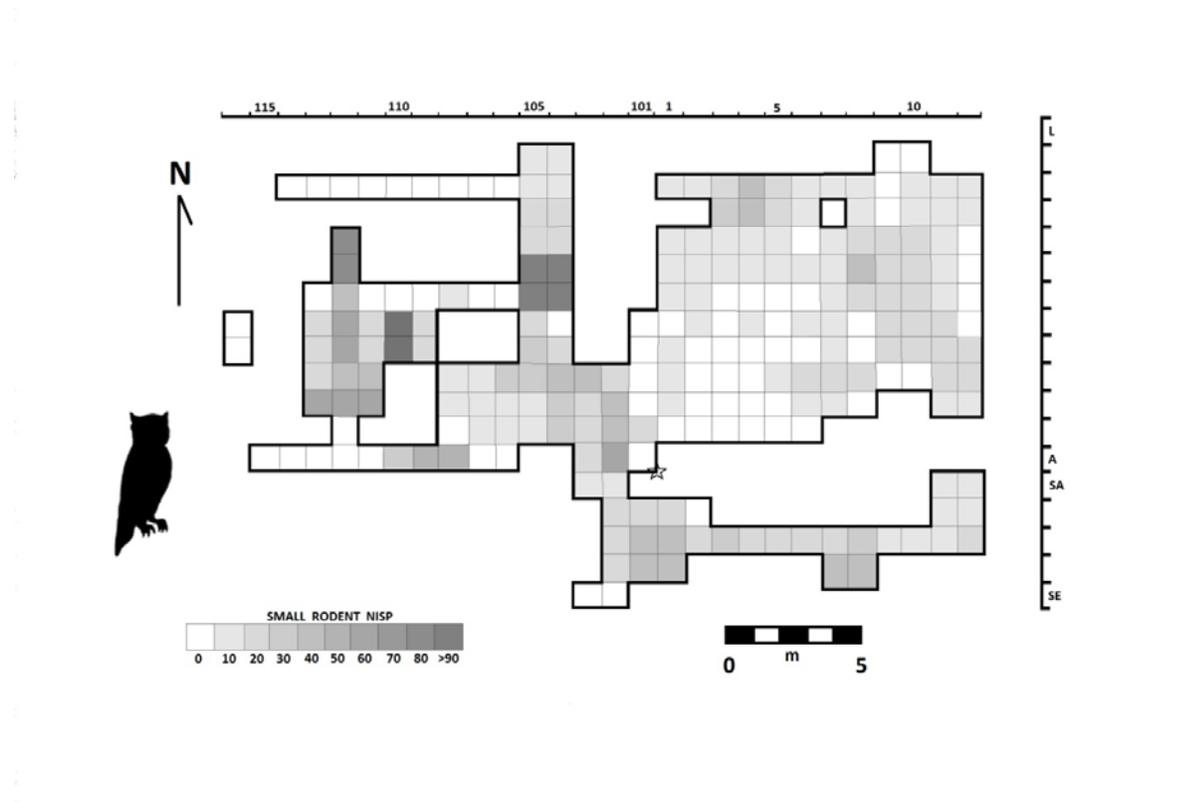
**Small Rodent Accumulation at OGSE-80**

Small rodent specimens (n=3652, and one additional rib which is likely that of a small rodent) are the most abundant of the preserved and identified mammal bones recovered from excavated contexts at OGSE-80. Specimens of small rodents identified to the level of genus are mainly cotton rat (*Sigmodon*), although the sample also includes Oryzomyine rodents, at least some of which are possibly coastal rat (*Aegialomys*). In terms of their relative ubiquity in the excavated deposits of OGSE-80, small rodent bones are second only to canid specimens, having been recovered from over 58% of archaeological contexts (Table 13). The preserved small rodent specimens (Table 14) are clearly dominated by hind limb and head elements, particularly the femur and dentary. The total MNI for small rodents in the OGSE-80 deposits is calculated on the basis of the left proximal femur with preserved shaft portion (MNI<sub>Min</sub>=561, MNI<sub>Max</sub>=764).

Although relatively ubiquitous throughout the site contexts, small rodent specimens appear to have been preserved in noticeable concentrations, particularly in a few units to the northwest of datum. Densest concentrations appear in units situated between the northern transect data points E through I and western transect points 104 through 112 (Fig. 8). This is also an area in the site in which a number of pits appear as dark stains that penetrate some 20 cm to 30 cm into the compact yellowish substratum around the base of the midden (Fig. 9, Stothert 1988a:53, Figs 2.21 and 2.23). It includes Feature 90, a deep and amorphous feature less than one meter in diameter at 200 cm below datum that is visible as a concentration of carbon flecks which stain the yellow sandy underlying substratum (Fig. 9). The stake on the top of the step above Feature 90 marks its upper reaches, and the pit edges are quite obscure. The feature contained little cultural material, but screened contents included shell fragments, chert flakes and broken bone (Stothert, personal communication, 2013).

**Table 14 . Preserved small rodent elements at OGSE-80**

Element	NISP
Maxilla	70
Dentary	764
Scapula	1
Humerus	120
Radius	3
Ulna	16
Hip	254
Femur	1689
Tibia	373
Fibula	0
Vertebrae	64
Incisor	128
Molar	124
Calcaneum	18
Astragalus	15
Ribs	1
Metapodial	9
Phalange	4



**Figure 8. Spatial Distribution of Small Rodent Specimens at OGSE-80**

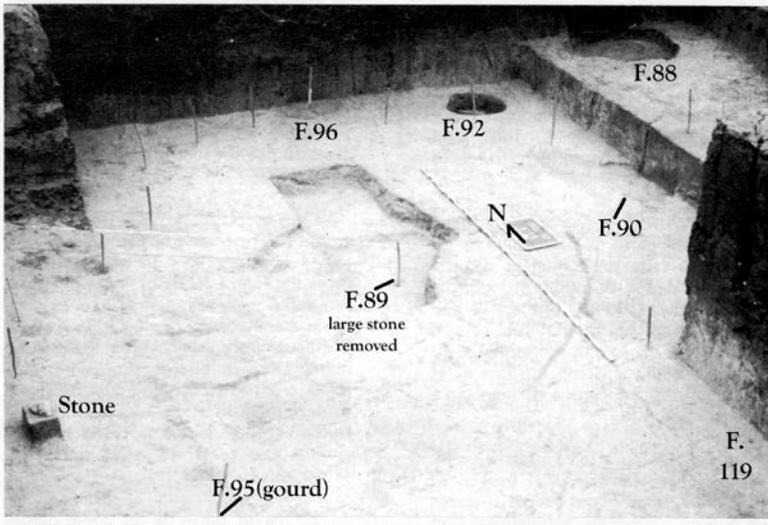


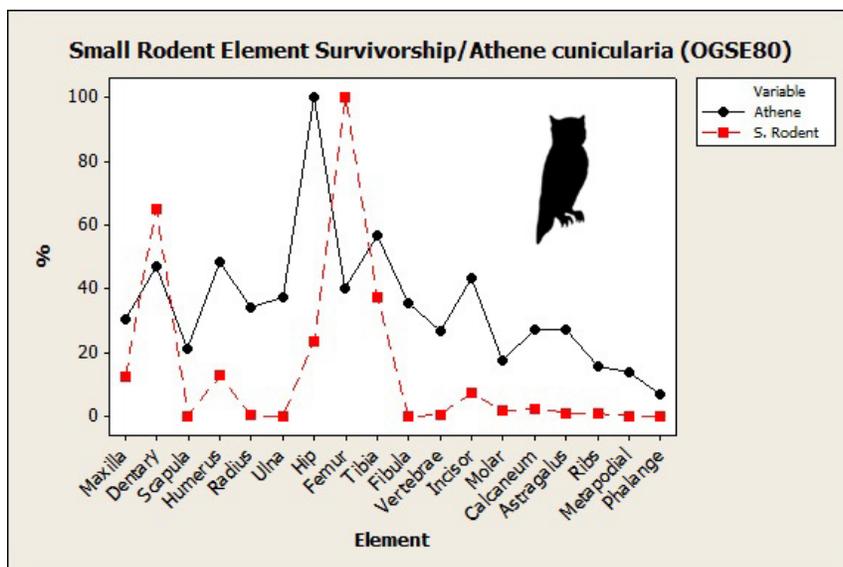
Fig. 2.22. El Corte D-F/110-113 excavado hasta un nivel de 200 cm.

**Figure 9. Cut D-F/110-113 Excavated to 200 cm (modified from Fig. 2.22, Stothert 1988a, courtesy of Karen E. Stothert)**

It is possible that the majority of small rodent specimens recovered from contexts at OGSE-80 had been accumulated at some point as a byproduct of owl predation. Currently, at least four species of owls inhabit the Santa Elena Peninsula. They include the barn owl (*Tyto alba*), a relatively large (35.5-40.5 cm) principally nocturnal raptor that is widespread in semi-open areas particularly around human habitations where it feeds mainly on small mammals in addition to birds and large insects (Ridgely and Greenfield 2001a:211). Examination of Barn Owl pellets from roosts in northern Guayas Province indicate a diet that includes juvenile opossum (*Didelphis*), rabbit (*Sylvilagus*), and Pacific spiny rat (*Proechimys decumanus*), but with an overwhelmingly amount of cotton rat (*Sigmodon peruanus*) and yellowish coastal rat (*Aegialomys xantheolus*) (Moreno 2010). The west Peruvian screech-owl (*Otus roboratus*) is a very small (19-20.5 cm) screech-owl which usually inhabits semi-open and lightly wooded habitats (Ridgely and Greenfield 2001a:212) where it feeds nocturnally almost exclusively on insects in its preferred habitats of mesquite woodland and acacia scrub (König et al. 1999:70-71). The Pacific pygmy-owl (*Glaucidium peruanum*) is a smaller (16-16.5 cm) owl that ranges throughout varied woodland habitats, forest, open and inhabited areas, and desert scrub (Ridgely and Greenfield 2001a:217). A partially diurnal raptor, the major portion of its diet consists of insects and small birds, in addition to local small mammals and other small vertebrates (König et al. 1999:368). The burrowing-owl (*Athene cunicularia*) is a larger (21.5-24 cm) terrestrial and partially diurnal owl found locally in open arid country, where colonies of up to five to ten pairs burrow into soft, sandy soil (Ridgely and Greenfield 2001a:218). Insects, spiders, scorpions, small mammals, reptiles and some other small vertebrates are normally caught from perches on rocks or earthen mounds (König et al. 1999:387). A number of other owls, although not currently inhabiting the Santa Elena Peninsula, have ranges extending into the southwestern lowlands. They include crested owl (*Lophostrix cristata*), spectacled owl (*Pulsatrix perspicillata*), mottled owl (*Strix virgata*), and striped owl (*Asio clamator*) (Ridgely and

