Human Hunting and Site Occupation Intensity in the Early Epipaleolithic of the
Jordanian Western Highlands

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24 **Abstract**

25 We investigate the effects of the Last Glacial Maximum (~25,000-18,500 cal. BP) on
26 human hunting and settlement strategies through the study of faunal remains from four
27 Early Epipaleolithic sites located in the western highlands region of Jordan. Human
28 mobility is monitored by reconstructing site occupation intensity using zooarchaeological
29 measures of dietary breadth and prey mortality. Our data reveal light occupation and a
30 mobile human adaptation focused on the hunting of high-ranked adult ungulates and
31 large-bodied tortoises. Despite their mobile strategy, the Early Epipaleolithic inhabitants
32 clearly preferred particular locations on the landscape and reoccupied them repeatedly
33 over time.

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Introduction

Human-collected faunal assemblages originating from the arid regions of the southern Levant during the Last Glacial Maximum (ca. 25,000-18,500 cal. BP) are essential for understanding the dynamics of human settlement, demography and flexibility during an active and potentially challenging period of environmental change. In particular, studies of the Early Epipaleolithic period enable important insight into human adaptability in the face of landscape changes triggered by the Last Glacial Maximum (LGM). We reconstruct human adaptations to LGM landscapes by examining the scale of human occupation and population mobility in the western highlands region of Jordan. Occupation intensity is investigated using zooarchaeological measures of prey relative abundance and mortality from four Early Epipaleolithic sites.

An active program of research in the Wadi al-Hasa over the last several decades has produced archaeological data from a number of Upper Paleolithic and Epipaleolithic sites (Coinman et al., 1986; MacDonald, 1988; Olszewski and Coinman, 1998; Clark et al., 2000). Unfortunately, the arid, open-air setting of many of these sites has resulted in poor preservation of zooarchaeological remains, which are dramatically under-represented in comparison to lithic assemblages. Thus, beyond the stone tool technology we currently know little of human hunting strategies in this region beyond the taxonomic representation of key hunted species. Thanks to renewed excavations as part of the Western Highlands Early Epipaleolithic Project (WHEEP) directed by Deborah I. Olszewski and Maysoon al-Nahar in 2009-2012, faunal samples from four Early Epipaleolithic sites in the Wadi al-Hasa and Kerak Plateau (Table 1) are now sufficient to

enable an area synthesis. Ultimately, we connect the Early Epipaleolithic in this area to contemporaneous populations in the eastern and western Levant.

Current interpretations of Early Epipaleolithic adaptations in the southern Levant state that the LGM was a comparatively cold and arid episode (Bar-Matthews et al., 2003). Humans responded to environmental conditions by adopting a mobile settlement strategy that included frequent moves, low population densities and periodic seasonal aggregations of groups based on local resource abundance (Bar-Yosef, 1981; Goring-Morris and Belfer-Cohen, 1997; Olszewski, 2003; Kuhn et al., 2008; Maher et al., 2012b). In the Mediterranean Levant, the thorough use of ungulate carcasses and evidence for regional depression of the highest-ranked taxa such as wild cattle and red deer indicate intensified foraging strategies in comparison to the preceding Upper Paleolithic period (Stiner et al., 2000; Bar-Oz, 2004; Munro, 2009; Stutz et al., 2009). This shift is related to a change in the balance between resource abundance and human population size. In Jordan, small campsites with short-term occupations typify the Early Epipaleolithic period. Despite increased aridity across the region, the formation of shallow lakes and ponds in the Wadi al-Hasa and the Azraq Basin caused patchy distributions of preferred human resources (Schuldenrein and Clark, 1994; Cordova, 2007). Some of these patches, particularly those in lakeside settings, were well suited for human occupation. Two exceptional sites from the Azraq Basin, Kharaneh IV and Jilat 6, record unprecedentedly intensive occupation in similar lacustrine settings close to the steppic/desert boundary (Maher et al., 2012b; this volume). As the known range of Early Epipaleolithic adaptations in the eastern Levant expands (e.g., Byrd and Garrard, 2013)

so does our need to understand the factors that caused foragers to invest more heavily in some locales than others.

