

Guanaco bone piles from the Pampas region (Argentina) and their implications for hunter-gatherer subsistence

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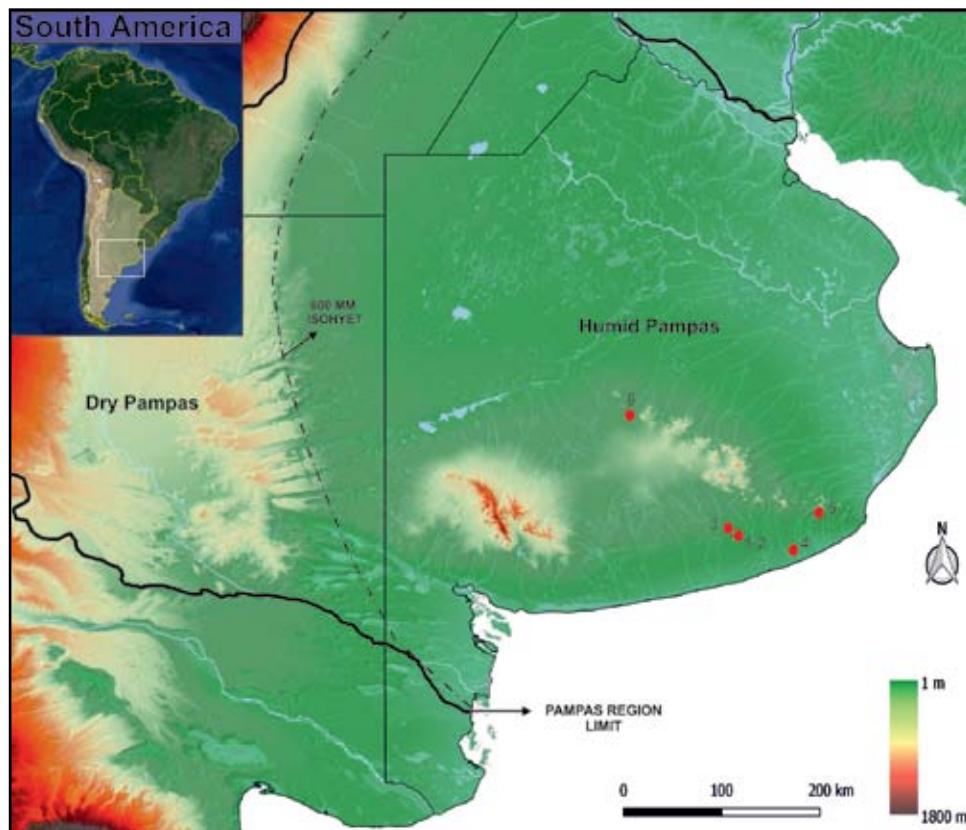
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Abstract: Six hunter-gatherer archaeological sites from the Pampas region (Argentina) are characterised by 'bone piles' dominated by guanaco bones. These assemblages are dated to the Middle and Late Holocene and their study contributes to the understanding of hunter-gatherer subsistence, especially in periods like these when diet was highly oriented to the consumption of guanaco. This article discusses assemblages with bone piles, with a special focus on the site Empalme Querandíes 1. This is a base camp where a wide variety of resources was exploited. Of particular interest at this site is the presence of two bone piles, mainly composed of complete guanaco bones. These features are associated with at least two different chronological events that took place during the Late Holocene. Analyses conducted on specimens from the bone piles show that they were deposited in palustrine environments, the elements were highly articulated, the time of burial was short, and they correspond to guanacos of different ages. Taking into account the cultural context, the association of the elements, and the presence of human modifications, it is proposed that both bone piles had an anthropogenic origin. Their presence could be the result of cooperative hunting and the premature abandonment of the base camp because of unpredictable situations or mobility decisions.

Keywords: bone piles, guanaco bones, Pampas region, taphonomy, Middle and Late Holocene, subsistence models

1. Introduction

The Pampas region of Argentina is a large ecosystem of grasslands located in southern South America and it has been inhabited by hunter-gatherers from the Final Pleistocene until recent times (Politis 2008). The guanaco (*Lama*



guanicoe) has been the main resource for these societies throughout the Holocene. Accordingly, there is a wide variety of archaeological sites in the Pampas which contain the remains of this ungulate. Some of these contexts, dated to the Middle and Late Holocene, present discrete accumulations of guanaco bone specimens that can be differentiated from the contiguous deposits. We term these features are [AQ1] spatially constrained and are usually dominated by guanaco bones, consisting of only few or tens of individuals, 'bone piles'. This is different to what has been traditionally defined as a bonebed, 'a single sedimentary stratum with a bone concentration that is unusually dense, relative to adjacent lateral and vertical deposits' (Behrensmeier 2007:66). The term bonebed is frequently associated with mass kills or mass death events (Kelly & Thomas 2012).

Sites with guanaco bone piles have been subjected to different interpretations and have played an important role in evaluating the subsistence strategies of hunter-gatherers. Nevertheless, these bone assemblages are usually affected

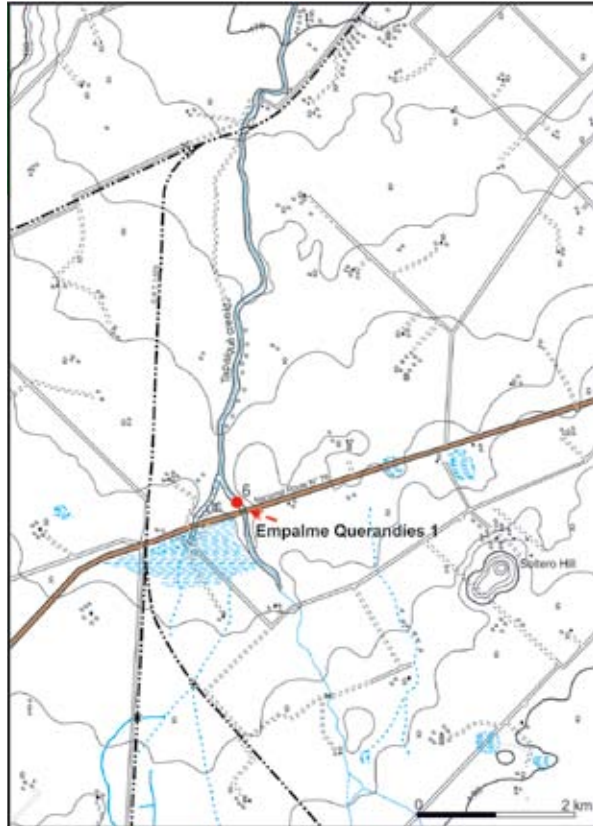


Figure 1 Left: Location of archaeological sites in the Humid Pampas with bone piles. 1=Paso Otero 1; 2=Paso Otero 3; 3=Zanjón Seco 3; 4=Nutria Mansa 1; 5=Cueva Tixi; 6=Empalme Querandies 1. [AQ2] Right: Detail of the location of Empalme Querandies 1

by different taphonomic processes and their genesis and configuration are sometimes hard to interpret. In this article, we present analyses and interpretation of the bone pile assemblages of Empalme Querandies 1 (henceforth EQ1), an archaeological site located in the Humid Pampas (Figure 1). The main objectives of this contribution are:

- to evaluate the origin of the bone piles from EQ1 to determine if it is natural, cultural, or a combination of both processes
- to interpret the role of these features at an intra-site scale.

To achieve these goals, we conducted different analyses of the bone assemblage, including detailed techniques for the determination of age and sex in guanaco bone and teeth, many of which have been developed by one of the authors of this article (Kaufmann). Finally, we also summarise the data from all the sites with bone piles from the Humid Pampas, to interpret the behaviour related to these features at a regional scale.

The presence of anthropogenic bone piles has important implications when understanding the relationship between the animals and the hunter-gatherers in the past, and how this changes over time. For example, a key debate about hunting tactics for procurement of animal resources is the distinction between cooperative and communal hunting (Kornfeld et al 2010; Borrero 2013; Belardi et al 2017). These strategies have important implications for the social sphere of past societies and can be elucidated through detailed analyses of faunal assemblages.