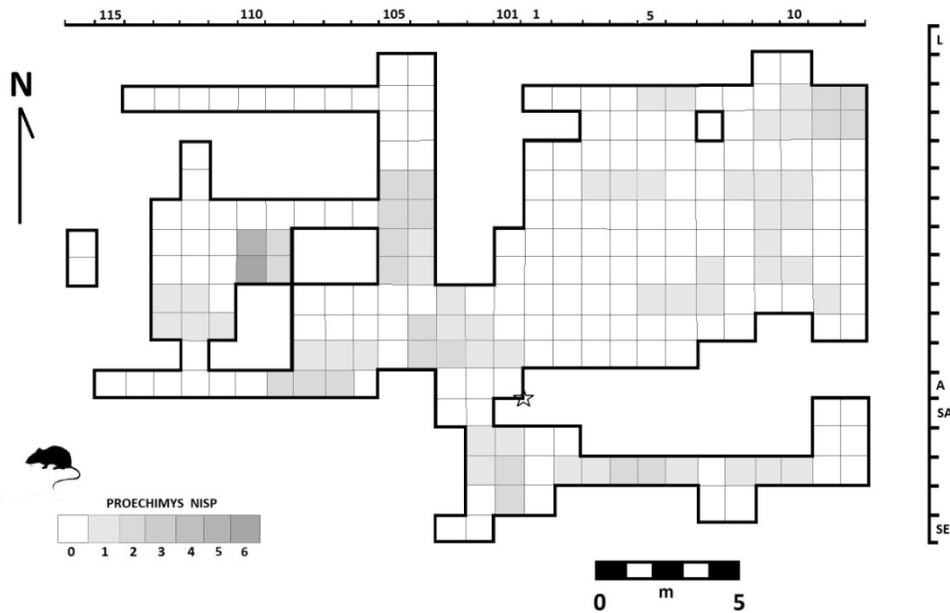
Greenfield 2001a). A phalanx identified as a preserved specimen of striped owl was recovered in the deposits of OGSE-80. Marchant's (1958) earlier systematic account of birds in the arid Santa Elena Peninsula lists only three owls: the barn owl; burrowing owl (noted as a common and widespread resident); and, a pygmy owl (he identifies *Glaucidium brasilianum* which inhabits lowland areas east of the Andes). Ridgely and Greenfield (2001b:310) consider the burrowing owl as uncommon to fairly common in semi-open, usually sandy areas near the coast from central Manabí through the arid coastal regions of southwestern Ecuador to El Oro province on the south coast.

Specimen survivorship of preserved OGSE-80 small rodent faunas was compared with results from controlled feeding experiments conducted on owls. Specimen representation of all small rodents in archaeological deposits are presented as a percentage based on the minimum MNI ( $MNI_{\min}=561$ ) and divided by the number of elements occurring in each skeleton. Archaeological survivorship was compared to published results for barn owls (Dodson and Wexlar 1979) and burrowing owls (Gómez 2007), and statistically evaluated using Spearman's correlation coefficient. No significant pattern was associated with barn owl accumulation, whereas comparisons with burrowing owl accumulations (Fig. 10) are statistically comparable ( $r_s = .68, p = .002$ ). Controlled feeding of *Mus musculus* to captive burrowing owls produced a greater proportion of postcranial to cranial elements. Isolated teeth suggested destruction of tooth bearing elements. Almost half the recovered elements consist of dentary, humerus, tibia, and incisors, followed by the femur, ulna, radius, and maxilla. Level of breakage and destruction is considered to be very low, with a higher survivorship of large bones and complete mandibles and maxillae (Gómez 2007:94).

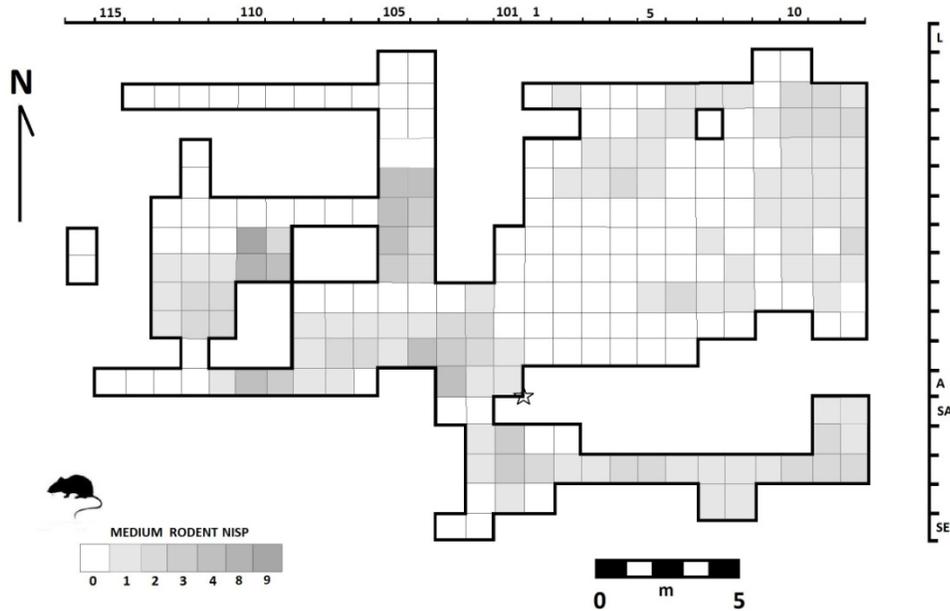


**Figure 10. Comparison Between Small Rodent Specimen Preservation at OGSE-80 and Controlled Feeding Experiments with Burrowing Owls**

As one of the most locally abundant of frugivores and granivores in various tropical contexts, spiny rats (*Proechimys*) are particularly important in terrestrial food chains (Adler and Kestell 1998; Emmons 1982, 1984; Gliwicz 1973). Spiny rats are important food sources for both humans (e.g. Suárez et al. 1995) and owls (Moreno 2010) in the western lowlands of Ecuador. It is possible that at least some of the specimens identified as spiny rat may have been accumulated by owls at OGSE-80. Figure 11 plots the distribution of spiny rat specimens in the central excavation contexts at the site. Some spatial concentrations are discernable, particularly in certain areas with higher concentrations of small rodent accumulations, although the number of specimens in the sample is far lower. For comparison, Figure 12 plots the spatial distributions of all medium-sized rodents (n= 218), which would include spiny rats, squirrels, and indeterminate medium-sized rodents. As it includes spiny rats, the distribution maintains some of the concentrations, yet also increases the spatial distribution of specimens through the central excavation contexts. Distributions of opossum (*Didelphis*) specimens (n= 76), juvenile individuals of which are also a potential owl prey item (Moreno 2010) are not plotted as these preserve as isolated specimens distributed widely throughout the excavated contexts.



**Figure 11. Spatial Distribution of Spiny Rat Specimens at OGSE-80**

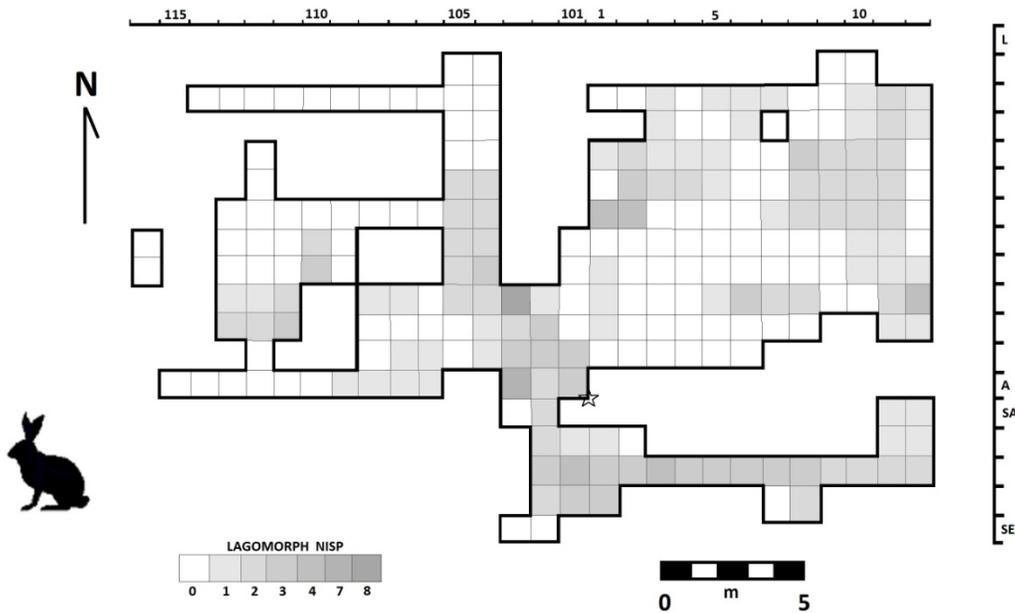


**Figure 12. Spatial Distribution of Medium-Sized Rodent Specimens at OGSE-80**

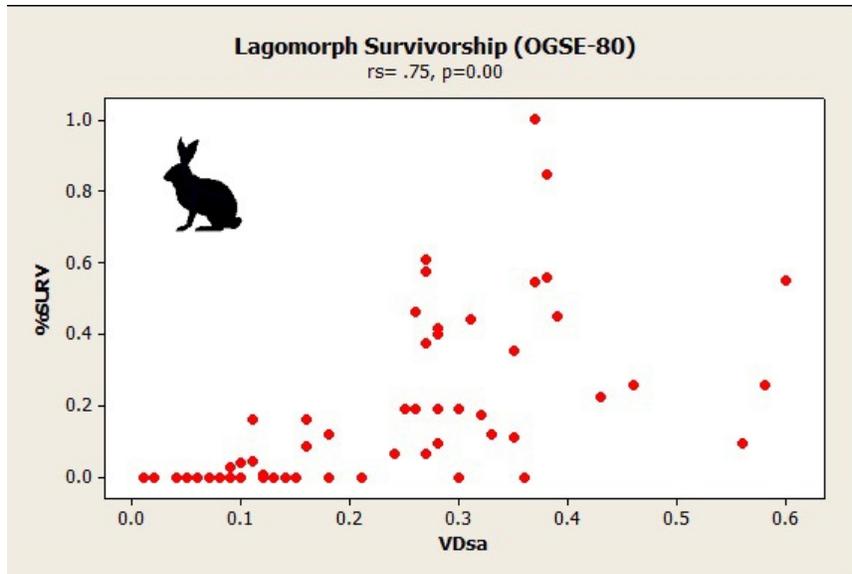
### **Rabbit Accumulation at OGSE-80**

Rabbit specimens ( $n= 274$ ) were preserved in one-third of the excavated contexts at OGSE-80. Their spatial distribution (Fig. 13) is roughly similar to, yet more dispersed than, the spatial distribution of medium-sized rodent specimens (Fig. 12). The average number of preserved rabbit specimens per context (3.3) is relatively low, and although only marginally higher in this regard than spiny rat specimens, they were recovered from almost twice the number of archaeological contexts. With Head-Body dimensions less than 400 mm, and live weights ranging from 450-1200 g (Emmons and Feer 1999:246), small to medium-sized South American rabbits are easily introduced into site contexts as intact bodies regardless of how they had originally accumulated. Figure 14 presents a scatterplot comparing the survivorship of lagomorph skeletal specimens with their respective bone mineral density. The %survivorship value is calculated using discrete scan sites as MNE values (Lyman 1994:255) and compared against mean leporid shape-adjusted volume density measurements (Pavao and Stahl 1999:56-57). The relationship between %survivorship of rabbit specimens and differential volume density at OGSE-80 is highly positive and statistically significant ( $r_s= .75$ ,  $p= 0.00$ ). The comparison also shows that scan sites of certain complete rabbit skeletal elements, particularly

ribs and phalanges, were not recovered. This could be due to a general failure to assign elements with relatively low diagnostic acuity to higher resolution zoological identification as rabbit. Nevertheless, the fraction of small indeterminate mammals recovered from excavated deposits only includes two complete phalanges (5 mm) and one proximal rib and shaft (10 mm). Also, these and other small elements like sterna and patellae, may have been lost in recovery. Although this is certainly possible, the missing elements also have very low volume density values. Their absence is associated with the patterned destruction of low density element portions of recovered specimens, which reasonably leads to the interpretation that denser skeletal portions in the rabbit skeleton had an increased likelihood of preserving. A patterned of density-mediated preservation in the OGSE-80 archaeofaunal sample is characteristic of bone preservation in many southwestern Ecuadorian archaeological sites. This might be attributed to environmentally desiccating conditions which are occasionally punctuated by periods of intense rainfall, and especially in this case, exacerbated by the age of deposition in an open-air setting.