This study examines the ecological footprint left by human foragers inhabiting the Wadi al-Hasa and Kerak Plateau during the Early Epipaleolithic period. Following a behavioral ecological framework, foragers are expected to remain in a given patch until the cost effectiveness of foraging there becomes greater than the cost/benefits of foraging in another region minus the costs of moving (Kelly, 1995). Thus forager mobility and site occupation intensity are related to the relative resource abundance of particular locations on the landscape.

Zooarchaeological Measures of Site Occupation Intensity

Human landscape use is examined by measuring site occupation intensity at the western highlands sites using zooarchaeological data. To do so, we apply ecological models previously used in similar investigations of site occupation intensity in the western Levant (Stiner et al., 2000; Munro, 2004, 2009; Stutz et al., 2009). Human occupation of archaeological sites is expected to have an increasing impact on local resources over time (Tchernov, 1993). Because humans are expected to maximize cost effectiveness when hunting, they should initially cull the highest-ranked taxa (Stephens and Krebs, 1986). However as the length of site occupation and/or the number of people occupying a site increases, the availability of high ranked prey may decline either through extirpation, increased mortality, or changes in prey escape behavior (Lyman, 2003). At this point, lower-ranked (smaller-bodied or costly to capture) species will enter the diet (Stephens and Krebs, 1986). The balance between high-and low ranked animals or human

foraging efficiency is thus a useful relative measure of site occupation intensity. High-ranked taxa are the most cost effective prey and include large-bodied animals and prey with low capture costs, while low-ranked prey include smaller bodied animals or those with high capture costs.

Site occupation intensity is measured using four indices that compare the abundance of high and low ranked game: 1) a big game index that examines the relative contributions of ungulates in comparison to carnivores and smaller prey; 2) a large big game index that examines the proportion of large ungulates relative to smaller ungulates; 3) a slow small game index that examines the relative abundance of slow to fast-moving small game taxa; and 4) an adult gazelle index that examines the relative abundance of adult to juvenile gazelles. High-ranking animals are expected to be more common when site occupation is low and decline in abundance in relation to low-ranked taxa as site occupation intensity increases. Thus large game, large ungulates, slow, small prey and adult gazelles should be most abundant during periods of low occupation intensity and decline in relation to small game, small ungulates, fast-small prey and juvenile gazelles respectively as site occupation intensifies.

We also investigate average tortoise body-size using the minimum humeral breadth as a proxy measure (Stiner et al., 2000; Munro, 2004; Stiner, 2005). Because tortoises grow continually through life, body-size correlates with age, and thus the longevity of the population. Increased mortality reduces average longevity (Caughley, 1984) and thus sustained hunting is expected to produce smaller-bodied death assemblages.

The Western Highlands of Jordan in the LGM

Three of the four Early Epipaleolithic assemblages investigated here derive from the Wadi al-Hasa (Tor Sageer, Tor at-Tareeq, Yutil al-Hasa), while the fourth (KPS-75) is on the adjacent Kerak Plateau in the middle of the western highlands region of Jordan (Figure 1; Table 1; Olszewski and al-Nahar, this volume). All of the sites were inhabited during and immediately after the peak of the Late Glacial Maximum (ca 25,000-18,500 cal. BP). Here, we focus only on the Early Epipaleolithic occupations. For more details on these sites and their excavation see al-Nahar and Olszewski and Olszewski and al-Nahar (this volume).

The LGM was a significant cooling and drying event with global impact, although it had a less dramatic effect on the eastern Mediterranean than more northern regions (Bar-Matthews et al., 2003). Nevertheless, the amount of water tied up in the ice sheets translated into lower annual precipitation and thus greater aridity in the Levant. Despite these conditions, fluctuations between wetter and drier periods undoubtedly occurred within the LGM and the western Highlands was surprisingly well watered, especially compared to today (Cordova, 2007). Standing water from the potential paleolake, Hasa, springs and annual streams provided reliable access to permanent water sources in the Wadi al-Hasa and at least seasonally reliable sources of standing water on the Kerak Plateau (Olszewski 2003). Thus, it is not surprising that the Hasa sites are situated in paludal or lacustrine contexts and therefore had ready access to water year-round.

During the LGM, Wadi al-Hasa was located within the Irano-Turanian vegetation zone. The environment was dominated by grasses and shrubs and scattered with oak and pistachio trees (Cordova, 2007). Patches of riparian species such as willow, cattail and

alder were located close to permanent water courses (Schuldenrein and Clark, 1994; Ramsey and Rosen, this volume). KPS-75 is located on the Kerak Plateau, which forms the upland immediately to the north of the Wadi al-Hasa. Geological evidence shows that this site was situated within one mile of a shallow lake that was present at least on a seasonal basis. The plateau was covered by open parkland vegetation during the LGM (al-Nahar et al., 2009).