2. Background

2.1. *The Pampas region of Argentina*

The Pampas region is a vast plain that includes two sub-regions divided by the 600 mm isohyet (Figure 1). The Dry Pampas (to the west) are dry steppes of moderate continental climate, whilst the Humid Pampas (to the east) have a humid temperate climate and rich soils (Prieto 2000). In the northeast, the average temperatures range between 24°C in summer (January–February) and 10°C in winter (July–August), whereas in the southwest the average for the same months is between 20°C and 7°C (Burgos 1968). There is no dry season in the Humid Pampas, but a decrease in precipitation occurs during the end of the summer and the winter. The annual total rainfall increases towards the east, from 400 mm in the southwest to 1000 mm or more in the northeast (Burgos 1968; Prieto 2000). The native vegetation of the Humid Pampas is medium-height grassland, with perennial and annual grasses with scattered shrubs (Soriano 1991).

2.2. *The guanaco (Lama guanicoe)*

The guanaco was the main resource for the hunter-gatherers that inhabited the Pampas throughout the Holocene. These societies used its meat, skin, bone and marrow (Politis & Pedrotta 2006). The guanaco is one of the largest wild South American artiodactyls and is distributed from the north of Peru to Southern Chile. Guanacos have long, slender necks and long legs typical of camelids (Franklin 2011). Adult individuals weight between 88 and 120 kg and newly born young weigh between 8 and 12 kg (Franklin 1983; Fritz 1985). They are diurnal and grazers, but also feed on tree and shrub foliage. The social organisation of guanacos is based on a polygamous mating system. The family group is territorial and is the basic social unit. This consists of a territorial male and several females, with offspring less than 15 months old. Other units found

during the reproductive season include solitary males (>15 months old) expelled from the family group and non-territorial male groups, mainly composed of males (6 to 167 animals) of various ages (Franklin 1983, 2011; Bank et al 2003). Guanacos do not present evident sexual dimorphism, although males have larger canines than females (Raedeke 1979; Kaufmann 2009).

2.3. Hunter-gatherer subsistence in the Humid Pampas

Although the guanaco was the main faunal resource in the diet of hunter-gatherer populations throughout the Holocene, the role of this camelid in subsistence changed over time. During the Pleistocene–Holocene transition (14,000–10,800 years cal BP) there was a generalised regional economy that included a broad spectrum of exploited resources as well as now-extinct animals. Assemblages dated to the early Holocene (10,800–8200 years cal BP) indicate that the subsistence strategy was focused on medium-sized game (mainly artiodactyls) (Martínez et al 2016). In the Middle Holocene (8200–4200 years cal BP) there was an emphasis on guanaco hunting, especially from the second half of this period (Álvarez 2014). Finally, towards the end of the Late Holocene (4200–500 years cal BP), a process of diversification and intensification took place, with an increase in the use of small, medium and large prey (Martínez & Gutiérrez 2004). The intensification process involved an increase in the use and selection of small animals, with shorter reproductive cycles and high birth rates (Quintana & Mazzanti 2001). However, in some sectors of the Humid Pampas grasslands such as the inter-hill plains and the Central Pampean Dunefields area, the zooarchaeological record indicates that the subsistence strategy was similar to that of the Middle Holocene, highly oriented to the procurement of guanaco (Frontini 2013; Álvarez 2014; Scheifler & Messineo 2016).

2.4. Sites with bone piles in the Humid Pampas

Besides EQ1, there are five sites in the Humid Pampas with bone piles (Figure 1). A brief summary of these contexts is presented below, highlighting the regional context and the different interpretations of these assemblages.

Paso Otero 1 is located on the left bank of the Quequén River, in Necochea County. Between 1989 and 1991, 22 m² were excavated during different field seasons and about 3700 bone elements and a minimum of 36 guanacos recovered (Politis et al 1991; Gutiérrez 1998). Bone specimens were distributed in at least five piles, one of them associated with the upper A buried soil horizon and the rest associated with the middle A buried soil horizon (Gutiérrez 2001;

Johnson et al 2012). Radiocarbon dates on soil samples indicate an age of $c 5586 \pm 130$ years cal BP for the middle horizon, while a radiocarbon date on a guanaco tooth from one of the bone piles from this horizon was dated to $c 3264 \pm 63$ years cal BP (Martínez 2006). The radiocarbon dates of the soil organic matter from the upper horizon (younger bone assemblage) indicate an age of $c 3199 \pm 77$ years cal BP (Martínez 2006). The integration of archaeological and contextual information led the researchers to postulate that the site was generated by human activities related to the capture and initial butchery of guanacos (Politis et al 1991). However, the initial work lacked detailed taphonomic analysis, and later the assemblage was re-analysed considering taphonomic and geoarchaeological studies (Favier Dubois 2006). The new analysis showed that the guanaco bones were in an erosive channel structure and the water flow also generated abrasion and polishing in a significant number of bones (Gutiérrez & Kaufmann 2007). The site is now interpreted as a natural accumulation by turbulent stream flow, although it could have incorporated some human-processed remains from unknown sites. Bone piles were later restructured by the lower energy action of water, which displaced unfused epiphyses, vertebrae, ribs and sternbrae outside of the site (Gutiérrez & Kaufmann 2007). The possible cause of death of the guanacos could be alimentary stress produced by droughts or floods.

Paso Otero 3 is located 500 m downstream from Paso Otero 1, on the left bank of the Quequén River (Martínez 1999). The archaeological materials were lying on backswamp deposits, which suggest landscape stability. Considering the radiocarbon dates on soil samples, this site corresponds to the Middle Holocene (dated between 5466 ± 94 and 3199 ± 117 years cal BP). A bone pile composed almost exclusively of guanaco bones was identified. Most of the bones are complete appendicular elements (MNE=52) of at least two adults and a juvenile individual (Martínez et al 2001). Cultural evidence was recovered above and below the bone pile: two fragments of marine shells (*Volutidae* and *Adelomedon cf ancilla*) and spots and fragments of red ocher, respectively. Many lithic tools were recorded outside the bone pile, as well as other taxa besides guanaco: Pampas deer (*Ozotoceros bezoarticus*), Plains viscacha (*Lagostomus maximus*), Pampas fox (*Lycalopex gymnocercus*), armadillos and fragments of eggshell and marine molluscs. Considering all this evidence, the site was defined as a residential camp site (Martínez 2006).

Zanjón Seco 3 is located in a tributary gully of the Quequén River. The archaeological component lies on eolian sediments of La Postrera Formation and dates to $c 1351 \pm 41$ years cal BP (Politis 1984; Politis & Beukens 1991). This site was originally interpreted as a dump or a waste structure of guanaco bones.

The functional hypothesis was later expanded, suggesting that the excavated surface represents an area of activity that was part of a larger site related to multi-activity base camps (Martínez 1999). The dumping structure is approximately elliptical in shape and is composed of skeletal remains mostly assigned to guanaco (MNE=537; MNI=11) and associated with lithic artefacts – four tools and 16 flakes (Politis 1984). The guanaco skeletal part profile indicates that all anatomical units are represented in the sample, from mature and immature individuals. The bone remains were incomplete and most of the long bones had helical fractures. Other species recorded are medium-sized rodents and carnivores (Martínez 1999).

Nutria Mansa 1 is an open-air site located within the alluvial deposits of a stream that flows to the coast (Bonomo 2005). The archaeological remains are in a cumulic A horizon and have a chronology of $c\ 3255 \pm 139$ and 2827 ± 59 years cal BP. This site was characterised as a base camp, where multiple activities were carried out. Recovered materials include a wide variety of lithic artefacts as well as faunal remains from several species (numerous carnivores, armadillos, seals, rodents and even great white shark *Carcharodon carcharias*). Two bone piles mainly composed of guanaco bones were identified but only one was studied in detail. This accumulation was composed of a minimal number of eight guanacos, represented by a great diversity of skeletal parts (MNE=150). Moreover, two plates of armadillo, a deer femur, and three rodent teeth were found in this feature (Bonomo & Massigoge 2004; Bonomo 2005). Some of the guanaco elements (eg humerus, radius-ulna, tibia) had cut marks. The location of these marks could indicate activities related to the dismemberment and disarticulation of the carcasses. In addition, helical fractures and thermal alteration were recorded in some specimens. According to the authors, the bone piles are composed of elements in close association, have well defined boundaries, and a limited vertical development, which could be the product of the deliberate disposition of the elements at one specific time by human groups (Bonomo & Massigoge 2004).