**Figure 13. Spatial Distribution of Lagomorph Specimens at OGSE-80**



**Figure 14. Scatterplot of %survivorship of Lagomorph Skeletal Specimens from OGSE-80 with Shape-adjusted Bone Mineral Density Values for Rabbits**

#### **Deer Accumulation at OGSE-80**

A total of 476 cervid specimens were recovered from excavated contexts at OGSE-80. Where possible, they were assigned to a relative size category: Large (n= 51), Medium (n= 366), Small (n= 5), and Indeterminate (n= 54). Most are identified as specimens of *Mazama*; however, as its upper size range overlaps with the larger *Odocoileus*, genus-level identifications remain provisional. The spatial distribution of all cervid specimens recovered from contexts at OGSE-80 is illustrated in Figure 15. They appear in just under one half of the excavated proveniences (43.9%) where they are represented by an average 4.2 specimens per provenience. Figure 16 presents a scatterplot comparing the survivorship of cervid skeletal specimens against bone mineral density. The %survivorship value is calculated using discrete scan sites as MNE values (Lyman 1994:255) and compared against *Odocoileus* volume density measurements (Lyman 1984: Table 6). The relationship between %survivorship of deer specimens and differential volume density at OGSE-80 is positive and statistically significant ( $r_s = .47, p = 0.00$ ).

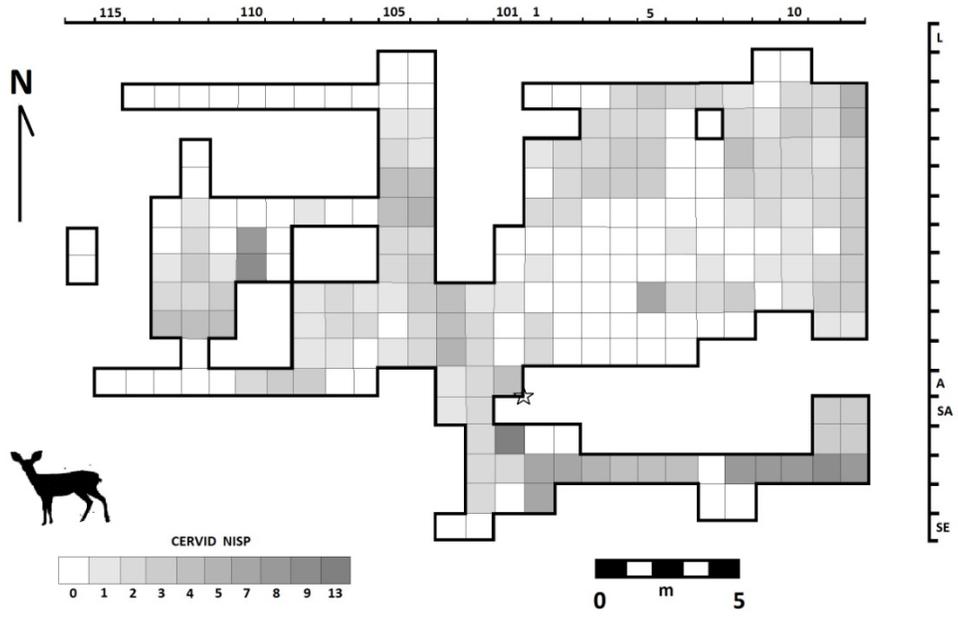


Figure 15. Spatial Distribution of Cervid Specimens at OGSE-80

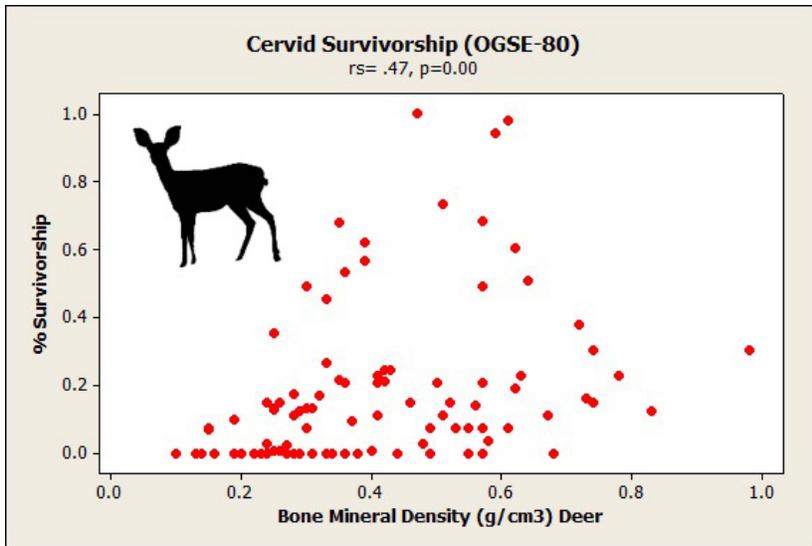


Figure 16. Scatterplot of %survivorship of Cervid Skeletal Specimens from OGSE-80 with Bone Mineral Density Values for White-tailed Deer

The comparison also shows that scan sites of cervid atlas and axis vertebrae were not recorded in the assemblage, although one specimen was identified as a possible atlas fragment. The density values for these elements are relatively low (0.1 -0.26), and some cervical fragments were identified, suggesting that they may have been comminuted to an extent that exacerbated recording of a scan site. Indeterminate large mammal vertebral fragments were recovered in the sample, and are preserved as smaller specimens. They range in size from 15 mm to 40 mm (avg.= 25 mm), compared to larger identified cervid vertebral fragments that range in size from 20 mm to 45 mm (avg.= 35 mm). This suggests the general failure to assign elements with lower diagnostic acuity to higher resolution zoological identification as a factor of fragment size. A few scan sites that are absent in the assemblage are relatively high density mid-shafts, particularly of the femur and radius. It is possible that these element portions were also comminuted to a size which precluded more precise identification; however, there are also some preserved examples of possibly worked bone in the Las Vegas assemblage. These items include a few indeterminate mammal long bone specimens, and one large cervid antler, that appear to have been modified through heating, drilling and/or polishing (Figs. 17 -21).



**Fig. 17 Drilled Mammal Long Bone (80 Lindao A1)**



**Fig. 18 Drilled Indeterminate Bone (7 D-H)**



**Fig. 19 Worked Mammal Long Bone (OGSE-67 F4)**



**Fig. 20 Worked Mammal Long Bone (OGSE-67 U.N, L.3)**



**Fig. 21 Worked Cervid Antler (SC 2-6, L. 0-10)**

The differential preservation of cervid elements is not associated with their relative meat and marrow utility. A comparison of meat and wet marrow weight distributions in white-tailed deer (Madrigal and Holt 2002) to minimum animal units (MAU) for cervids at OGSE-80 was negatively and insignificantly correlated. The predominance of low utility and high density lower limb elements (metapodia, phalanges), and relatively high density element portions of recovered specimens, reasonably leads to the interpretation that denser skeletal portions in the deer skeleton had an increased likelihood of preserving. Density-mediated preservation of deer specimens in the OGSE-80 archaeofaunal sample, although less pronounced, is consistent with rabbit bone preservation and typical of bone survivorship in many southwestern Ecuadorian archaeological sites.

### **Fox Accumulation at OGSE-80**

A total of 2720 specimens, identified as a small fox most likely *Lycalopex sechurae*, were recovered from excavated contexts at OGSE-80. An additional three metapodial specimens of a small indeterminate canid were also identified. Small canid specimens are ubiquitous in site deposits, appearing in more contexts ( $n= 173$ , 67.3%) than any other identified taxon, and in concentrations second only to small rodents (15.7/context). Their spatial distributions in the central excavations at OGSE-80 are illustrated in Figure 22. In addition, 408 medium-sized indeterminate carnivore specimens were recovered, consisting primarily of phalangeal elements ( $n= 368$ ) with the remainder primarily represented by tooth fragments. A total of 3137 small canid specimens were used to compare the survivorship of canid skeletal specimens against bone mineral density which is presented as a scatterplot in Figure 23. The %survivorship value is calculated using discrete scan sites as MNE values (Lyman 1994:255) and compared against average volume density measurements for small canids (Novacosky and Popkin 2005:Table 2). The relationship between %survivorship of small canid specimens and differential volume density at OGSE-80 is positive and statistically significant ( $r_s= .42$ ,  $p= 0.00$ ).