The faunal assemblages published here include samples from multiple excavation seasons derived from different excavation projects (Table 1). The assemblages include the 2009-2012 excavations at Tor at-Tareeq, KPS-75 and Yutil-al Hasa directed by Deborah Olszewski and Maysoon al-Nahar as part of the Western Highlands Early Epipaleolithic Project (Olszewski and al-Nahar, 2011, 2014). Faunal assemblages from excavations lead by Olszewski at Tor at-Tareeq in 2000 (Olszewski et al., 2000) and at Yutil al-Hasa in 1998 (Olszewski et al., 1998) were combined with these assemblages, as were samples from two excavation seasons directed by Olszewski at Tor Sageer in 1997 and 1998 (Olszewski and al-Nahar, 1997; Olszewski et al., 1998).

Although late Upper Paleolithic and Middle to Late Epipaleolithic deposits were also uncovered at Yutil-al Hasa and Tor-at Tareeq, only faunal remains originating from Early Epipaleolithic contexts are included in this study. Because of stratigraphic mixing in the upper layers from KPS-75, the fauna from layers 1-3 were excluded except from unit N4 located inside the rockshelter.

Results

Quality of Bone Preservation

172 The rarity of Early Epipaleolithic faunal assemblages is partially related to the
173 poor preservation of bone, especially in open-air sites in the arid and semi-arid regions of
174 the southern Levant. The fact that lithic tools are more than ten times as common as
175 identified bones at all of the sites except Yutil-al Hasa suggests that preservation biases
176 are pronounced (see also Samei et al., this volume). It is thus essential that the quality of
177 preservation is assessed and the nature of potential biases identified so that accurate
178 behavioral interpretations can be drawn from the surviving fauna.

179 Several lines of evidence show that the faunal assemblages were affected by
180 attritional taphonomic processes. This is especially apparent in the high rate of bone
181 fragmentation in all assemblages. Although heavy fragmentation is typical of Levantine
182 Epipaleolithic assemblages due to extensive human processing for bone fat, the average
183 fragment size from the studied assemblages except Tor Sageer is less than 2 cm in length.
184 This exceeds the extent of fragmentation typical of well-preserved Natufian cave sites,
185 although the Natufian assemblages include higher proportions of small ungulate and
186 small game remains (Munro and Bar-Oz, 2005). That fragmentation extends beyond
187 routine breakage for marrow extraction is confirmed by the percentage of spiral breaks in
188 comparison to transverse fractures. Spiral fractures occur most often when bone is fresh
189 and reflect bone processing by humans, while transverse fractures most often occur after
190 the collagen decays (Villa and Mahieu, 1991). The percentage of spiral fractures thus
191 provides a coarse measure for the extent of post-depositional breakage (Table 2). In three
192 of the four assemblages transverse fractures on gazelle long bone shafts are nearly as
193 common as spiral fractures, but transverse fractures greatly exceed spiral fractures at
194 KPS-75. The fact that both spiral and transverse fractures are abundant indicates that the

assemblages were first broken by human processing when they were fresh, and again by post-depositional fracture caused by processes such as trampling or compression of sediments after disposal.

This last point is confirmed by the % completeness values of select compact elements that lack marrow cavities, in this case carpals (following Marean, 1991). Since carpals are small, structurally dense elements with no nutritional value, they are expected to enter the archaeological record as complete bones. Breakage of these bones can thus be attributed to post-depositional processes. Gazelle carpals from Tor Sageer are complete 92% of the time suggesting minimal post-depositional attrition and quite good preservation. Carpals from other assemblages however, suffered from more extensive *in situ* fragmentation, especially those from Tor at-Tareeq that were complete only 50% of the time. The Yutil al-Hasa assemblage was too small for this analysis.

The three measures of preservation reported here agree for each site. They indicate that the faunal assemblage at Tor Sageer is the best preserved assemblage, while those from Tor at-Tareeq, Yutil al-Hasa and KPS-75 are less well preserved. These results are taken into account when reconstructing patterns of human behavior below.