Unlike the other sites, Cueva Tixi is located in the Tandilia hill range (La Vigilancia). This cave has a stratigraphic sequence of four separate occupational episodes that show hunter-gatherers used this place from at least $12,237 \pm 163$ years cal BP (Mazzanti 2001). One of these occupations is dated to the Middle Holocene (5591 ± 81 years cal BP). The analysis of different evidence from this level, such as lithic/bone tools and faunal remains, indicates that numerous ungulates that were hunted in the near valley were transported to the cave and butchered. Associated with this settlement, there is a bone pile consisting of numerous guanaco (MNI=9) and Pampas deer (MNI=7) elements (Quintana

& Mazzanti 2001). This accumulation is composed of bones from the entire skeleton of mature and immature ungulates, but with a greater representation of limbs. Some anatomical parts remained articulated, such as part of the neck and the skull of a Pampas deer and the foreleg of a guanaco. There are several guanaco bones with helical fractures and cut marks associated with primary and secondary butchery activities, as well as with the manufacture of bone tools (Mazzanti & Valverde 2001). Also, a fragment of a human mandible was found in the middle section of the pile. Other species recorded outside the feature are armadillos, medium-sized rodents and Greater rhea (*Rhea Americana*) (Quintana & Mazzanti 2001).

3. Empalme Querandíes 1 (EQ1)

EQ1 is located in the inter-hills area of the Humid Pampas, on the left margin of Tapalqué Creek (Olavarría County, province of Buenos Aires, Argentina; Figure 1). Fieldwork was conducted in 2010 and 2011. Six units (U1–6) were excavated, covering an area of 6 m² and reaching a depth of 1.55 m. Different types of analyses – environmental, chronological, taphonomic, archaeological – suggest that EQ1 corresponds to a multiple-activity site or base camp, occupied by hunter-gatherers at least three different times (see radiocarbon dates below) during the Late Holocene.

Faunal analyses show the consumption of several taxa such as guanaco, Pampas deer, Greater rhea, plains viscacha, coypu (*Myocastor coypus*), and four armadillo species. Butchery evidences include thermal alteration, helical fractures and cut marks. The proportion of cut marks on guanaco bones is 6% while the percentage of anthropic fractures is 3% (Messineo et al 2013). Bone remains of guanaco and Pampas deer were also used as raw material for the manufacture of tools. The most abundant lithic artefacts at the site are manufactured in orthoquartzite and chert (Colantonio et al 2016). Plain and geometrically decorated potsherds were also recovered.

One feature of this site is the presence of two spatially separated bone piles corresponding to two different periods and mainly composed of complete guanaco bones and with several lithic artefacts within the accumulations. These were named bone pile #1 and bone pile #2. Bone pile #1 was almost completely excavated during the 2010 and 2011 fieldwork seasons while bone pile #2 continued into the profile [AQ3]. Previous analyses of the bone piles did not reveal the origin of the features (Messineo et al 2013). For this reason, during field seasons in 2012 and 2013 we decided to open two more adjacent

units (U7–8) and to deepen the excavation to 1.90 m. In this article, we present analysis of the complete assemblage, including re-analysis of material from 2010–2011 and material from the new excavation and including a detailed analysis of the guanaco age profile.

3.1. Stratigraphy, chronology and paleoenvironmental data

Geoarchaeological and sedimentological studies of EQ1 were performed by CM Favier Dubois (Messineo et al 2013), who identified that the archaeological remains are included in deposits of fluvial origin in which three pedostratigraphic units are recognised (A, 2Ab1 and 2Ab2). In the lower section of the profile there is a C horizon of the buried soil 3Cb2, assignable to the Guerrero Member of the Luján Formation (Late Pleistocene). Figure 2 shows the main characteristics for each stratigraphic unit.

Three radiocarbon dates have been obtained at the NSF Arizona AMS Laboratory, all on guanaco bones from different archaeological levels (Figure 2; Table 1). All dated samples had evidence of human processing (cut marks or helical fractures).

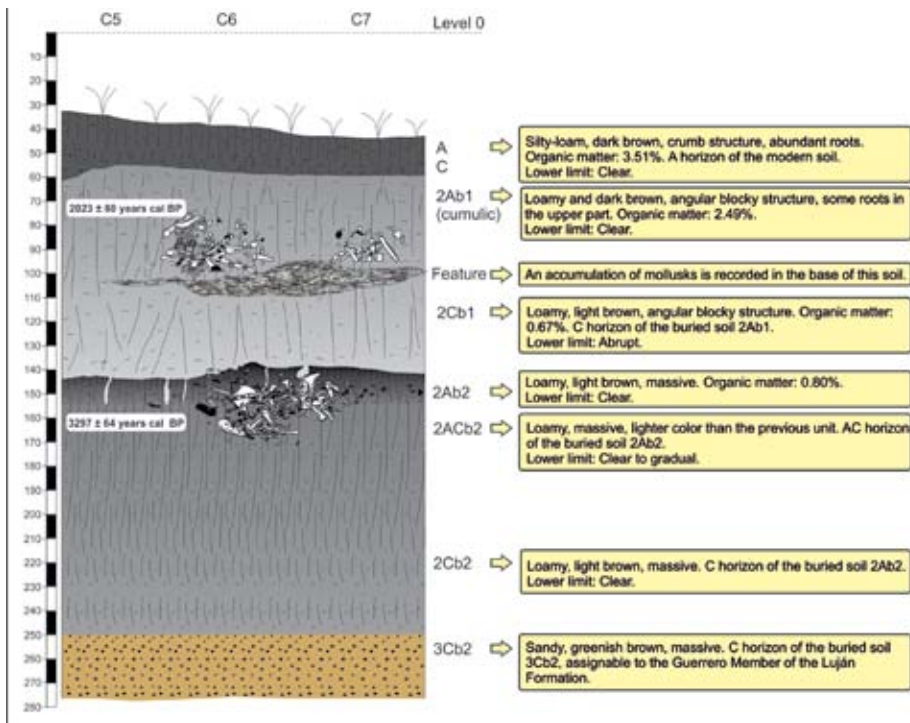


Figure 2 Stratigraphic sequence of EQ1 and location of bone pile #1 (upper) and #2 (lower) [AQ4]

Table 1 Radiocarbon dates obtained for the site EQ1

Lab number	Buried soil	Bone pile	14C age	δ 13C value	2 Sigma cal age range
AA-94557	2Ab1	#1	2052 \pm 62	-23.9	1820–2130
AA-94558	2Cb1	-	2816 \pm 49	-19.9	2755–2975
AA-94559	2Ab2	#2	3095 \pm 50	-18.6	3080–3370

Paleoenvironmental data for EQ1 comes from two types of studies: palynology and malacology. Regarding the paleoenvironmental data, three stratigraphic profiles located 100 m away from the site were studied by Prieto (1989). These analyses indicate that for the Late Holocene the grasslands of this area corresponded to species associated with an annual mean precipitation of 800 mm, as well as annual mean precipitation efficiency values of 0–100 mm (Prieto et al 2009; Tonello & Prieto 2010).

The malacological studies were conducted by Dr P Steffan, who sampled the north wall profile of Unit 6 (Messineo et al 2013), which had a lenticular feature with abundant gastropods (Figure 2). The malacofauna is formed by five species of continental gastropods (*Heleobia parchappii*, *Biomphalaria peregrina*, *Succinea meridionalis*, *Antillorbis nordestensis* and *Miradiscops brasiliensis*). The majority of the gastropods associated with bone pile #2 and in the buried soil 2Ab2 correspond to *Succinea meridionalis*, a species that lives in swampy areas. Above this section, there is an increase in terrestrial species, related to the development of the buried soil 2Cb1. The major abundance of fluvial and lacustrine taxa is recorded in the lenticular feature. There, the gastropod specimens present a high fragmentation and polish and are associated with fish and aquatic plant remains. These data indicate a flood event and the subsequent formation of a lacustrine environment during the beginning of the development of the 2Ab1 horizon. Malacofauna associated with bone pile #1 has a predominance of palustrine species, related to the formation of cumulic soils in the A horizon of the 2Ab1 (Messineo et al 2013).