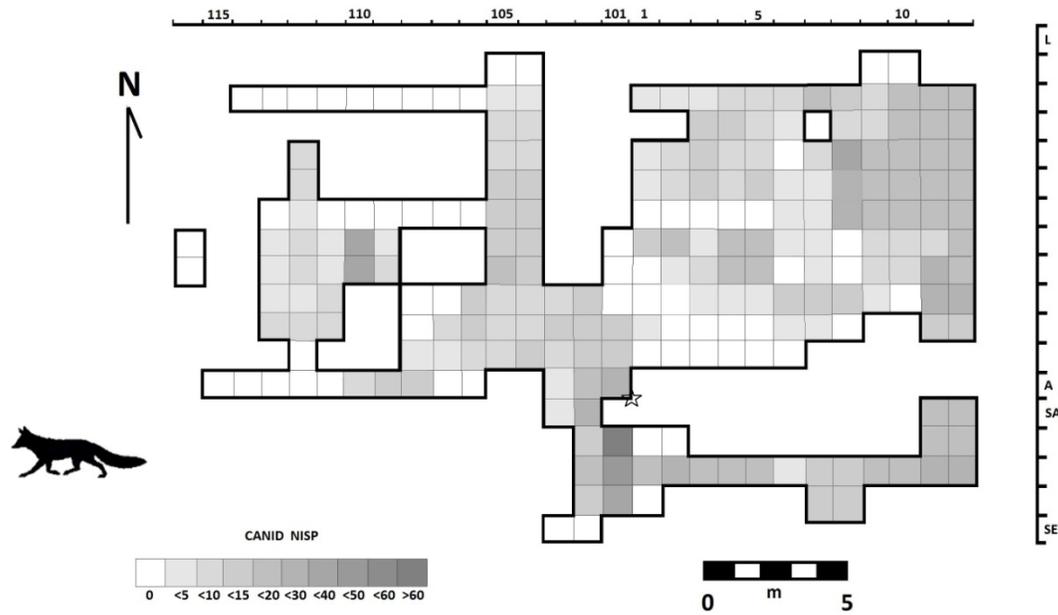


Figure 22. Spatial Distribution of Fox Specimens at OGSE-80

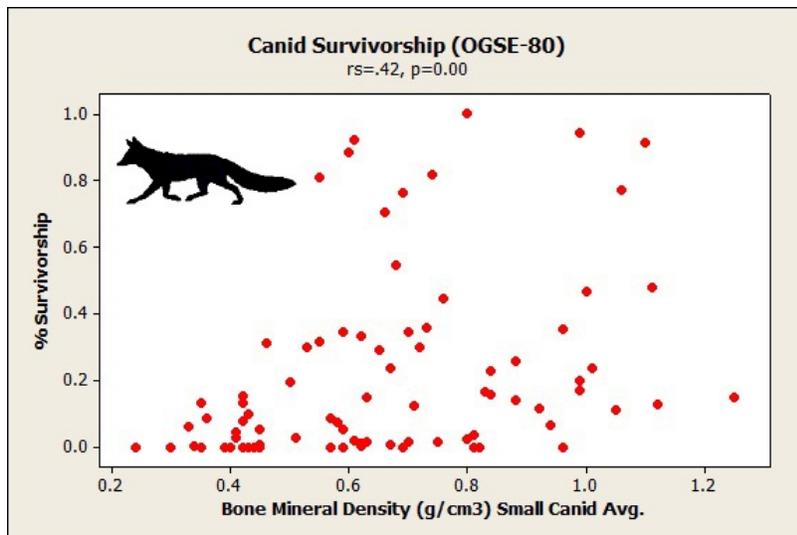


Figure 23. Scatterplot of %survivorship of Small Canid Skeletal Specimens from OGSE-80 with Averaged Bone Mineral Density Values for Small Canids

A number of small canid elements were not identified in the excavated deposits. These include the third, fourth, and accessory carpals, and the patella. All are small elements that, as disarticulated specimens, may have escaped recovery; however, equally small complete carpal and tarsal elements were recovered in varying quantities. Fibulae and ribs are also absent in the recovered sample. A total of 57 rib specimens were identified as indeterminate medium mammal; however, their degree of fragmentation precluded the reliable recording of a scan site. No fibulae were identified, and although proximal portions of this element are relatively dense, fragmentation of the long and slender fibula may have rendered it non-identifiable to the ordinal level. The rest of the absent scan sites are relatively lighter density portions of otherwise identified elements. At least two fox long bone specimens recovered at OGSE-80, one femoral and one tibial shaft, appear to have been modified (Figs. 24-25). The patterned survivorship of low density portions of small canid elements reasonably leads to the interpretation that denser skeletal portions in the skeleton had an increased likelihood of increased preservation. Density-mediated preservation of small canid specimens in the OGSE-80 archaeofaunal sample, although less pronounced, is consistent with rabbit and deer bone preservation and typical of bone survivorship in many southwestern Ecuadorian archaeological sites.



**Fig. 24 Possible Worked Fox Femoral Shaft (OGSE-67 D4)**

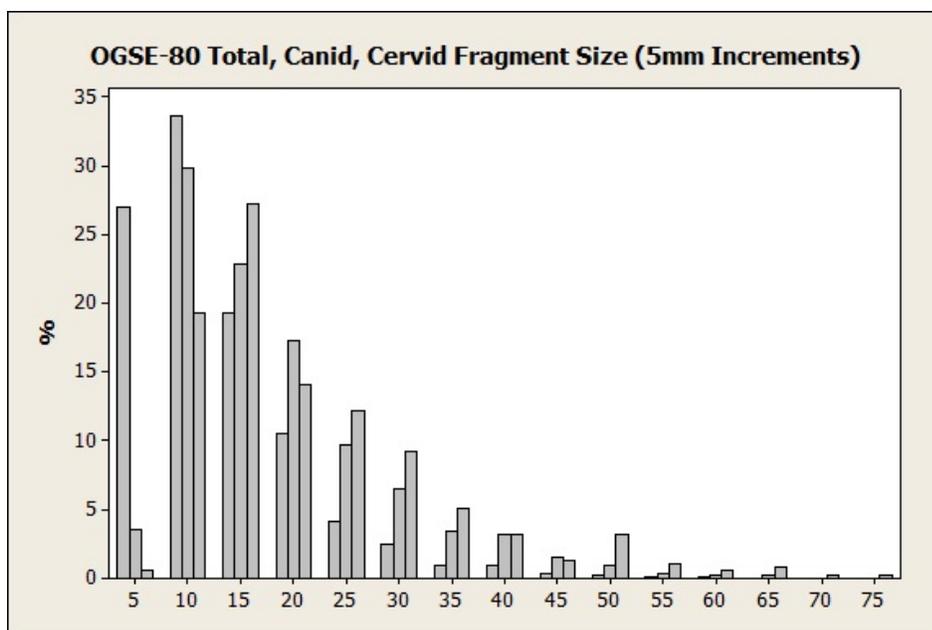
**Fig. 25 Worked Fox Tibia Shaft (OGSE-38)**

Although the preservation of abundant and ubiquitous small canid specimens is density-mediated within the excavated deposits at OGSE-80, these specimens appear to have survived as larger and more complete fragments than their cervid counterparts. The frequency of fragments in 5 mm size class intervals for all preserved bone is compared with frequencies of small canids and cervids in the excavated deposits (Table 15). A similar graphical comparison is expressed in percentages in Figure 26. Both small canid and cervid specimens survive in the same pattern of size dimension as all mammalian specimens at OGSE-80. The correlation of fragment size class distributions between small canids and cervid specimens is highly positive and significant ( $r_s = .91$   $p=0.00$ ), as is the correlation of fragment size class distributions between small canid and all specimens ( $r_s = .95$   $p=0.00$ ), and the correlation between cervid and all specimens ( $r_s = .92$   $p=0.00$ ). This is particularly striking when considering the body size differences between native cervids (HB= 900-2260 mm, wt.= 12-120 kg) and *Lycalopex sechurae* (HB= 445-780, wt.= 2.2-4.2 kg). Skeletal elements of ubiquitous smaller fox survived at OGSE-

80 as similar-sized fragments in comparison to more isolated larger cervid skeletal elements. Moreover, relatively higher numbers of fox specimens in the assemblage are preserved as either complete or almost complete bones. These include smaller carpal, tarsal, and metapodial elements of the lower limb, but also include relatively intact vertebrae, especially thoracic (n= 56, 90%), lumbar (n=25, 76%), and cervical (n= 80, 66%) vertebrae, albeit in much lower than expected quantities. Atlas (n=3, 4%) and axis (n= 17, 21%) vertebrae survive far less completely; whether or not this is related to removal of the skull remains speculative.

**Table 15. Frequency of Fragment Sizes for Total, Small Canid, and Cervid Specimens in 5mm Intervals (OGSE-80)**

<b>Size Class mm</b>	<b>Total (n=37,540)</b>	<b>Canid (n=2,7230)</b>	<b>Cervid (N=476)</b>
5	10,129	97	3
10	12,631	813	92
15	7,267	623	130
20	3,968	471	67
25	1,554	266	58
30	946	177	44
35	374	94	24
40	357	88	15
45	122	41	6
50	96	25	15
55	30	10	5
60	25	6	3
65	15	8	4
70	5	1	1
75	5	0	1
80	3	0	2
85	4	2	1
90	3	1	1
95	0	0	0
100	2	0	2
105	1	0	0
110	0	0	0
115	0	0	0
120	1	0	1
125	1	0	1
195	1	0	0

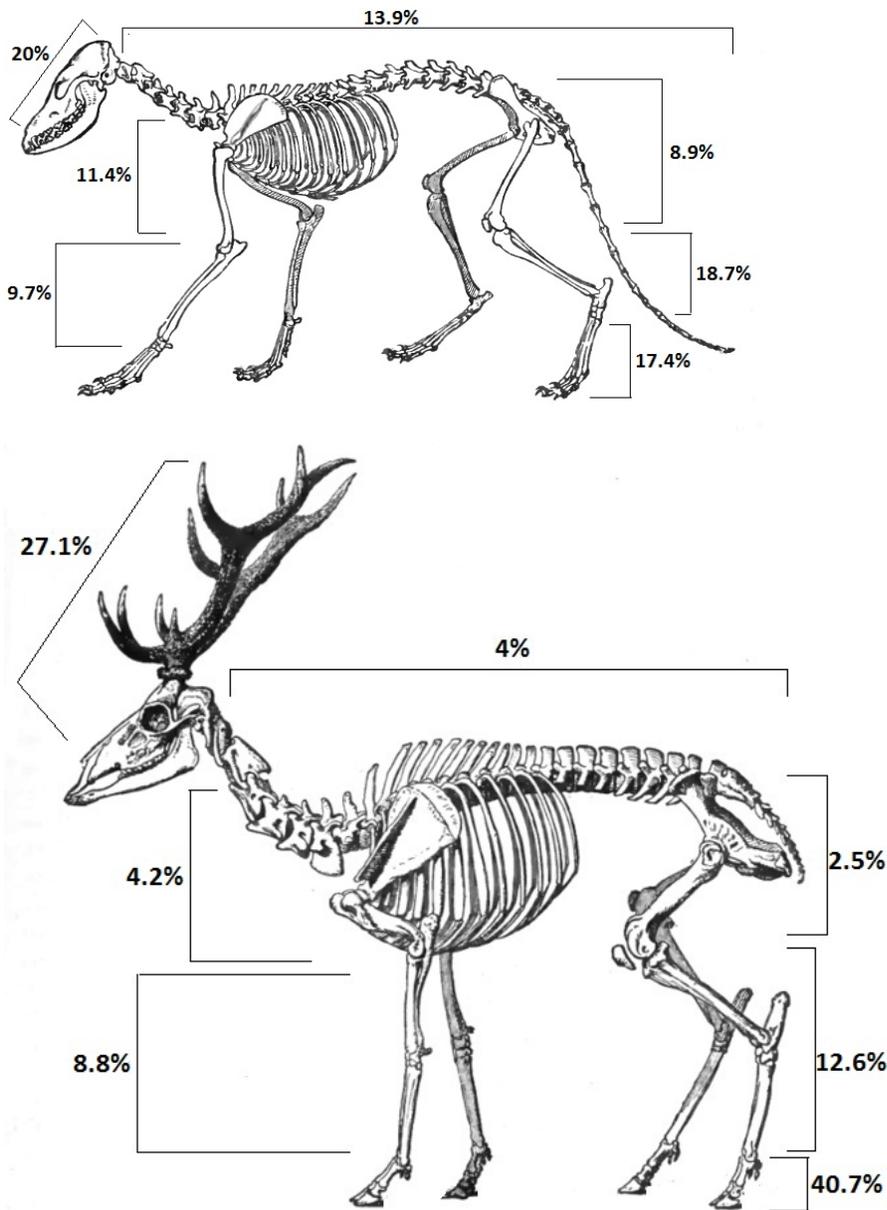


**Figure 26. Fragment Size in 5 mm Increments for Total (n= 37540), Small Canid (n= 2723), and Cervid (n= 476) Specimens Expressed as Percentages at OGSE-80**