Prey Relative Abundance Indices

The primary taxa represented in the western highland assemblages include four ungulate species: gazelle (*Gazella* sp.), aurochs (*Bos primigenius*), wild ass (*Equus hemionus*) and wild goat (*Capra aegagrus*) (NISP values in Appendix 1). Small fauna are also common, most importantly, the Mediterranean spur-thighed tortoise (*Testudo graeca*), hare (*Lepus capensis*) and fox (*Vulpes vulpes*). Birds also appear on occasion;

the chukar partridge (*Alectoris chukar*) is the most common. Other avian taxa are more difficult to identify due to poor recovery of the more diagnostic long bone epiphyses.

Taxonomic representation is similar when the four assemblages are divided into broad taxonomic groups of ungulates, carnivores and small game (Figure 2). At all sites except Tor at-Tareeq, the assemblages are dominated by ungulates. Carnivores are virtually absent, which is surprising given the large proportions of fox in Epipaleolithic Mediterranean Levantine sites. In all cases small game provides an important, albeit secondary food source. Tor at-Tareeq stands apart from the other sites due to the very large size of its small game fraction (63.6%).

All of the ungulate assemblages are dominated by smaller-bodied gazelle, while equids and aurochs play distinctly secondary roles (Figure 3). Wild goat are present, but rare. These ungulate taxa are all at home in the steppic grassland environment that covered the area during the LGM. Taxa typical of more forested Levantine environments such as deer and wild boar are absent. Although the gazelle dominates all Epipaleolithic assemblages, the largest ungulates (equids and aurochs) play a more significant role here than in the larger contemporary Epipaleolithic sites such as Wadi Jilat 6 and Kharaneh IV in the semi-arid Azraq Basin (Martin et al., 2010) where gazelle compose more than 90% of the ungulate assemblages, and aurochs and equids are nearly absent.

Finally, like the ungulate fraction, the small game assemblages from the study sites are dominated by a single species, the tortoise (Figure 4). Lower-ranked hares and birds are rare in all assemblages. Interestingly, lower-ranked small game is most abundant at KPS-75, an assemblage with more serious post-depositional breakage. Birds and hares are more abundant in this assemblage than any other. It is likely that birds were

originally even more numerous, but have since been destroyed due to quality of preservation of this assemblage. Although the small game taxa presented here provide similar returns, the cost of capture of hares and birds is higher than tortoises even when special technology is used. The slow-moving tortoise has virtually no cost of capture once encountered. In contrast, hares and birds require greater investment in technology and/or capture time. Overall, the inhabitants of the western highlands sites invested minimally in small game procurement, focusing nearly exclusively on high-ranked small game groups.

Gazelle Mortality

Unfortunately, gazelle tooth eruption and wear data from the four sites is not sufficient to construct robust age profiles from teeth. This is partially related to the especially poor preservation of teeth in these assemblages due to cracking and crumbling of the enamel. Likewise, sample size will not allow the construction of survivorship curves based on bone fusion. Instead we use a coarser measure of gazelle mortality that plots the combined percentage of fused gazelle long bones that fuse between the ages of 10-18 months (distal radius, proximal and distal ulna, proximal and distal femur; proximal tibia, tuber calcis of the calcaneum, distal metacarpal and metatarsals) (Davis, 1980; Munro et al., 2009) as a measure of the proportion of adults in the four assemblages. The samples from Yutil al-Hasa are too small to include here (Figure 5). Tor Sageer (75.5% fused) and Tor-at Tareeq (91.7% fused) reveal higher proportions of adults than expected in a living population (66% adults; Baharav, 1974). This suggests that these hunters intentionally retrieved higher-ranked prime-aged adult animals which is

the preferred human hunting pattern when resources are sufficiently abundant (Stiner, 1994). Poor preservation may be partially responsible for the low representation of juvenile bone. Nevertheless, the well-formed epiphyses and bone shafts of the metapodials are the most common elements in the age sample and also have high rates of fusion. Likewise, the better-preserved Tor Sageer assemblage has lower proportions of juveniles than the more poorly preserved KPS-75. The proportion of adult animals is lowest at KPS-75 (62%), the site that also has the highest fast small game fraction.