4. Materials and methods

All specimens that were assigned to the bone piles (N=412) were studied in this work; 173 re-analysed from earlier work and 239 from the new excavations. During fieldwork the location and orientation for all bone specimens over 1 cm in size was established by taking several measures for each specimen.

Bone remains were examined with the naked eye and under a stereoscopic microscope with a magnification of 50x. Faunal identifications were determined at the taxonomic and anatomic levels. Different taphonomic variables were considered for each bone specimen. Weathering was evaluated taking into account the stages proposed by Behrensmeyer (1978). Manganese, root, and rodent marks were quantified by using four stages of affected surface percentages (1–25%, 26–50%, 51–75%, 76–100%). Evidence of carnivore action was recorded considering the types of marks described by Binford (1981) and Haynes (1980). Trampling was determined through the presence of the marks characterised by Olsen & Shipman (1988). The existence of sedimentary abrasion was evaluated considering the three stages proposed by Gutiérrez & Kaufmann (2007).

The variables related to the identification of human exploitation included the determination of thermal alteration, type of fracture, and cut marks (Binford 1981; Shipman 1981; Johnson 1985; David 1990). Where possible, the cut marks were differentiated into filleting, skinning and disarticulation. These categories were originally defined by Binford (1981). However, we consider new information obtained through controlled experiments to differentiate these activities based on qualitative data (Nilssen 2000; Soulier & Costamagno 2017).

Measures of Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI) were calculated for each taxon (Grayson 1984; Klein & Cruz-Uribe 1984; among others). NISP was obtained by adding the number of skeletal elements or fragments identified to the taxon level. MNI was calculated by considering the most commonly occurring kind of skeletal element of a taxon (Lyman 2008). The construction of skeletal part profiles included the quantification of Minimum Number of Elements (MNE) and Minimum Animal Units (MAU and %MAU) (Binford 1978; Klein & Cruz-Uribe 1984). MNE is the minimum number of skeletal elements necessary to account for the specimens under study, while MAU is the MNE standardised by the number of times the skeletal portion occurs in a complete skeleton. MAU values are normed by dividing the greatest MAU in an assemblage and multiplying each resulting value by 100 (%MAU) (Lyman 2008). Skeletal part profiles were compared with the guanaco Meat Utility Index (MUI) developed by Borrero (1990) through Spearman's *rho* correlations.

Ontogenetic ages of individual animals were estimated by using a combination of different techniques: observing the state of molar eruption and wear, evaluating the sequence of bone fusion, and the quantitative and qualitative indicators of incisor teeth (Kaufmann 2009; Kaufmann et al 2017). Where possible, sex was estimated using the canine teeth and the innominate bones

(Kaufmann 2009; Kaufmann et al 2013). To estimate the proportion of different age classes in the sample, long bone fusion scheduling was classified into early and late fusion (Kaufmann 2009).

Different criteria were considered in order to evaluate the potential incidence of fluvial transport. First, frequencies of anatomical parts with high and low transport potential were compared. This criterion was defined by taking into account the results obtained by Kaufmann et al (2011) in an experimental study performed in an artificial flume with guanaco bones of different ontogenetic development. The proportion of unfused long bone diaphyses to epiphyses was evaluated (Gutiérrez & Kaufmann 2007). The proportion of teeth and vertebrae was considered as a way of assessing fluvial selection (Behrensmeier 1975). These elements present different transport potential. Unfused epiphyses and vertebrae are highly transportable while diaphysis and teeth are less susceptible to fluvial transport. If they are found together, it indicates that selective sorting did not occur. Contextual information and element associations were also considered (Gutiérrez & Kaufmann 2007). Finally, in the case of long bones, orientation was measured with a compass from the field drawings.

5. Results

Bone pile #1 is composed of 166 specimens, of which 163 (98%) are guanaco bones (Table 2, Figure 3). The other three bone specimens correspond to meso-mammals (1 to 15 kg) and *Dasipodidae*. Bone pile #2 contains 246 specimens, of which 231 (94%) are guanaco bones (Table 2, Figure 4). The others are specimens assigned to hairy armadillo (*Chaetophractus villosus*) and Pampas deer.

Table 2 Taxonomic structure of the bone piles

Taxa	Bone pile #1		Bone pile #2	
	NISP	MNI	NISP	MNI
<i>Lama guanicoe</i>	163	5	231	4
<i>Ozotoceros bezoarticus</i>	–	–	2	1
Meso-mammal	2	1	–	–
<i>Dasipodidae</i>	1	1	–	–
<i>Chaetophractus villosus</i>	–	–	13	3

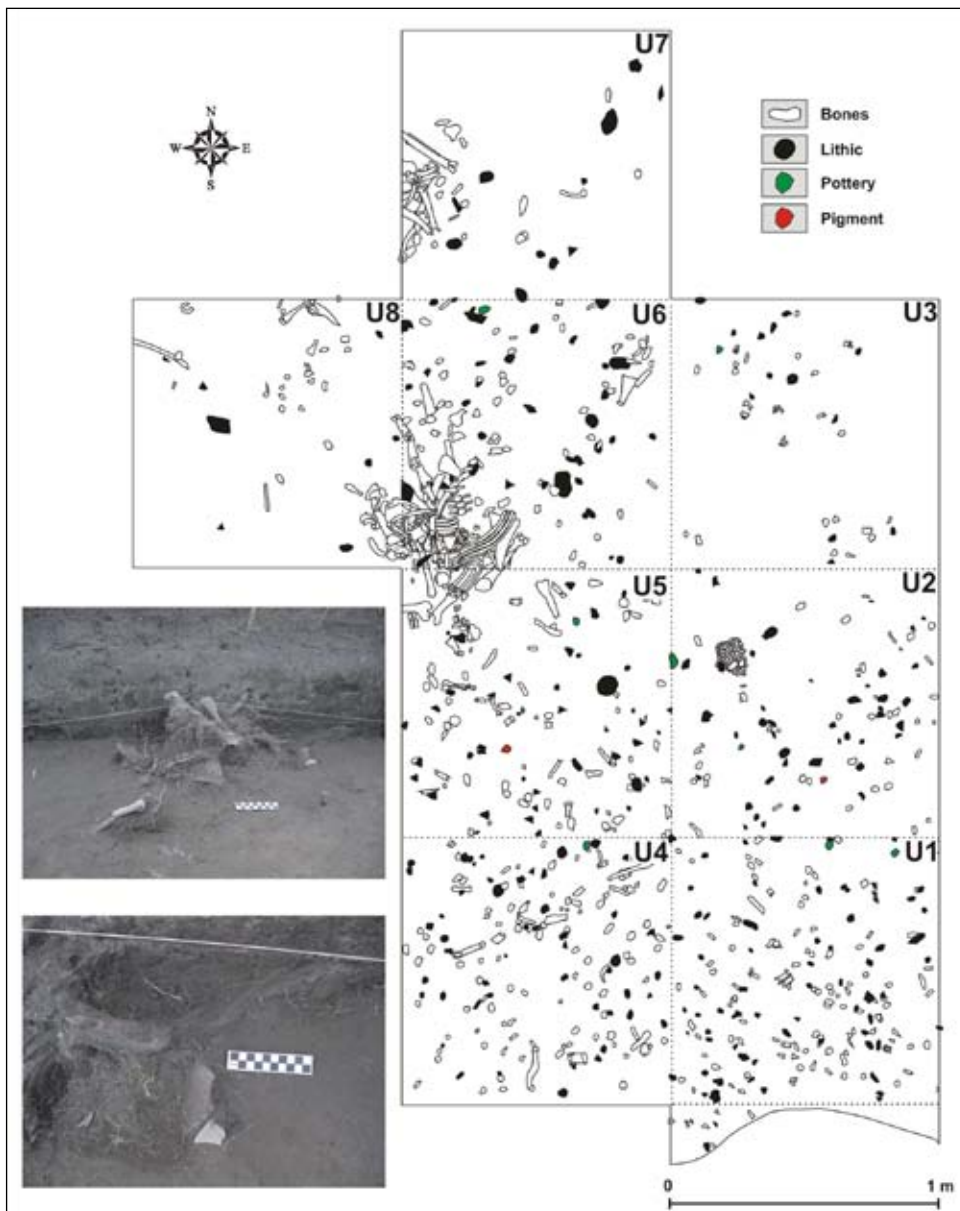


Figure 3 Digital mapping of bone pile #1 (from 0.65 to 1.05 m). U=Unit. Images show details of the bone concentration in unit 6