Faunal preservation at OGSE-80 is characterized by heavy comminution and density-mediated preservation. The density-mediated survivorship of small-bodied and easily transportable rabbits at the site supports the interpretation that animals introduced into site contexts as complete bodies are duripartically preserved as fragmented skeletons. Some limited evidence from larger animal specimens suggests that tool manufacture may have at least contributed to this pattern of preservation. Equally it may have been the byproduct of some other form of animal processing at the site, or due to post-depositional conditions of punctuated humidity exacerbated by the deposit's extreme age in an open-air setting. Fox specimens are particularly abundant, and survive at denser concentrations in far more contexts, and in relatively larger size fractions than an important food animal like deer. Although the differential preservation of deer specimens cannot be correlated with food utility in the form of meat or marrow, when compared to fox specimens, deer specimens are heavily dominated by lower limb specimens. Fox specimens are more evenly represented by different body regions (Table 16, Figure 27).

**Table 16. Frequency of Canid and Cervid Element by Body Region (OGSE-80)**

<b>Body Region</b>	<b>Canid (n=2,723)</b>	<b>Cervid (n=476)</b>
<b>Head</b>	545	129
<b>Vertebral Column</b>	377	19
<b>Upper Fore Limb</b>	311	20
<b>Lower Fore Limb</b>	265	42
<b>Upper Hind Limb</b>	243	12
<b>Lower Hind Limb</b>	509	60
<b>Feet</b>	473	194



**Figure 27. Relative Percentage of Canid and Cervid Element by Body Region (OGSE-80)**

### Summary and Discussion

Despite a substantial increase in sample size, this comprehensive analysis of all available mammalian archaeofaunal specimens recovered from Las Vegas contexts adds only ocelot (*Leopardus pardalis*), jaguarondi (*Puma* [*Leopardus*] *yagouaroundi*), agouti (*Dasyprocta*), and possibly yellowish coastal rat (*Aegialomy*) to the list of mammalian taxa identified in earlier analyses of relatively small samples from limited contexts at OGSE-80 (Byrd 1976; Chase 1988; Stothert 1988b). Also, when compared with relatively smaller yet roughly coeval archaeofaunal assemblages from Early Preceramic El Palto (11,700 to 9800 BP) and Middle Preceramic Las

Pircas phase (9800-7800 BP) contexts in the Nanchoc and Jequetepeque valleys of northern Peru, the list of recovered and identified mammalian species is virtually identical (Dillehay 2011; Pavao-Zuckerman 2004; Stackelbeck 2011).

The mammalian terrestrial faunas represented in the excavated Las Vegas archaeological deposits are characterized by their shared tolerance of a wide range of lowland habitats which include the current semi-arid conditions of southwestern Ecuador. These mammals were all available until quite recently in and around the dry scrublands of the Santa Elena Peninsula where the sites are located (Stothert 1998b:193). Open areas and landscape mosaics with dry forests, vegetative cover, and access to gallery formations of small creek or river beds are implicated. Although many of the smaller rodents at OGSE-80 were likely accumulated by owls during occupational hiatuses or after site abandonment, the potential prey items all infer a continuation of relatively dry conditions. The habitat preferences of sigmodontine rodents identified in the deposits include dry forests and disturbed locales like anthropogenically altered conditions, especially in the vicinity of small rivers. Other possible owl accumulated prey like squirrels and spiny rats share a proclivity for dry forests and cultivated clearings, with spiny rats preferring areas closer to rivers. The mammalian archaeofaunal taxa that were most likely accumulated during site occupation tend to consist of dietary generalists, many of which abound in and near fragmented vegetational mosaics, including anthropogenic settings. Tree anteaters are broadly tolerant of a wide range of habitats, including open ground where they can forage terrestrially. Agoutis prefer proximity to creek beds and thrive in mosaic borders like those created in agricultural habitats. Cervids and rabbits, whose browsing opportunities are enhanced through the creation of borders and mosaics, need the vegetative cover of gallery formations for refuge. Vegetative cover is also required by other taxa like opossums that thrive in anthropogenic disturbance, yet exclude arid and semi-arid habitats from their range. The endemic Sechuran fox is frequently encountered in and around anthropogenic settings and disturbed locales in desertic to dry forest habitats. These habitats are also included in the wide range of environments frequented by peccary and jaguarundi. Ocelots frequent open areas yet require corridors of good vegetation cover for movement between open areas.

Many of the larger mammalian accumulations, particularly tree anteater, mustelids, native cats, peccary, and agouti, were recovered from site contexts in relatively low abundance as isolated specimens. Smaller mammals like opossum and rabbit, which may have been originally accumulated for subsistence, were recovered in higher numbers but as relatively isolated specimens. The small and easily transportable bodies of rabbits could certainly have been introduced into site contexts as intact prey items. If so, then their potentially complete skeletons were subsequently subjected to density-mediated attrition, or the differential survivorship of denser skeletal material. West Ecuadorian archaeofaunal assemblages frequently exhibit high fragmentation and density mediated preservation, which might be attributed to burial conditions that were repeatedly subjected to the intermittent fluctuations of humidity which is a characteristic of the often labile peninsular climate. No viable ancient DNA could be extracted from *Lycalopex* teeth which is also a characteristic of the poor state of organic preservation in this area of the coast. Many larger deer specimens were also recovered from archaeological contexts. Although it is possible that these animals may have been

introduced into site contexts as discrete portions, the available evidence indicates that their skeletons were also subjected to density-mediated attrition. Although not as strong as their smaller rabbit counterparts, the correlation between cervid specimen survivorship and bone density is also positive and statistically significant. No relationship, however, could be established between preserved cervid skeletal portions and higher amounts of meat or marrow utility. There is also some limited evidence of possible bone modification at the site which may have contributed to the selective preservation of certain skeletal elements (see also Stothert 1988c).

In terms of their relative abundance at OGSE-80, small canid specimens (n= 2,723) are second only to small rodent specimens (n= 3,652). Ubiquitous small rodent specimens were recovered from fewer contexts (n= 151, 58.8%) and in greater concentration (NISP/context= 24.2) compared to small canid specimens (contexts, n= 173, 67.3%, NISP/context= 15.7). Patterned survivorship of small rodent skeletal specimens at OGSE-80 implicates the possibility that owl predation may have been a major accumulating mechanism in site contexts during occupational hiatuses by humans. The extraordinarily large frequency of fox specimens at OGSE-80 is increased to 3,137 through the inclusion of indeterminate small canid specimens, and to at least 3,179 specimens for the entire Las Vegas assemblage. Some fox long bone shafts were clearly modified; however, the majority of fox specimens at OGSE-80 preserve differently from those of a major food animal like cervids. Both survive through comparable density-mediated attrition. Nevertheless, the skeletons of smaller canids and larger cervids preserve as similarly sized fragments. Small canid specimens also preserve more completely, suggesting that fox skeletons were less fragmented. Moreover, fox specimens recovered from site contexts are more evenly distributed from different body regions than cervid specimens which are dominated by lower limb elements. It is suggested that the majority of fox elements were originally accumulated and deposited as relatively complete specimens.

The astonishingly high numbers of fox specimens preserved in Las Vegas site contexts represent a minimum of 75 individual bodies but likely many more. Although the association of fox specimens with early archaeological contexts in South America is relatively common, their sheer numbers in Las Vegas contexts is entirely unique. Despite the few examples of modified bone described here and elsewhere (Stothert 1988c), the manufacture of bone or tooth implements does not appear to have been extensive in Las Vegas contexts. However, fox teeth were recovered in association with some of the mass secondary burials at OGSE-80 (Features 25, 34, 58). Unmodified peccary teeth were also encountered with two secondary burials (Features 25a, 66, 84) (Stothert 1988c:96). Preserved fox specimens are relatively ubiquitous in the central excavated deposits at OGSE-80, although Wing (1988) earlier suggested that they may have been more commonly recovered from contexts around human burials. Based upon a small sample representing five different zones at the site, she suggests that higher percentages of fox teeth are particularly noticeable in contexts with massive secondary burials (Wing 1988:183). The spatial relationship between human burial features and recovered fox specimens can be seen by comparing Figure 22 with Figure 6.2 in Stothert (1988d:136). The spatial associations in certain instances are readily visible; however, fox specimens are

distributed widely throughout site contexts including many that are outside of areas in which human burial features were found (Figure 28).