Tortoise Body-Size and Skeletal-Part Representation

A closer look at the tortoise assemblages reveals that the ratios of major body-parts (carapace, plastron and limbs) are similar to those expected in a complete skeleton. They deviate from this pattern only in the slight under-representation of limb bones and corresponding over-representation of plastron specimens (Figure 5). This is not unexpected given that limb bones are much smaller, and less identifiable than tortoise shell fragments, particularly plastrons and thus less likely to be retrieved from the archaeological record. The body-part pattern suggests that tortoises were deposited at the site as complete units and that their shells were not intentionally curated for secondary use. In assemblages where carapaces display clear evidence for secondary use or modification, carapaces are curated and thus over-represented (Munro, 2001, 2013).

Unfortunately, tortoise humeri are rare in the studied assemblages. Only KPS-75 produced samples large enough for comparison with contemporary sites in the Jordan Valley and the Mediterranean Levant ($n = 10$). Six measurable humeri also derive from the Tor Sageer assemblage, but this sample is too small to be statistically meaningful.

Although a wide range of body-sizes are represented, the tortoises from KPS-75 are significantly larger on average than those from contemporaneous sites in the Mediterranean Levant and the Jordan Valley (Table 3; Figure 6). In addition, the tortoise measurements from KPS-75 (Skew=0.219) are skewed toward the larger measurements in the upper half of the graph. Although the range of measurements represented at KPS-75 is similar to that from the Kebaran layers at Hayonim Cave and the early Kebaran deposits from Meged Rockshelter, 40% of the KPS-75 tortoises fall within the largest size category represented at these sites. Thus, although tortoises from these populations have similar body-size ranges, residents of KPS-75 harvested larger, older tortoises than those inhabiting the Mediterranean sites. Tortoises from the sites of Nahal Hadera V on the coastal plain and Locus 1 and 2 from Ohalo II in the Jordan Valley are even smaller on average than the Mediterranean sites and are also skewed toward the smaller body-sizes (Table 3; Figure 6). The largest tortoises from these site samples are significantly smaller than those from the other sites.

Interestingly, the KPS-75 tortoise size profile is a closer match to earlier Middle Paleolithic assemblages from Hayonim Cave and Kebara Cave (Speth and Tchernov, 2002; Stiner, 2005) than to contemporaneous Kebaran counterparts. Both the average size of KPS-75 tortoise humeral shafts, their size distribution and the size of the largest tortoises resemble those from the Middle Paleolithic—a time when there was minimal hunting pressure in the Mediterranean Levant (Stiner et al., 1999, 2000). Most surprisingly, all six of the measured tortoise humeri from Tor Sageer are very large (minimal humerus shaft diameter: 5.0-6.0 mm)—as large as or marginally larger than the

largest tortoise measurements from Paleolithic Levantine assemblages including those from KPS-75 and the largest tortoises from the Middle Paleolithic.

Why are the Tor Sageer tortoises so large? Could these represent a different and larger species or subspecies of tortoise or might past hunters simply have captured the largest tortoise specimens on the landscape (also see discussion by Stiner, 2005:146-147)? The tight distribution of the six measurements indicates that only a small range of potential body-sizes were harvested from the population. The morphological characteristics of the tortoise shells are consistent with the species *Testudo graeca*. The margins of the peripherals do not flare as in *Testudo kleinmanni* and the anal scutes that were recovered (two from KPS-75 and one from Tor Sageer) are not split as in *Testudo hermanni*, which although it does not occur in the Levant today, may have ranged there in the past. Researchers have observed an increasing gradient in the size of *Testudo graeca* from west to the east, with larger tortoises inhabiting the more arid steppes and deserts of Jordan (Stubbs, 1989). Nevertheless the proximity of Tor Sageer to KPS-75 in time and space and the similar size range of the tortoises from KPS-75, Hayonim Cave and Meged Rockshelter, and the morphological characteristics of the tortoise shells suggest that these are likely the same subspecies that resided in the Mediterranean Levant—*Testudo graeca terrestris*. Even if the Jordanian tortoises were somewhat larger on average than those from the Mediterranean zone, the contrast in the skewing of body-size to the lower end of the spectrum in the Mediterranean and the upper end of the spectrum in the steppic sites reveals that they were collected under different circumstances.