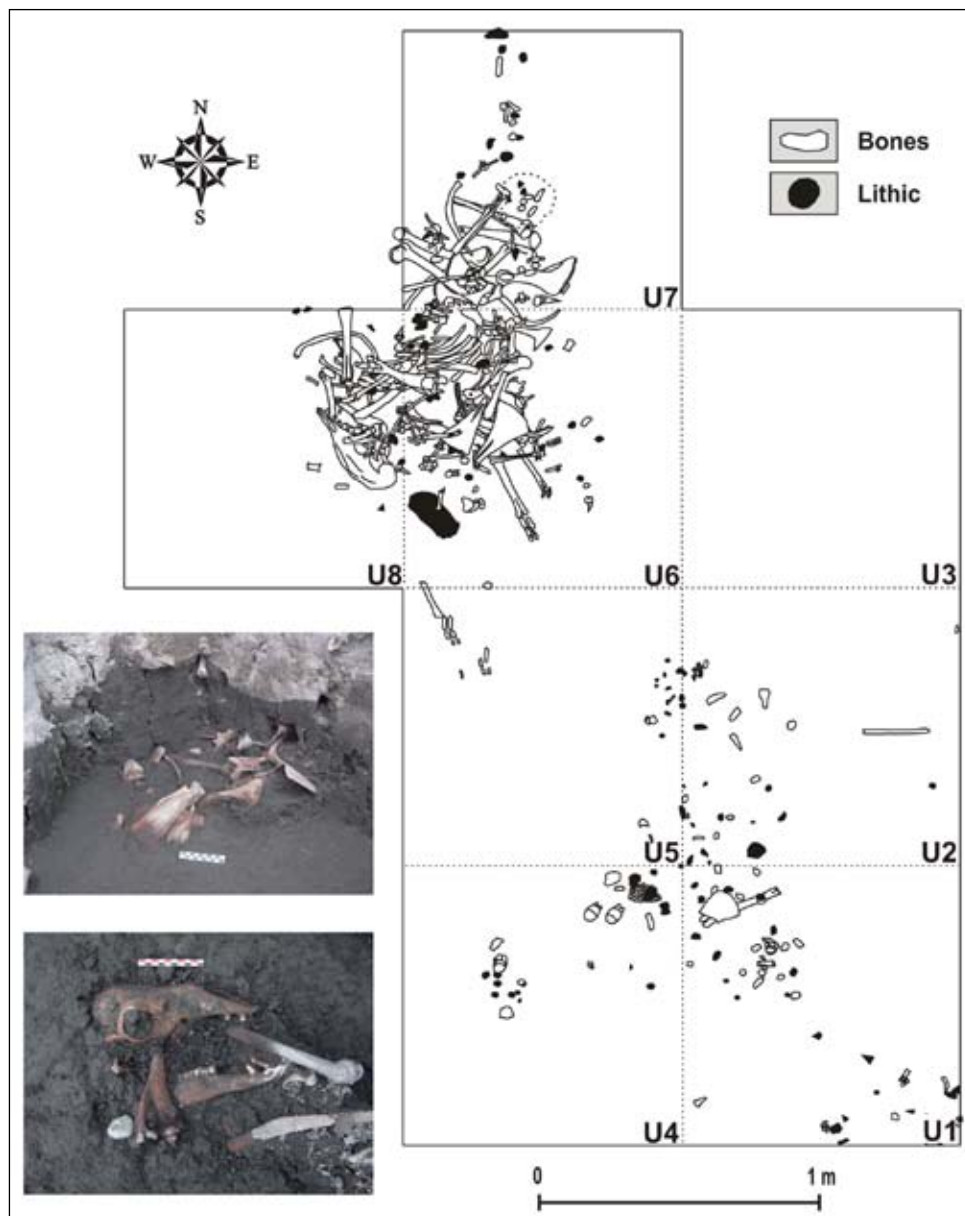


Figure 4 Digital mapping and images of bone pile #2 (from 1.35 to 1.90 m). U=Unit. Images show details of the bone concentration in the units 6 and 8

5.1. Taphonomic analyses

In both piles most of the bones are non-weathered while a very low percentage is in stage 1. Only one specimen for bone pile #2 is in stage 2. The presence of manganese is also recorded in low percentages and affects less than 25% of the cortical surface of the bones. Root marks were present on 48% of the bones in bone pile #1, although most of the marks affected less than 50% of the cortical surface. Only 2% of the specimens from bone pile #2 were affected by roots (Table 3, Figure 5).

Sedimentary abrasion is a variable that is usually recorded in the assemblages of the Pampas region because they are often located near to water courses. In bone pile #1 a high proportion of the bones present sedimentary abrasion; however, most of the specimens are in the lower stage, which is characterised by the presence of brightness and smooth texture. Most of the specimens from bone pile #2 do not present any evidence of sedimentary abrasion (Table 3, Figure 5).

In terms of bone fractures, 51% of the bones from bone pile #1 and 19% from bone pile #2 are incomplete. Nevertheless, these data can be misleading because most of the fractures are modern – produced during the excavation when bones dried (66.67% and 52.17%, for bone piles #1 and #2 respectively) – and old – post-depositional (28.57% and 47.83%, respectively). In this sense, the majority of the bones were complete at the moment of their burial. Finally, carnivore and rodent action, as well as trampling were not recorded in either bone sample (Table 3, Figure 5).

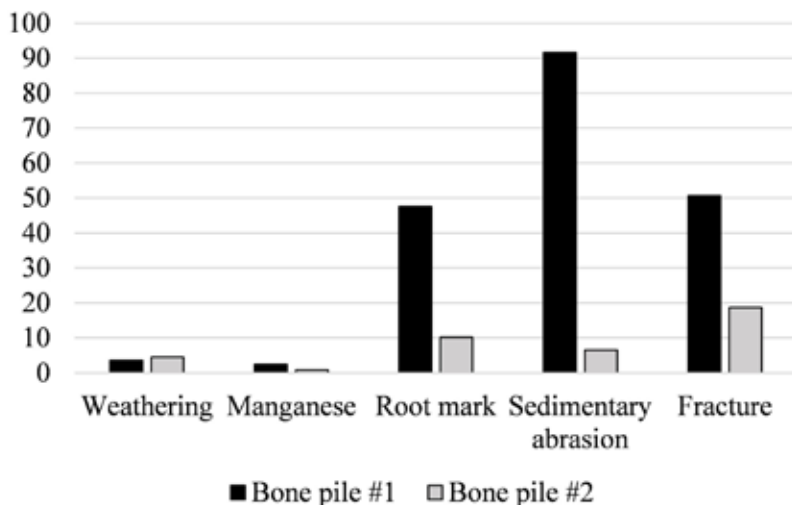


Figure 5 Taphonomic modification recorded in the bone piles, shown as percentage of total sample

Table 3 Taphonomic modifications recorded in the bone piles

Variable	Stages	Bone pile #1		Bone pile #2	
		NISP	NISP%	NISP	NISP%
Weathering	Stage 0	160	96.39	235	95.53
	Stage 1	6	3.61	10	4.06
	Stage 2	–	–	1	0.41
Manganese	Absence	162	97.59	244	99.19
	1–25%	4	2.41	2	0.81
Root mark	Absence	87	52.41	242	98.37
	1–25%	48	28.91	3	1.22
	26–50%	29	17.47	1	0.41
	51–75%	2	1.21	–	–
Sedimentary abrasion	Absence	14	8.43	230	93.49
	Stage 1	152	91.57	16	6.51
Fracture	Yes	84	50.61	46	18.70
	No	82	49.39	200	81.30

5.2. Guanaco skeletal part profiles

The minimum number of guanacos was calculated considering all the criteria for age determination together. The MNI for bone pile #1 is five individuals from which one is a foetal/newborn (nine months of gestation–15 days of birth), according to the incisors. The remaining four guanacos, represented by the occipital condyles, correspond to subadult/adult individuals. The MNI for bone pile #2 is also five. Unfused long bones show the presence of two foetal/newborn individuals while the humerus indicates that there are at least three individuals older than six months. From these, according to the tooth categories, the age range is: 6–48 months, 30–60 months and 84–96 months. Taking into account the pelvis and cranium, there is at least one female and one male guanaco (Figure 6).