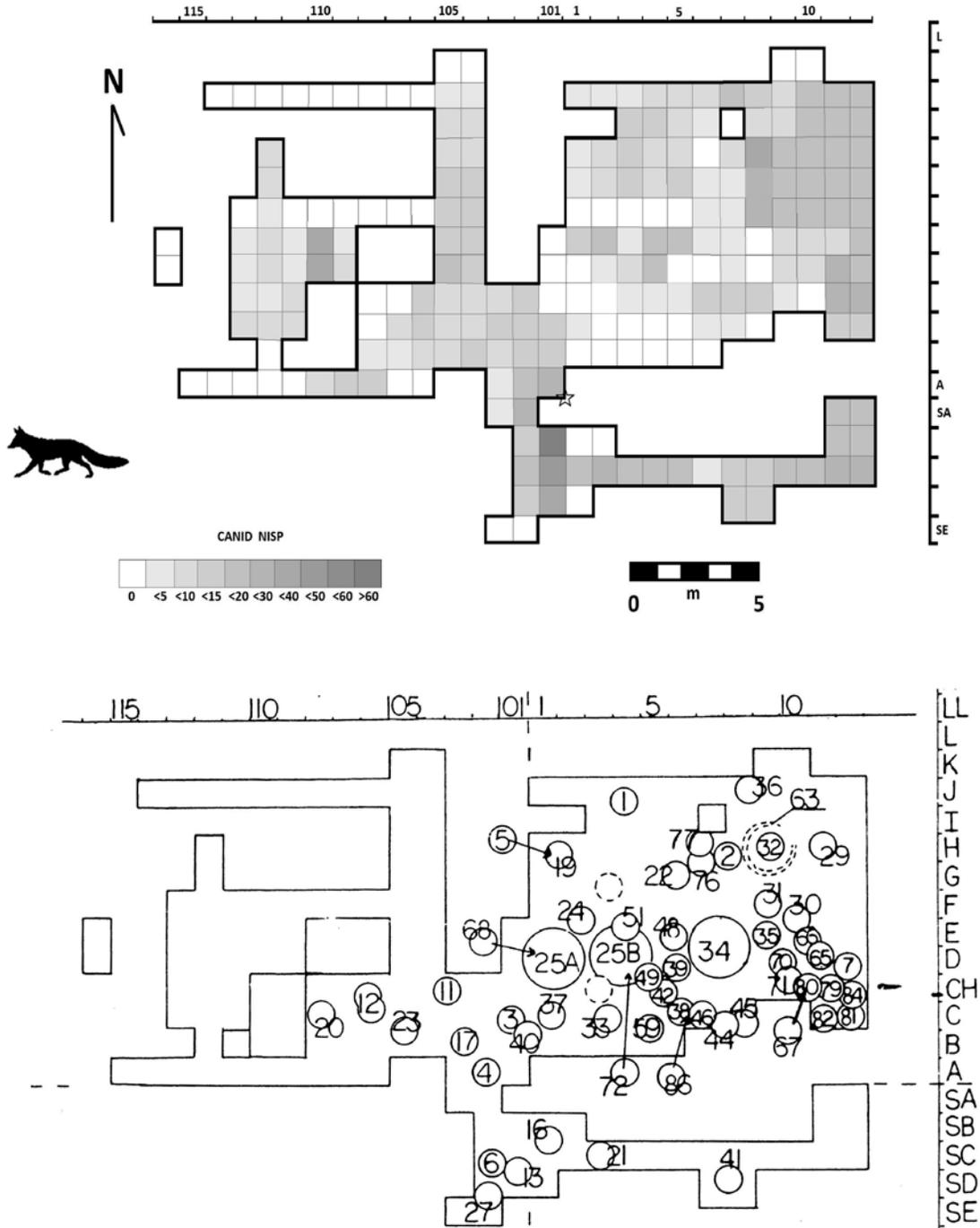


Figure 28. Spatial Distribution of Fox Specimens (top) and human burials (bottom)

The Las Vegas assemblage includes unfused specimens and examples of deciduous dentition, suggesting the at least some skeletally immature individuals were accumulated. It also includes evidence of arthritic, perhaps old, individuals as well (Figs 29-30). Based upon her earlier



Fig. 29 Fox Right Calcaneum (40 Cut 5)



Fig. 30 Medium Carnivore Phalanx (B-C 103-104)

studies of fox specimens from OGSE-80, Wing (1988; 1989) suggested that the desert fox could perhaps have fulfilled a similar role to that of the domestic dog, and had been minimally controlled or conceivably domesticated by humans. Archaeologists, primarily in the southern cone, have often commented on the relationship between ancient humans and native fox in South America (e.g., CluttonBrock 1977; Mengoni Goñalons 1987:64; Miotti and Salemme 1999:64; Mondini 2000; 2002; 2004; Stahl 2012). Fox specimens are commonly associated with earlier Holocene contexts throughout South America (Table 17, Figure 31). Most early contexts with associated archaeofaunal materials include canid specimens consisting of endemic canids. These include various species of native fox (*Chrysocyon* but mostly *Lycalopex*) as well as the now extinct endemic *Canis avus*. Confusion between the latter and exotic *Canis lupus familiaris* led to earlier claims of ancient domesticated dogs in various archaeological contexts as far south as Fell's Cave. Native foxes in particular are characterized by various attributes which predispose them to habituate to humans and anthropogenic conditions (Stahl 2012). Direct associations between fox skeletal specimens and human burials are also recorded at two other early sites in South America. Specimens of culpeo (*Lycalopex culpaeus*) were clearly associated with human burials at Cueva Baño Nuevo-1 in the Asien region of Chile (Mena et al. 2003; Trejo and Jackson 1998). Perforated teeth, most likely of pampas fox (*Lycalopex gymnocercus*) and maned wolf (*Chrysocyon brachyurus*), were recovered as grave offerings associated with three human burials at site 2 of Arroyo Seco, near Buenos Aires (Fidalgo et al. 1986; Politis 1998). Both contexts are dated to early in the seventh millennium prior to the Christian era. Sechuran desert fox (*Lycalopex sechurae*) is added to the list of South American archaeological association between early humans and fox, albeit in a highly spectacular manner.

**Table 17. Early Post-Pleistocene South American Canid Identifications and Dated Associations**

<b>Site</b>	<b>Canid Taxon</b>	<b>Early Date (BP)</b>	<b>References</b>
Pikimachay (Zone H)	<i>Dusicyon</i>	16,000-14,000?	MacNeish 1979
JE-431, 439, 993	<i>Pseudalopex</i> , Canidae	11,700	Dillehay 2011, Pavao-Zuckerman 2004, Stackelbeck 2004
Cueva Lago Sofía 1	<i>Dusicyon avus</i>	11,575 ± 60	Borrero 2009, Casamiquela 1996-1997
Quereo	<i>Dusicyon</i> , <i>Dusicyon avus</i>	>11,000	Casamiquela 1996-1997, Jackson 2003
Tagua Tagua	<i>Dusicyon culpaeus</i> , <i>Canis</i>	11,380	Casamiquela 1996-1997, Montané 1968, Palma 1969
Casa del Minero 1	Canidae, <i>Dusicyon avus</i>	10,999 ± 55	Borrero 2009, Paunero 2003
Mylodon Cave	Fox, Dog, <i>Dusicyon avus</i>	10,832 ± 400	Bird 1988, Casamiquela 1996-1997, Caviglia 1985
Tres Arroyos (TA1)	<i>Dusicyon avus</i>	10,575 ± 65	Arroyo-Kalin 1998, Borrero 2003, 2009, Caviglia 1985, Mengoni-Goñalons 1987
Paso Otero 5	<i>Dusicyon gymnocercus</i>	10,450	Gutiérrez and Martínez 2008, Miotti 1999
Cueva Tixi	<i>Dusicyon avus</i> , <i>Lycalopex gymnocercus</i>	10,375 ± 90	Borrero 2009, Gutiérrez and Martínez 2008, Martínez and Gutiérrez 2004, Mazzanti and Quintana 1997, Miotti 1999
Cueva del Puma	<i>Dusicyon avus</i>	10,345 ± 75	Borrero 2009
Fell's Cave	Canidae, <i>Dusicyon culpaeus</i> , <i>Dusicyon griseus</i> , <i>Canis familiaris</i>	10,180 ± 160	Amarosi and Prevosti 2008, Bird 1988, Clutton-Brock 1988, Caviglia 1985, Caviglia et al. 1986, Mengoni-Goñalons 1986
Las Vegas OGSE-38, 67, 78, 80	Canidae, <i>Dusicyon</i>	9800 ± 100	Stoothert et al. 2003
JE-1002	<i>Pseudalopex</i> , Canidae	9800	Dillehay 2011, Pavao-Zuckerman 2004, Stackelbeck 2004

Cueva Arroyo Feo	<i>Dusicyon griseus</i>	9330 ± 80	Mengoni-Goñalons 1986
Cueva de Los Manos	<i>Dusicyon griseus</i>	9320 ± 90	Mengoni-Goñalons 1986
Las Buitreras	Canidae, <i>Dusicyon avus</i>	9100	Borrero 2009, Caviglia 1985, Caviglia et al. 1986
Uchcumachay	<i>Dusicyon culpaeus</i>	9000?	Wheeler Pires-Ferreira et al. 1976
Baño Nuevo	<i>Dusicyon avus</i> , <i>Pseudalopex culpaeus</i>	8880 ± 50	Mena et al. 2003, Trejo and Jackson 1998
Los Toldos (Toldense)	Canidae, <i>Dusicyon</i>	8750 ± 480	Cardich et al. 1977, Mengoni-Goñalons 1986
Palli Aike	Canidae	8639 ± 450	Amarosi and Prevosti 2008, Bird 1988
Chobshi	<i>Canis cf. familiaris</i>	8615 ± 90	Lynch and Pollock 1981
Arroyo Seco (2)	<i>Pseudalopex gymnocercus</i> <i>Chrysocyon brachyurus</i> , <i>Canis</i>	8558 ± 316	Fidalgo et al. 1986, Gutiérrez and Martínez 2008, Politis 1986
Cañadón Leona (5)	Canidae	8500	Bird 1988
Campo Laborde	<i>Dusicyon</i>	8080	Politis and Messineo 2008
Nemocón	Fox	7530 ± 100	Correal Urrego 1986
Panaulauca	<i>Canis familiaris</i>	7500?	Wheeler Pires-Ferreira et al. 1976
Los Toldos (Casapedrense)	<i>Canis familiaris</i>	7260 ± 350	Cardich et al. 1977, Caviglia 1985, Tonni and Politis 1981
El Abra	<i>Canis</i>	7000?	Ijzereef 1978
Puente	<i>Dusicyon</i> , Dog?	6900	MacNeish and Vierra 1983
Telarmachay	<i>Canis familiaris</i>	6800	Wheeler 1985
La Moderna	<i>Canis familiaris</i>	6550 ± 160?	Politis 1986
Uchcumachay	<i>Canis familiaris</i>	6200	Wheeler Pires-Ferreira et al. 1976
Pachamachay	<i>Canis familiaris</i>	6200	Wheeler Pires-Ferreira et al. 1976
Lauricocha	<i>Canis familiaris</i>	6200	Wheeler Pires-Ferreira et al. 1976