Discussion

The relative abundance indices and gazelle mortality profiles from the western highlands sites indicate that Epipaleolithic foragers focused primarily on high-ranked prey, especially large-bodied adult ungulates and tortoises. Clearly, high-ranked game was adequate to meet subsistence needs and Epipaleolithic foragers did not need to invest significantly in the capture of lower-ranked animals such as juvenile ungulates or fast small game. Likewise, human hunting did not significantly impact local resources. The only possible indication of mounting harvest pressure in the Wadi al-Hasa is the dominance of the smallest-bodied ungulate, the gazelle, in comparison to higher-ranked ungulates such as aurochs and equids. Aurochs and equids were not encountered frequently enough to solely provision human diets. Whether this is because local habitats could only support dispersed populations of these large ungulates or human-induced depression reduced numbers over the long term as in the Mediterranean Levant, cannot be ascertained without comparison to faunas from Jordanian Middle and Upper Paleolithic assemblages. Despite this, the focus on the lower-ranked gazelle, the heavy reliance on adult gazelles and high-ranked small game animals shows that the Early Epipaleolithic foragers were still a long way from imbalance with local animal populations. A variety of additional meat sources remained to be tapped, yet hunters rarely exploited them.

Likewise, the large body-size of tortoises and their frequency in the Early Epipaleolithic assemblages attest to light human impact on local ecosystems. Tortoise populations are especially sensitive to human hunting and thus provide effective barometers of hunting pressure. The large size of the tortoises from KPS-75 and Tor Sageer aligns with the high slow small game indices. Together this evidence indicates

that tortoise populations were able to withstand the mortality induced by Early Epipaleolithic foragers. This was true despite the fact that tortoise populations grow very slowly and are far more susceptible to overhunting than other Epipaleolithic prey taxa (Stiner et al., 2000). A trend toward decreasing body size from the Middle Paleolithic to the Natufian periods in the Mediterranean zone of the eastern Levant has been interpreted as the result of increasing hunting pressure over time. Because tortoises grow through life, body-size and age are correlated—the larger the tortoise the older the individual. The focus on larger bodied tortoises at KPS-75 indicates that predation was light enough for many tortoises to reach old age. This point is made especially clear by the very large size of the tortoises at Tor Sageer. The fact that these tortoises and many of those from KPS-75 are as large as Middle Paleolithic tortoises in the Mediterranean Levant supports the light impact of human foragers in the western highlands region.

Although there is some variation in the faunal indices recorded in the western Highlands sites, the results are in agreement at least in the Wadi al-Hasa. Three of the indices from KPS-75 however, suggest that this site on the Kerak Plateau may have been somewhat more intensively occupied (see also Olszewski and al-Nahar, this volume). Despite poorer faunal preservation overall, KPS-75 has the highest proportions of the more delicate low-ranking bird, hare and juvenile gazelle elements. The fact that these bones are more susceptible to attritional processes suggest that they were likely more abundant at the time of deposition. In addition, although the tortoises are larger on average than those from Early Epipaleolithic Mediterranean, tortoises from a range of sizes were collected at KPS-75, unlike the specimens from Tor Sageer which were all

377 very large, high-ranking adults. Together these differences suggest more intensive
378 occupation at KPS-75 than the other three sites.

379 In summary, the lack of evidence for harvest pressure reveals that humans tread
380 lightly on the landscape and that site occupation intensity was low in this part of the
381 western highlands during the Early Epipaleolithic period. The small game data indicate
382 that hunters did not stay at any of the sites long enough to impact local prey populations.
383 This does not mean that all occupations were strictly short-term affairs representing only
384 a day or two of encampment. It would likely have taken visits of many days or weeks for
385 foragers to leave lasting impacts on local prey populations. Nevertheless, the contrast
386 between the faunal evidence for light occupation intensity and the quite significant
387 deposits of lithic remains reveals that although visits to these sites were brief, they were
388 repeated. Clearly, all of these sites were preferred places on the landscape to which
389 humans returned again and again. The fact that humans moved on before having a lasting
390 impact on local animal populations made re-occupation sustainable.