The skeletal part profiles are different for the two bone piles. In bone pile #1, the forelimb is well represented, while the axial skeleton has low %MAU values and the hind limb is practically absent. In bone pile #2, all the skeletal units are well represented but the long bones have the higher %MAU values (Table 4). Figure 7 is a visual representation of Table 4, in which elements with similar values of %MAU were grouped according to three categories (low, medium



Figure 6 Cranium of male guanaco from bone pile #2. Note the large canines that are characteristic of this sex

and high, in relation to 100%). In terms of MUI, there is a significant positive correlation with the skeletal part profile of bone pile #1 ($r_s: 0.48, p < 0.016$) while the correlation with the profile from bone pile #2 was negative and the result had no statistical significance ($r_s: -0.180, p < 0.399$).

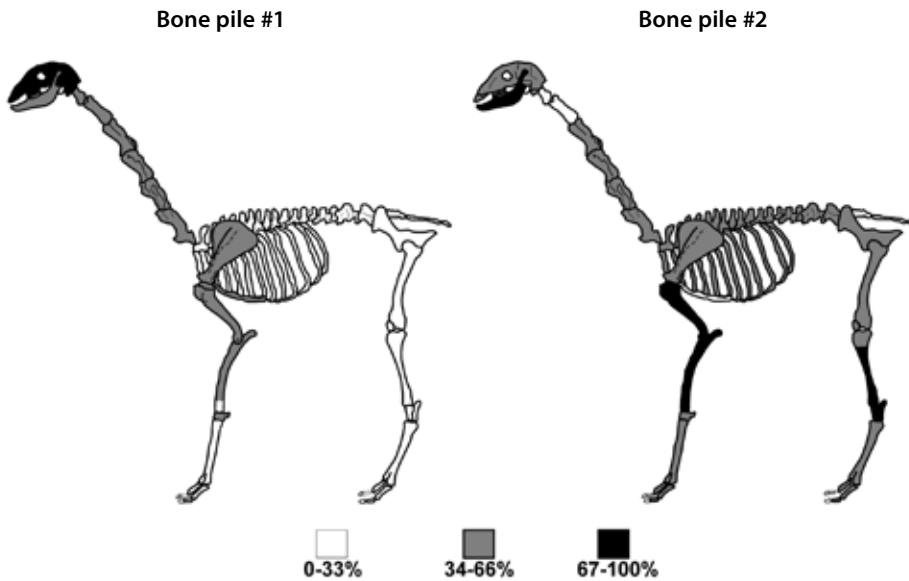


Figure 7 % MAU of the guanaco skeletal profile from bone piles #1 and #2

Table 4 Skeletal part representation of guanaco for the bone piles #1 and #2. References: L=Left, R=Right, A=Axial, ND=Non-determined, v=Vertebra, P=Proximal, S=Shaft, D=Distal; grey boxes=Absent elements

Element	Bone pile #1							
	L	R	A	ND	MNI	MNE	MAU	%MAU
Cranium	–	–	4	–	4	4	4	100
Hemimandible	1	2	–	–	2	3	1.5	37.5
Atlas	–	–	2	–	2	2	2	50
Axis	–	–	2	–	2	2	2	50
Cervical v	–	–	7	–	2	7	1.4	35
Thoracic v	–	–	13	–	2	13	1.08	27
Lumbar v	–	–	6	–	1	6	0.86	21.5
Caudal v	–	–	–	–	0	0	0	0
Sternebra	–	–	12	–	2	12	2	50
Sacrum	–	–	–	–	0	0	0	0
Rib	17	15	–	–	2	32	1.33	33.25
Scapula	2	2	–	–	2	4	2	50
Humerus P	2	2	–	–	2	4	2	50
Humerus S	2	1	–	–	2	3	1.5	37.5
Humerus D	2	1	–	–	2	3	1.5	37.5
Radius-ulna P	2	1	–	–	2	3	1.5	37.5
Radius-ulna S	3	1	–	–	3	4	2	50
Radius-ulna D	2	–	–	–	2	2	1	25
Scaphoid	1	–	–	–	1	1	0.5	12.5
Magnum	–	–	–	–	0	0	0	0
Pisiform	2	2	–	–	2	4	2	50
Lunate	1	–	–	–	1	1	0.5	12.5
Trapezoid	2	–	–	–	2	2	1	25
Unciform	–	1	–	–	1	1	0.5	12.5
Cuneiform	–	–	–	–	0	0	0	0
Metacarpal P	1	1	–	–	1	2	1	25
Metacarpal S	1	1	–	–	1	2	1	25
Metacarpal D	–	–	–	–	0	0	0	0
Innominate	1	1	–	–	1	2	1	25
Femur P	–	–	–	1	1	1	0.5	12.5

Bone pile #2							
L	R	A	ND	MNI	MNE	MAU	%MAU
-	-	2	-	2	2	2	57.14
2	1	-	-	2	3	3	85.71
-	-	1	-	1	1	1	28.57
-	-	1	-	1	1	1	28.57
-	-	7	-	2	7	1.4	40
-	-	17	-	2	17	1.42	40.57
-	-	10	-	2	10	1.43	40.86
-	-	3	-	1	3	0.23	6.57
-	-	4	-	1	4	0.67	19.14
-	-	1	-	1	1	1	28.57
17	16	-	-	2	33	1.37	39.14
1	1	-	1	2	3	1.5	42.86
3	3	-	-	3	6	3	85.71
3	3	-	-	3	6	3	85.71
3	4	-	-	4	7	3.5	100
2	3	-	-	3	5	2.5	71.43
2	4	-	-	4	6	3	85.71
2	3	-	-	3	5	2.5	71.43
1	2	-	-	2	3	1.5	42.86
2	1	-	-	2	3	1.5	42.86
1	1	-	-	1	2	1.5	42.86
1	1	-	-	1	2	1	28.57
-	-	-	-	0	0	0	0
1	1	-	-	1	2	1	28.57
2	3	-	-	3	5	2.5	71.43
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
2	1	-	-	2	3	1.5	42.86

Element	Bone pile #1							
	L	R	A	ND	MNI	MNE	MAU	%MAU
Femur S	-	-	-	1	1	1	0.5	12.5
Femur D	-	-	-	-	0	0	0	0
Patella	-	-	-	-	0	0	0	0
Tibia P	1	-	-	-	1	1	0.5	12.5
Tibia S	-	-	-	-	0	0	0	0
Tibia D	-	-	-	-	0	0	0	0
Calcaneum	-	-	-	-	0	0	0	0
Astragalus	1	-	-	-	1	1	0.5	12.5
1° tarsal	-	-	-	-	0	0	0	0
Cuboid	-	-	-	-	0	0	0	0
Fibular	1	-	-	-	1	1	0.5	12.5
Navicular	-	-	-	-	-	-	0	0
Ectocuneiform	-	-	-	-	-	-	0	0
Sesamoid	-	-	-	4	1	4	0.25	6.25
Metatarsal P	-	-	-	-	0	0	0	0
Metatarsal S	-	-	-	-	0	0	0	0
Metatarsal D	-	-	-	-	0	0	0	0
Metapodial S	-	-	-	1	1	1	0.5	12.5
Metapodial D	-	-	-	1	1	1	0.5	12.5
1° Phalanx	-	-	-	4	1	4	0.5	12.5
2° Phalanx	-	-	-	-	0	0	0	0
3° Phalanx	-	-	-	-	0	0	0	0

Bone pile #2							
L	R	A	ND	MNI	MNE	MAU	%MAU
2	1	-	-	2	3	1.5	42.86
2	1	-	-	2	3	1.5	42.86
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
2	2	-	1	3	5	2.5	71.43
2	3	-	-	3	5	2.5	71.43
3	3	-	-	3	6	3	85.71
3	2	-	-	3	5	2.5	71.43
1	1	-	-	1	2	1	28.57
3	1	-	-	3	4	2	57.14
3	2	-	-	3	5	2.5	71.43
3	1	-	-	3	5	2.5	71.43
2	2	-	-	2	4	2	57.14
-	-	-	4	1	4	0.25	7.14
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
2	2	-	-	2	4	2	57.14
-	-	-	1	1	1	0.25	7.14
-	-	-	1	1	1	0.25	7.14
-	-	-	18	3	18	2.25	64.29
-	-	-	12	2	12	1.5	42.86
-	-	-	7	1	7	0.87	24.86

5.3. Guanaco long bone fusion sequence

The long bone fusion sequences constructed for the bone piles show some differences. In the case of bone pile #1, foetal/newborn, subadult and adult individuals are equally represented. In the case of bone pile #2 the percentages of foetal/newborns and adults are similar, but subadults are not represented (Table 5, Figure 8).