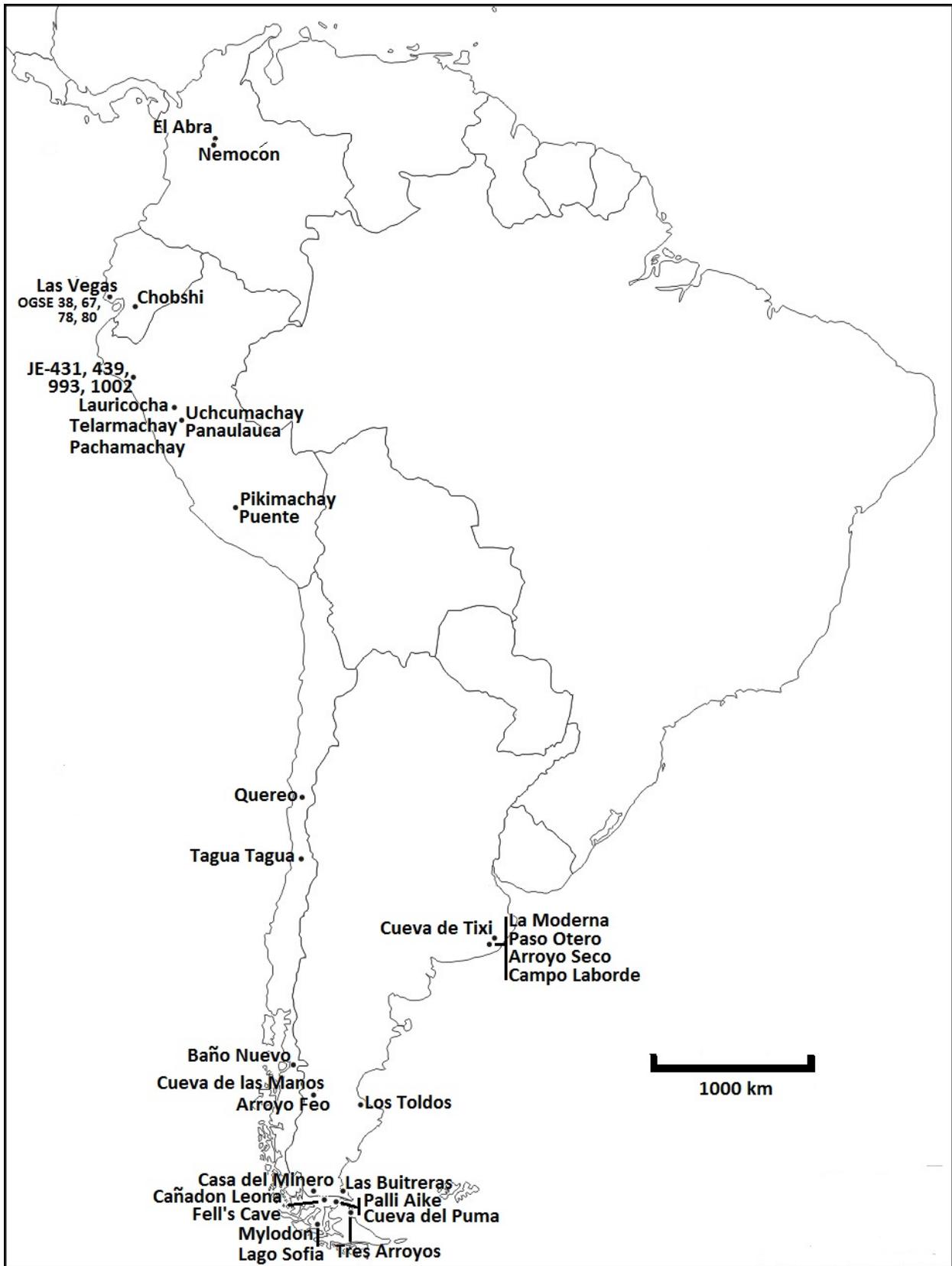


Figure 31. Early South American Archaeological Sites with Canid/Human Associations

## References Cited

Adler, Gregory H., and Douglas W. Kestell

- 1998 Fates of neotropical tree seeds influenced by spiny rats (*Proechimys semispinosus*). *Biotropica* 30:677-681.

Amorosi, Thomas and Francisco J. Prevosti

- 2008 A Preliminary Review of the Canid Remains from Junius Bird's Excavations at Fell's and Pali Aike Caves, Magallanes, Chile. *Current Research in the Pleistocene* 25:25-27.

Arroyo-Kalin, Manuel

- 1998 Restos Óseos de Canidae en Cerro Los Onas. Resultados Preliminares para los Sitios TA-1 y TA-14 (30). Proyecto Fondecyt No. 1960027. Hombre Temprano y Paleoambiente en Tierra del Fuego, Informe de Avance, Segundo Año, Chile.

Asa, C., and E.D. Cossíos

- 2004 Sechuran fox *Pseudalopex sechurae* (Thomas, 1900). In, *Canids: Foxes, Wolves, Jackals and Dogs*, edited by Claudio Sillero-Zubiri, Michael Hoffman and David W. MacDonald, pp.69-72. IUCN/Species Survival Commission, Gland.

Bird, Junius B.

- 1988 *Travels and Archaeology in South Chile*. University of Iowa Press, Iowa City.

Bodmer, Richard E. and Lyle K. Sowls

- 1993 The collared peccary (*Tayassu tajacu*). In, *Pigs, Peccaries, and Hippos: Status Survey and Conservation Action Plan*, edited by William L.R. Oliver, pp. 7-13. IUCN/Species Survival Commission, Gland.

Borrero, Luis A.

- 2003 Taphonomy of the Tres Arroyos 1 Rockshelter, Tierra del Fuego, Chile. *Quaternary International* 109-110:87-93.

- 2009 The Elusive Evidence: The Archaeological Record of the South American Extinct Megafauna. In *American Megafaunal Extinctions at the End of the Pleistocene*, ed. G. Haynes, pp. 145-168. Springer, New York.

Brannan, William v., Marga C.M. Werkhaven, and R. Larry Marchinton

- 1985 Food habits of brocket and white-tailed deer in Suriname. *Journal of Wildlife Management* 49:972-976.

Brokx, P.A., and F.M. Andressen

1970 Análisis estomacales de venado caramerudo de los llanos Venezolanos. *Boletín Sociedad Venezolano de Ciencias Naturales* 28:330-353.

Byrd, Kathleen M.

1976 *Changing Animal Utilization Patterns and their Implications: Southwest Ecuador (6500 B.C. – A.D. 1400)*. Unpublished Dissertation, Department of Anthropology. University of Florida, Gainesville.

Cardich, A., E.P. Tonni and N. Kriscautzky

1977 Presencia de *Canis familiaris* en Restos Arqueológicos de Los Toldos (Provincia de Santa Cruz, Argentina). *Relaciones de la Sociedad Argentina de Antropología* 11:115-119.

Casamiquela, Rudolfo

1996-1997 The Pleistocene Vertebrate Record of Chile. *Quaternary of South America and Antarctic Peninsula* 12:91-107.

Caviglia, Sergio E.

1985 Nuevos Restos de Canidos Tempranos en Sitios Arqueológicos de Fuego-Patagonia. *Anales del Instituto de la Patagonia, Serie Ciencias Sociales* 16:85-93.

Caviglia, Sergio E, Hugo D. Yacobaccio, and Luis A. Borrero

1986 Las Buitreras: Convivencia del Hombre con Fauna Extinta en Patagonia Meridional. In *New Evidence for the Pleistocene Peopling of the Americas*, ed. A.L. Bryan, pp. 295-317. Center for the Study of Early Man, Orono.

Cerqueira, Rui, and Christopher J. Tribe

2007 Genus *Didelphis* Linnaeus, 1758. In, *Mammals of South America. Volume 1, Marsupial, Xenathrans, Shrews, and Bats*, edited by Alfred L. Gardner, pp.17-25. University of Chicago Press, Chicago.

Chapman, Joseph A., and Gerardo Ceballos

1990 The cottontails. In, *Rabbits, Hares, and Pika: Status Survey and Conservation Action Plan*, edited by Joseph A. Chapman and John E.C. Flux, pp. 93-110. IUCN/Species Survival Commission, Gland.

Chase, Thomas

1988 Restos funicos. In, *La Prehistoria Temprana de la Pennsula de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 171-178. Serie Monogrfica 10, *Miscelnea Antropolgica Ecuatoriana*, Guayaquil.

Clutton-Brock, Juliet.

1977 Man-made Dogs. *Science* 197:1340-1342.

1988 The Carnivore Remains Excavated at Fell’s Cave in 1970. In *Travels and Archaeology in South Chile*, ed. J. Hyslop, pp. 188-195. University of Iowa Press, Iowa City.

Correal Urrego, Gonzalo

1986 Apuntes Sobre el Medio Ambiente Pleistocnico y el Hombre Prehistrico en Colombia. In *New Evidence for the Pleistocene Peopling of the Americas*, ed. A.L. Bryan, pp. 115-131. Center for the Study of Early Man, Orono.

Cossos, E. Daniel

2010 *Lycalopex sechurae* (Carnivora: Canidae). *Mammalian Species* 42 (848):1-6.

De Oliveira, Tadeu G.

1998 *Herpailurus yagouaroundi*. *Mammalian Species* 578:1-6.

Dillehay, Tom D.

2011 Introduction, In, *From Foraging to Farming in the Andes: New Perspectives on Food Production and Social Organization*, edited by Tom D. Dillehay, pp. 1-28. Cambridge University Press, Cambridge.

Dodson, Peter, and Diane Wexlar

1979 Taphonomic investigations of owl pellets. *Paleobiology* 5:275-284.

Emmons, Louise H.

1982 Ecology of *Proechimys* in southeastern Peru. *Tropical Ecology* 23:280-290.

1984 Geographic variation in densities and diversities of non-flying mammals in Amazonia. *Biotropica* 16:210-222.

Emmons, Louise H. and Franoise Feer

1999 *Neotropical Rainforest Mammals. A field Guide, Second Edition*. University of Chicago Press, Chicago.

Fidalgo, Francisco, Guzman, Luis M.M., Politis, Gustavo G., Salemme, Monica C., Tonni, Eduardo.P., Carbonari, Jorge E., Gomez, Gabriel J., Huarte, Roberto A. and Anibel J. Figini.

1986 Investigaciones Arqueológicas en el Sitio 2 de Arroyo Seco (Odo. De Tres Arroyos -Pcia. de Buenos Aires- República Argentina). In *New Evidence for the Pleistocene Peopling of the Americas*, ed. A.L. Bryan, pp. 221-269. Center for the Study of Early Man, Orono.

Gardner, Alfred J.

2007 Suborder Vermilingua Illiger, 1811. In, *Mammals of South America. Volume 1, Marsupial, Xenathrans, Shrews, and Bats*, edited by Alfred L. Gardner, pp.168-177. University of Chicago Press, Chicago.

Gliwicz, J.

1973 A short characteristics of a population of *Proechimys semispinosus* (Tomes, 1860) –a rodent species of the tropical rain forest. *Bulletin de l'academie Polonaise de Sciences* 21:413-418.

Gómez, Gustavo N.

2007 Predators categorization based on taphonomic analysis of micromammal bones: a comparison to proposed models. In, *Taphonomy and Zooarchaeology in Argentina*, edited by M.A. Gutierrez, L. Miotti, G. Barrientos, G. Mengoni-Goñalons, and M. Salemme, pp. 89-103. British Archaeological Reports, International Series 1601. Archaeopress, Oxford.

Gutiérrez, María A. and Gustavo A. Martínez

2008 Trends in the Faunal Human Exploitation during the Late Pleistocene and Early Holocene in the Pampean Region (Argentina). *Quaternary International* 191:53-68.

Ijzereef, Gerard F.

1978 Faunal Remains from the El Abra Rock Shelters (Colombia). *Palaeogeography, Palaeoclimatology, Palaeoecology* 25:163-177.

Jackson, Donald

2003 Evaluating Evidence of Cultural Associations of *Mylodon* in the Semiarid Region of Chile. In *Where the South Wind Blows*, eds. L. Miotti, M. Salemme, and N. Flegenheimer, pp. 77-81. Texas A&M University, College Station.