391 Although the landscapes of these sites appear far from hospitable today, paludal
392 and lacustrine conditions in the Wadi al-Hasa and Kerak Plateau would have provided
393 attractive settings for foraging camps. Despite the permanent water sources and wetland
394 habitats, visitors to the Wadi al-Hasa still moved on quite quickly to the next place. In
395 this sense, this area of the western highlands differed from areas such as the Azraq Basin
396 or the Upper Jordan Valley, where sites like Kharaneh IV, Jilat 6 and Ohalo II hosted
397 more intensive, potentially seasonal aggregations of human occupations (Garrard and
398 Byrd, 1992; Nadel, 2002; Maher et al., 2012b, this volume). The difference in the scale of
399 occupation at Ohalo II and the Azraq sites is also suggested by some of the same faunal

measures applied here. For example, the small size of the Ohalo II tortoises from Locus 1 and 2 reflect more sustained harvest of local populations. The average tortoise from Ohalo II was harvested well before it attained full body size, likely because the rate of capture of tortoises exceeded the growth rate of these slow-growing, long-lived animals. Even after impacting local resources, the useable biomass on the shores of the Sea of Galilee, was likely sufficiently diverse and concentrated to make staying at this location more cost effective than moving on to less productive locales. Likewise, more abundant gazelle, and fast small game at the sites of Kharaneh IV and Wadi Jilat 6 in the Azraq Basin reflect more intensive occupation (Martin and Edwards, 2010) than the Wadi al-Hasa sites. Regardless of the scale of occupation, it is clear that permanent standing water sources and associated habitats were key attractions to human populations in otherwise arid landscapes.

Although high mobility has long been understood to have been a crucial part of LGM adaptations in the arid Levant, the conflation of material remains at repeatedly occupied sites makes it impossible to distinguish individual visits to test this proposition. Because faunal data allows us to gauge the average degree of impact of each visit, they provide a useful indicator of site occupation intensity. The faunal data from the Early Epipaleolithic sites in the western highlands confirms that despite large concentrations of lithics, these sites were formed by small-scale occupations, and thus were clearly favored locations on the Late Pleistocene landscape.

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434

Appendix 1: Number of identified specimens (NISP) of taxa represented at the four Early Epipaleolithic sites.

TAXON COMMON NAME	TAXON LATIN NAME	KPS75		WHNBS242		WHS784		WHS1065	
		NISP	%	NISP	%	NISP	%	NISP	%
Crab	<i>Potamon potamios</i>	0	0.0	0	0.0	1	0.3	0	0.0
Fish	Pisces	0	0.0	0	0.0	1	0.3	0	0.0
Tortoise	<i>Testudo graeca</i>	369	33.9	259	23.3	80	26.4	319	62.1
Small Bird		1	0.1	0	0.0	0	0.0	1	0.2
Medium Bird		2	0.2	4	0.4	0	0.0	6	0.9
Large Bird		0	0.0	0	0.0	0	0.0	1	0.2
Falconiforme	Falconiformes	1	0.1	0	0.0	0	0.0	2	0.3
Partridge	<i>Alectoris</i> sp.	1	0.1	5	0.5	0	0.0	0	0.0
Owl	Strigidae	1	0.1	0	0.0	0	0.0	0	0.0
Small Perching Bird	Passeriformes	1	0.1	0	0.0	0	0.0	1	0.2
Swift	<i>Apus</i> sp.	1	0.1	0	0.0	0	0.0	0	0.0
Hare	<i>Lepus capensis</i>	23	2.1	40	3.6	0	0.0	10	1.6
Wild Ass	<i>Equus hemionus</i>	63	5.8	12	1.1	11	3.6	20	3.5
Red deer	<i>Cervus elaphus</i>	1	0.1	0	0.0	0	0.0	0	0.0
Wild Boar	<i>Sus Scrofa</i>	0	0.0	1	0.1	0	0.0	0	0.0
Aurochs	<i>Bos primigenius</i>	24	2.2	5	0.5	14	4.6	3	0.8
Goat	<i>Capra aegagrus</i>	13	1.2	35	3.2	5	1.7	1	0.2
Gazelle	<i>Gazella</i> sp.	294	27.0	546	49.1	55	18.2	100	18.2
Small Ungulate		220	20.2	149	13.4	97	32.0	53	8.6
Medium Ungulate		13	1.2	10	0.9	12	4.0	3	0.9
Large Ungulate		18	1.7	21	1.9	21	6.9	9	1.1
Huge Ungulate		7	0.6	0	0.0	2	0.7	1	0.2
Small/Med Ungulate		10	0.9	0	0.0	1	0.3	0	0.0
Med/Large Ungulate		2	0.2	0	0.0	0	0.0	0	0.0
Small Carnivore		2	0.2	5	0.5	1	0.3	0	0.0
Weasel Family	Mustelidae	1	0.1	0	0.0	0	0.0	0	0.0
Dog Family	Canidae	0	0.0	0	0.0	1	0.3	1	0.2
Fox	<i>Vulpes vulpes</i>	4	0.4	8	0.7	0	0.0	3	0.5
Wild cat	<i>Felis</i> sp.	0	0.0	3	0.3	1	0.3	0	0.0
Leopard	<i>Panthera pardus</i>	0	0.0	1	0.1	0	0.0	0	0.0
Medium Mammal		8	0.7	4	0.4	0	0.0	2	0.3
Small Mammal		7	0.6	3	0.3	0	0.0	1	0.2
TOTAL		1087		1111		303		537	