Table 5 Guanaco long bone fusion sequence for the bone piles. UF=unfused; F=fused

		Bone pile #1		Bone pile #2	
Region		UF	F	UF	F
Early-fusing	Humerus (distal)	1	4	2	5
	Radius-ulna (radius+ulna)	2	3	4	2
	Radius-ulna (proximal)	2	3	4	2
	Total	33.33%	66.67%	52.63 %	47.37%
Late-fusing	Tibia (tibial tuberosity)	–	–	0	4
	Radius-ulna (distal)	2	2	4	2
	Radius-ulna (olecranon)	3	1	4	2
	Femur (distal)	1	–	0	3
	Femur (proximal)	–	–	0	3
	Total	66.67%	33.33%	36.37%	63.63%
Fetal/Newborn		33.33%		52.63%	
Subadult		33.34%		0%	
Adult		33.33%		47.37%	

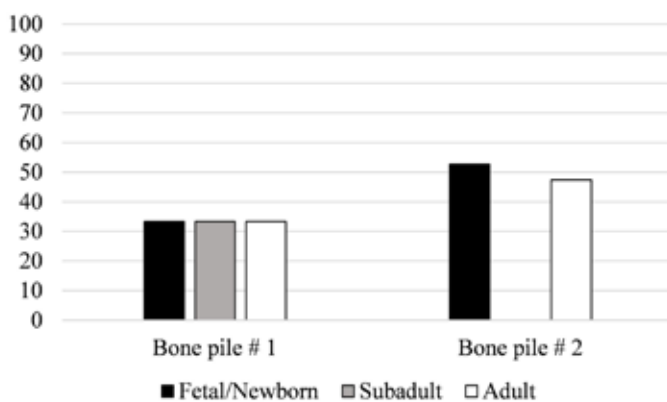


Figure 8 Age groups represented for the bone piles

5.4. Evidence of human exploitation

Only a few bones from the piles show evidence of human exploitation. As most of these remains were complete, anthropogenic fractures were recorded only in four specimens from bone pile #1 and none from bone pile #2. Cut marks are infrequent. In bone pile #1 there is only a vertebra with evidence of filleting on the thoracic spine. In bone pile #2 there are seven specimens with cut marks that indicate skinning activities (Figure 9). Finally, thermal alteration was not recorded on the bones from the bone piles.

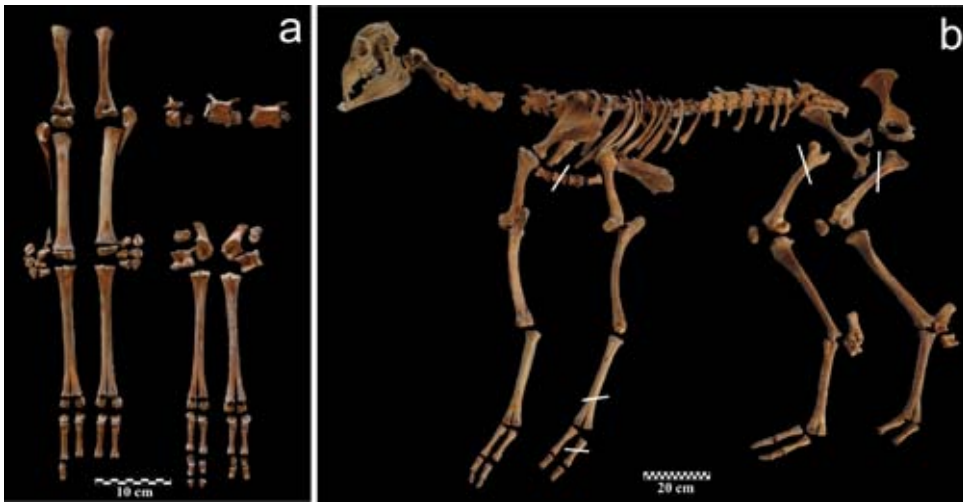


Figure 9 Reassembled guanaco bones from bone pile #2. a = forelimb and hind leg from a foetal/newborn individual, b = adult individual. The white lines indicate the location of the cut marks

5.5. Evidence of fluvial transport

Examination of the skeletal part profile indicates that both elements with higher as well as lower transport potential are present in the bone piles (Table 4 and Table 5). Unfortunately, the sample was too small to apply statistical analyses that could indicate if there is any type of preferential orientation (Lyman 1994). However, azimuths were clustered in 18 groups of 10° each. There are eight groups in bone pile #1 (10 specimens) and 13 in bone pile #2 (27 specimens). In this sense, no specific orientation could be identified for the bones from both features. On the other hand, the proportion of unused long bone diaphyses to epiphyses indicates that water would not have selected the bones according to their density and size (Table 6).

Table 6 MNE of guanaco unfused long bone for diaphyses and epiphyses

Element	Bone pile #1	Bone pile #2
Humerus proximal	0	2
Humerus shaft	1	3
Humerus distal	1	2
Radius-ulna proximal	2	3
Radius-ulna shaft	2	3
Radius-ulna distal	1	3
Femur proximal	1	0
Femur shaft	0	2
Femur distal	0	0
Tibia proximal	1	0
Tibia shaft	0	2
Tibia distal	0	1
Metapodial shaft+proximal	3	5
Metapodial distal	2	4

The teeth/vertebrae index resulted in 0.08 for bone pile #1 and 0.92 for #2. This indicates an over-representation of vertebrae for bone pile #1 and a similar proportion of both elements for bone pile #2. On the other hand, according to Rogers & Kidwell (2007), in hydraulic concentrations the degree of articulation and element association is usually low. In both bone piles there is a high degree of element articulation, observed during the fieldwork as well as in the laboratory. Many of the bones could be reassembled as shown in Figure 9: A newborn and an adult individual from bone pile #2 were highly articulated.

Taking into account that the bones from both bone piles were articulated, fluvial transport models constructed for complete anatomical portions were considered. Coard & Dennell (1995) and Coard (1999) built a model for articulated elements from mouflon (*Ovis musimon*), pig-tailed macaque (*Macaca nemestrina*), and dog (*Canis familiaris*). Results indicated that when articulated units are transported, bones that are not usually associated with fluvial transport can be carried by the moving water. Also, articulated units are more transportable than isolated bones and the axial skeleton has more chances of being transported than the appendicular. This characteristic does not occur in the EQ1 bone piles, which contain both axial and appendicular elements.