König, Claus, Friedhelm Weick, and Jan-Hendrick Becking

1999 *Owls. A Guide to the Owls of the World*. Yale University Press, New Haven.

Lyman, R. Lee

1984 Bone density and differential survivorship of fossil classes. *Journal of Anthropological Archaeology* 3:259-299.

1994 *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

Lynch, Thomas F. and Susan Pollock

1981 La Arqueología de la Cueva Negra de Chobshi. *Miscelánea Antropológica Ecuatoriana* 1:92-119.

MacNeish, Richard S.

1979 The Early Man Remains from Pikimachay Cave, Ayacucho Basin, Highland Peru. In *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities*, eds. R.L. Humphrey and D. Stanford, pp. 1-47. Anthropological Society of Washington, Washington D.C.

MacNeish, Richard S. and Robert K. Vierra

1983 The Preceramic Way of Life in the Thorn Forest Riverine Ecozone. In *Prehistory of the Ayacucho Basin, Peru. Vol. 4 The Preceramic Way of Life*, eds. R.S. MacNeish, R.K. Vierra, A. Nelkien-Terner, R. Lurie, and A.G. Cook, pp.48-129. University of Michigan Press, Ann Arbor.

Madrigal, T. Cregg, and Julie Zimmerman Holt

2002 White-tailed deer meat and marrow return rates and their implication to eastern woodlands archaeology. *American Antiquity* 67:745-759.

Marchant, S.

1958 The birds of the Santa Elena Peninsula, S.W. Ecuador. *Ibis* 100:349-387.

Martínez, Gustavo and María A. Gutiérrez

2004 Tendencias en la Explotación Humana de la Fauna Durante el Pleistoceno Final y Holoceno en la Región Pampeana (Argentina). In *Zooarchaeology of South America*, ed. G.L. Mengoni Goñalons, pp. 81-98. British Archaeological Reports, International Series 1298. Archaeopress, Oxford.

Mazzanti, Diana L. and Carlos A. Quintana

1997 Asociación Cultural con Fauna Extinguida en el Sitio Arqueológico Cueva Tixi, Provincia de Buenos Aires, Argentina. *Revista Español de Antropología Americana* 27:11-21.

Mena L., Francisco, Omar Reyes B., Thomas W. Stafford Jr. and John Southon

2003 Early Human Remains from Baño Nuevo-1 Cave, Central Patagonian Andes, Chile. *Quaternary International* 109-110:113-121.

Mengoni Goñalons, Guillermo L.

1986 Patagonian Prehistory: Early Exploitation of Faunal Resources (13,500-8500 B.P.). In *New Evidence for the Pleistocene Peopling of the Americas*, ed. A.L. Bryan, pp. 271-279. Center for the Study of Early Man, Orono.

1987 Modificaciones Culturales y Animales en los Huesos de los Niveles Inferiores del Sitio Tres Arroyos 1 (Tierra del Fuego, Chile). *Anales del Instituto de la Patagonia, Serie Ciencias Sociales* 17:61-66.

Merrick, Melissa J., John L. Koprowski, and R. Nathan Gwinn

2012 *Sciurus stramineus* (Rodentia: Sciuridae). *Mammalian Species* 44 (894):44-50.

Miotti, L. and M. Salemme

1999 Biodiversity, Taxonomic Richness and Specialist-Generalists during Late Pleistocene/Early Holocene Times in Pampa and Patagonia (Argentina, South America). *Quaternary International* 53/54:53-68.

Mondini, Mariana

2000 Tafonomía de Abrigos Rocosos de la Puna. Formación de Conjuntos Escatalógicos por Zorros y sus Implicaciones Arqueológicas. *Archaeofaunas* 9:151-164.

2002 Carnivore Taphonomy and the Early Human Occupations in the Andes. *Journal of Archaeological Sciences* 29:791-801.

2004 La Comunidad de Predadores en la Puna Durante el Holoceno. Interacciones Bióticas entre Humanos y Carnívoros. *Relaciones de la Sociedad Argentina de Antropología* 29:183-209.

Moreno, Pablo A.

2010 Mamíferos presentes en la dieta de la Lechuza de Companario (*Tyto alba*) en Valdivia, provincial de Guayas, Ecuador. *Avances en Ciencias e Ingenierías* 3:B87-B90.

Montané, J.

1968 Paleo-Indian Remains from Laguna de Tagua-Tagua, Central Chile. *Science* 161:1137-1138.

Murray, Julie L., and Gregory L. Gardner

1997 *Leopardus pardalis*. *Mammalian Species* 548:1-10.

Navarrete, Daya, and Jorge Ortega

2011 *Tamandua mexicana* (Pilosa: Myrmecophagidae). *Mammalian Species* 43 (874):56-63.

Novacosky, Brad J., and Peter R.W. Popkin

2005 Canidae volume bone mineral density values: an application to sites in western Canada. *Journal of Archaeological Science* 32:1677-1690.

Palma, Julie

1969 El Sitio de Tagua-Tagua en el Ambito Paleo-Americano. *Actas del V Congreso Nacional de Arqueología (Chile)*: 315-325.

Paunero, R.S.

2003 The Presence of a Pleistocene Colonizing Culture in La María Archaeological Locality, Casa del Minero 1. In *Where the South Wind Blows*, eds. L. Miotti, M. Salemme and N. Flegenheimer, pp. 127-132. Texas A&M University, College Station.

Pavao, Barnet, and Peter W. Stahl

1999 Structural density assays of leporid skeletal elements with implications for taphonomic, actualistic and archaeological research. *Journal of Archaeological Science* 26:53-66.

Pavao-Zuckerman, Barnet

2004 Preceramic period vertebrate use in the Jequetepeque valley, Peru. Manuscript on file, Stanley J. Olsen Laboratory of Zooarchaeology, Arizona State Museum, Tucson.

Politis, Gustavo G.

1986 Investigaciones Arqueológicas en el Área Interserrana Bonaerense. *Etnia* 32:7-52.

Politis, Gustavo G. and Pablo G. Messineo

2008 The Campo Laborde Site: New Evidence of the Holocene Survival of Pleistocene Megafauna in the Argentinian Pampas. *Quaternary International* 191:98-114.

Ridgely, Robert S., and Paul J. Greenfield

2001a *The Birds of Ecuador: Field Guide*. Vol. 2. Cornell University Press, Ithaca.

2001b *The Birds of Ecuador: Status, Distribution, and Taxonomy*. Vol. 1. Cornell University Press, Ithaca.

Smith, Winston Paul

1991 *Odocoileus virginianus*. *Mammalian Species* 388:1-13.

Smythe, Nicholas

1978 *The Natural History of the Central American Agouti* (*Dasyprocta punctata*). Smithsonian Contributions to Zoology 257. Smithsonian Institution Press, City of Washington.

Stackelback, Kary

2011 Faunal remains, In, *From Foraging to Farming in the Andes: New Perspectives on Food Production and Social Organization*, edited by Tom D. Dillehay, pp. 193-204. Cambridge University Press, Cambridge.

Stahl, Peter W.

2012 Interactions between humans and endemic canids in Holocene South America. *Journal of Ethnobiology* 32:108-127.

Stothert, Karen E.

1988a Excavaciones en el sitio OGSE-80. In, *La Prehistoria Temprana de la Península de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 21-54. Serie Monográfica 10, *Miscelánea Antropológica Ecuatoriana*, Guayaquil.

1988b Interpretación de los restos fáunicos. In, *La Prehistoria Temprana de la Península de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 187-202. Serie Monográfica 10, *Miscelánea Antropológica Ecuatoriana*, Guayaquil.

1988c Cultura Material de Las Vegas. In, *La Prehistoria Temprana de la Península de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 63-103. Serie Monográfica 10, *Miscelánea Antropológica Ecuatoriana*, Guayaquil.

1988d Patrones de entierros. In, *La Prehistoria Temprana de la Península de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 133-169. Serie Monográfica 10, *Miscelánea Antropológica Ecuatoriana*, Guayaquil.

Stothert, Karen.E., Dolores. R. Piperno and Thomas C. Andres

2003 Terminal Pleistocene/Early Holocene Human Adaptation in Coastal Ecuador: the Las Vegas Evidence. *Quaternary International*, 109-110: 23-43.

Suárez, E., J. Stallings, and L. Suárez

1995 Small-mammal hunting by two ethnic groups in north-western Ecuador. *Oryx* 29:35-42.

Tirira, Diego

2007 *Mamíferos del Ecuador. Guía de Campo*. Publicación Especial 6. Ediciones Murciélago Blanco, Quito.

Tonni, Eduardo.P. and Gustavo.G. Politis

1981 Un Gran Cánido del Holoceno de la Provincia de Buenos Aires y el Registro Prehispánico de *Canis (Canis) familiaris* en las Áreas Pampeana y Patagónica. *Ameghiniana* 18:251-265.

Trejo, Valentina and Douglas Jackson

1998 Cánidos Patagónicos: Identificación Taxonómica de Mandíbulas y Molares del Sitio Arqueológico Baño Nuevo (Alto Ñirehuao, XI Region). *Anales del Instituto de la Patagonia. Serie Ciencias Humanas* 26:181-194.

Voss, Robert S.

1992 *A Revision of the South American Species of Sigmodon (Mammalia: Muridae) with Notes on their Natural History and Biogeography*. American Museum Novitates 3050. American Museum of Natural History, New York.

Weksler, Marco

2006 *Phylogenetic Relationships of Oryzomine Rodents (Muroidea: Sigmodontinae): Separate and Combined Analyses of Morphological and Molecular Data*. Bulletin of the American Museum of Natural History 296, New York.

Weksler, Marco, Alexandre R. Percequillo, and Robert S. Voss

2006 *Ten New Genera of Oryzomyine Rodents (Cricetidae: Sigmodontinae)*. American Museum Novitates 3537. American Museum of Natural History, New York.

Wheeler, Jane

1985 De la Chasse a L'élevage. In *Chasseurs et Pasteurs Préhistoriques des Andes 1*. By D. Lavallée, M. Julien, J. Wheeler, and C. Karlin, pp. 61-79. Editions Recherche sur les Civilisations, Paris.

Wheeler Pires-Ferreira, Jane, Edgardo Pires-Ferreira and Peter Kaulicke

1976 Preceramic Animal Utilization in the Central Peruvian Andes. *Science* 194:483-490.

Wing, Elizabeth S.

1988 *Dusicyon sechurae*, en contextos arqueológicos tempranos . In, *La Prehistoria Temprana de la Península de Santa Elena, Ecuador: Cultura Las Vega*, by Karen E. Stothert, pp. 179-185. Serie Monográfica 10, *Miscelánea Antropológica Ecuatoriana*, Guayaquil.

1989 Human use of canids in the central Andes. In, *Advances in Neotropical Mammals*, edited by Kent Redford and John Eisenberg, pp. 265-278. Sandhill Crane Press, Gainesville.