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Figure Captions

Figure 1. Map showing location of the Wadi Hasa sites, KPS-75 and other Levantine Early Epipaleolithic sites mentioned in the text. The Wadi Hasa sites are Tor Sageer, Tor at-Tareeq and Yutil al-Hasa.

Figure 2. Relative abundance of broad taxonomic groups (ungulates, carnivores and small game) represented at the western highlands sites.

Figure 3. Relative abundance of ungulate species (aurochs, wild ass, wild goat and gazelle) represented at the western highlands sites.

Figure 4. Relative abundance of small game taxa (tortoises, hares and birds) represented at the western highlands sites.

Figure 5: Proportion of adult gazelles based on the proportion of fully fused elements that fuse between the ages of 10-18 months— distal radius, proximal and distal ulna, proximal and distal femur; proximal tibia, tuber calcis of the calcaneum, distal metacarpal and metatarsals.

Figure 6: Relative proportion of tortoise body-parts (carapace, plastron and limb bones) from the western highlands sites compared against the proportions present in a complete tortoise skeleton.

Figure 7: Frequency distribution of minimum humerus shaft breadth measures from tortoises from KPS-75 and other Early Epipaleolithic sites in the southern Levant.

Tables

Table 1: Sites, dates, and NISP values for Early Epipaleolithic sites in this study.

Site Number	Site Name	Date Range	Excavation Seasons	NISP	References
KPS-75	KPS-75	21,300-18,700 cal BP?	2009	1087	al-Nahar et al. 2009; Olszewski and al-Nahar this volume
WHS-1065	Tor at-Tareeq	21,800–18,300 cal. BP	2000, 2012	636	Olszewski and al-Nahar this volume, 2014; Olszewski et al. 2000
WHNBS-242	Tor Sageer	<24,600-24,150 cal BP	1997, 1998	1110	Olszewski and al-Nahar this volume, 1997; Olszewski et al. 1998
WHS-784	Yutil-al Hasa	25,300-22,400 cal BP	1998, 2010	302	Olszewski and al-Nahar this volume, 2011; Olszewski et al. 1998

The dates for all sites but KPS-75 are based on radiocarbon determinations. The dates for KPS-75 are estimates based on typological similarities with radiocarbon dated Qalkan assemblages from the Azraq Basin following Byrd and Garrard (2013).

Table 2: Measures of quality of faunal preservation; percentage of complete carpals, average length of bone fragments, and % spiral fractures.

Site Number	Site Name	% Complete Carpals	Average Length (cm)	% Spiral Fractures
KPS-75	KPS-75	71.4	2.1	23.5
WHSNB-242	Tor Sageer	92.9	2.7	61.4
WHS-784	Yutil al-Hasa	n/a	2.1	59.7
WHS-1065	Tor at-Tareeq	50.0	1.7	55.8

Table 3: Descriptive statistics of tortoise minimum humeral shaft breadth measures for Early Epipaleolithic assemblages from the southern Levant.

Tortoise Humerus	KPS-75	NHDV	HAYC	MEGD	OHLII
N	10	51	63	58	18
Average	3.82	3.46	3.29	3.21	2.98
Standard Dev	0.694	0.407	0.583	0.533	0.376
Smallest Breadth	2.6	2.3	2.1	2.1	2.1
Largest Breadth	5.1	4.1	5.3	4.8	3.7
Skewness	0.219	0.785	0.927	0.351	0.752
*T-Test P Value	N/A	P<0.05	P<0.01	P<0.005	P<.0005

* T-Test refers to one-tailed t-test assuming equal variance between KPS-75 and other Early Epipaleolithic sites.

Figure 1

Figure 1

0 25 50 100 Km

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7