6. Discussion

6.1 *Genesis and configuration of the bone piles from EQ1*

The excavated sector of the EQ1 site could represent a very small portion of a larger base camp site situated on the margin of Tapalqué Creek. The malacological and geoarchaeological evidence indicates that the bone piles were deposited in palustrine or swampy environments, associated with the old flood plain of the creek. The Humid Pampas are characterised by the cyclical occurrence of hydrological events of varying magnitude (Scarpati & Capriolo 2013). In this sense, it is expected that the assemblages of the EQ1 site had been recurrently affected by droughts and floods. It is well known that fluvial transport can generate hydraulic concentrations (Voorhies 1969; Rogers & Kidwell 2007). One of the initial questions that guided this work was whether the bone piles had a natural or anthropogenic origin. Different aspects that characterise these accumulations support an anthropogenic origin. First, both piles are within the archaeological context of the site and several lithic artefacts were found inside and outside these features (see Figure 3 and Figure 4). While this fact does not invalidate the possibility of a mixture of both natural and cultural materials, some of the bones present evidence of butchery that, although scarce, support the hypothesis of the human origin. These marks show activities of filleting and skinning, but also a few fractures indicate marrow consumption in bone pile #1. However, outside of the accumulations, the percentage of bones with cut marks and anthropic fractures is higher (6% and 3%, respectively). Second, the frequency and diversity of skeletal parts are not related to the presence of a particular fluvial transport group (Kaufmann et al 2011). Although there is evidence that indicates that fluvial action was present at the site, this process would not be responsible for the accumulation of the guanaco bones. Several of the bones show sedimentary abrasion, especially in bone pile #1. Nevertheless, this variable is commonly recorded in most of the sites of the Pampas region that are located near water courses or in flood plains (eg Álvarez et al 2013). In the case of the EQ1 site, all the specimens with sedimentary abrasion are in stage 1, characterised only by a light brightness or polish. Considering this variable and the mapping of the excavation levels, it is proposed that moving water could have dispersed some elements from the bone piles. In sum, taking into account the cultural context, the association of the elements, the presence of human modifications, and the rest of the characteristics already mentioned, it is proposed that both bone

piles had an anthropogenic origin, although they could have been affected by fluvial processes after their deposition.

6.2. Interpretation of the bone piles from EQ1

The second issue that arises from this work is the interpretation of the bone piles and their characteristics: spatial recurrence, number of guanacos represented, and scarce exploitation of the anatomical units. On the one hand, the geoarchaeological evidence, the high articulation of the elements, the weathering profile, and the excellent preservation of the bones suggest that each bone pile corresponds to a single or a few depositional events that took place during a short period of time. These accumulations would have had a rapid burial in a palustrine environment. This is also supported by the absence of carnivore and rodent marks on the bones. On the other hand, both piles are mainly composed of complete guanaco elements of different ages. The foetal/newborn age category is represented in both assemblages, indicating that at least part of the occupations of the EQ1 site took place between November and December (late spring and early summer) during the guanaco birth season (Franklin 1983). The sequence of long bone fusion from both bone piles showed the presence of foetal/newborn as well as adult individuals. Also, the analyses of the cranium and pelvic bone indicate the presence of at least one male and one female animal. According to this data, guanaco family groups are represented in the sample, suggesting that the hunting events could have been orientated towards this social group. Finally, the skeletal part profile indicates the presence of a wide variety of skeletal units. However, the forelimb and the anterior half are better represented in bone pile #1. Also, in this assemblage, there is a positive correlation between the skeletal part profile and the MUI. In bone pile #2, the proportion of skeletal units is more homogeneous, and there is no correlation with the MUI. The smaller quantity of elements in bone pile #1 could be related to more intensive processing of the animals, as is also shown by the volume of pottery and bone debris associated with this accumulation. On the contrary, the bone specimens that are around bone pile #2 are scarce and complete.

The spatial recurrence of the bone piles, as well as the number of guanacos, and the transport of large anatomical segments or complete animals to the site could be explained by the geographical location of the EQ1 site. This site is near the junction of Tapalqué Creek and a small tributary, which form a junction 600 m north of the base camp (Figure 1). In this sector of the basin the gullies are very deep (approximately 5 m), which would have made it much harder for guanacos to escape human hunters. If a human hunting strategy was to use the

water courses to drive guanacos during the Late Holocene, then the carcasses of successful kills would have been short distances from the EQ1 site, allowing the transport of relatively complete carcasses for processing and consumption in the base camp. The sector where the bone piles are placed could be an area where the hunted guanacos were deposited after one or more hunting events, to be later butchered. In this context, the light utilisation of carcasses may be explained through different hypotheses.

One possible explanation is that some guanacos were hunted but not consumed because they were ill or too lean. Some chronicles mention the existence of diseases in guanaco. For example, Musters (1871:51) wrote that there was 'also a disease prevalent amongst them something similar to scab in sheep. On one occasion a hunting party killed 10 guanacos, all of which were scabby, or, as we called it, "sanoso"; (sic) and, consequently, unfit for food'. Regarding lean animals, there are also references to the abandonment of guanacos in poor condition (eg Claraz 1988 [orig 1865/66]). Moreover, it is known that the nutritional state of both sexes increases in some periods (mid-summer and early autumn) and decreases in others (late winter and spring) (Raedeke 1979:107). However, in the case of ill and lean animals, it might be expected that carcasses would be abandoned at the kill sites because they would not be transported to the base camps. In some cases, if the guanacos are lean, hunters-gatherers will focus only on the extraction of bone fat (Speth & Spielmann 1983). However, the last case generates specific fragmentation patterns and most of the bones from the bone piles are complete, even those with high marrow content.

A second possibility to explain the presence of the bone accumulations is a food surplus generated by a cooperative hunting strategy where several animals were killed in one or a few events. If there was a surplus of meat, hunter-gatherers would transport only the choicest skeletal elements (Binford 1978; Winterhalder, 2001; Nagaoka 2005; Faith & Gordon 2007, among others). Only one of the bone piles showed a significant correlation between the %MAU and the MUI, but the obtained results did not match with a selective strategy. Nevertheless, if the base camp was close to the kill sites, the transport costs would be low, and the carcasses could have been transported complete. Thus, food surplus could be one explanation for the presence of the bone piles. However, it seems unlikely that whole animals that would not be consumed would have been transported.

A third possibility is the premature abandonment of the base camp. This could be due to unpredictable situations (eg the swelling of the river) or mobility decisions. In this sense, hunter-gatherers might have left part of the carcasses unprocessed and carried some anatomical portions or boneless meat with them.

6.3. *The regional scale*

There are only five sites with the presence of anthropogenic bone piles in the Humid Pampas. This characteristic is not such a common feature in the archaeological contexts of the Pampas region. A regular pattern of these piles is that they are dominated by guanaco bone remains. However, there are some differences among them: composition of anatomical units, fragmentation, age profile and the degrees of human processing. In two cases, bone piles are highly processed (Zanjón Seco 3 and Cueva Tixi). Zanjón Seco 3 corresponds to a dump structure and Cueva Tixi is a residential camp in a cave. In these cases, bone piles relate to the final processing and discardment of the bones. On the other hand, bone piles from Nutria Mansa 1 and Paso Otero 3 are similar to those from EQ1. These sites are open-air camps and all of them present bone piles representing under-exploited guanacos. It is remarkable that both Nutria Mansa 1 and EQ1 sites are located near to creek corners, places proposed as active traps (Kaufmann 2009).

Sites with bone piles with complete guanaco bones are only recorded in the second half of the Middle Holocene and the first half of the Late Holocene. It is in this time period that the diet becomes closely oriented to guanaco in some areas of the Pampas regions, such as the inter-hills, the Tandilia hill range, the south, and the central Pampean Dunefields (Quintana & Mazzanti 2001; Martínez & Gutiérrez 2004; Frontini 2013; Álvarez 2014; Scheifler & Messineo 2016). The presence of these assemblages indicates that during the Middle and Late Holocene, guanaco cooperative hunting constituted one of several strategies used to obtain one of the biggest prey in the Pampas. This strategy was possibly combined with the use of active traps.

7. Conclusion

The different analyses conducted with the bone assemblages from the EQ1 site indicate that the origin of both accumulations is anthropogenic. There is evidence of fluvial action in the sample, although this process would not be responsible for final configuration of the accumulations. The under-exploitation of the anatomical segments of the bone piles could be the result of strategies of cooperative hunting and the premature site abandonment. In addition, there are at least four more sites with these kind of features in the Humid Pampas. The detailed study of these assemblages contributes to an understanding of the subsistence strategies developed by Pampean hunter-gatherers. Finally, the chronology and composition of these accumulations are in accordance with a

specialisation in guanaco hunting during the end of the Middle Holocene and the Late Holocene in the inter-hills area.

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