Diet of brown hyaenas (*Parahyaena brunnea*) on the Namibian coast

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The diet of brown hyaenas on the southern Namibian coast was determined *via* direct observation, scat analysis and by examining the faunal remains at nine dens consisting of 16 135 bones and bone fragments. All remains were identified to species and element where possible. Movements of four individual hyaenas from three different coastal clans were tracked *via* satellite collar. Range use was higher in coastal areas than in inland areas of the range. However, seasonal range use differences were detected. Seals formed the major proportion of the diet determined by scat analysis. In addition, the number of seal remains found at dens decreased with increasing distance to a coastal food source, scat analysis and direct observations indicated that the local population of hyaenas utilises a much broader food source than just seals. Behavioural differences between the current study population and previously reported populations of *Parahyaena brunnea* are noted.

Key words: brown hyaena, diet, faunal assemblages, predation.

INTRODUCTION

Brown hyaenas (*Parahyaena brunnea*) are not particularly efficient hunters, previously documented as preying upon small items and occasionally on domestic livestock held in enclosures (Skinner, 2006). The brown hyaena has been largely thought of as a lone nocturnal scavenger, their diet consisting of fruit, insects, reptiles, birds and mammals (Skinner, 1976; Mills & Mills, 1977; Skinner & van Aarde, 1981; Mills, 1990; Lacruz & Maude, 2005; Maude, 2005; Maude & Mills, 2005). The coastal areas of the Namib Desert are unique due to the juxtaposition of an unproductive terrestrial habitat and a productive marine habitat. In this region, Cape fur seals (*Arctocephalus pusillus pusillus*) were found to be the most important food item for brown hyaenas (Stuart & Shaughnessy, 1984; Skinner & van Aarde, 1991; Skinner *et al.,* 1995; Wiesel, 2006). Seal pups are a permanent, localised food source, but the seasonally changing structure of the seal colonies might have an influence on the brown hyenas' foraging success. Seal pups are born between the middle of November and the beginning of January and are only weaned one year later, shortly before the birth of the next pup (Rand, 1967). Seal pup mortality is highest shortly after birth and up to 50 days after the peak in pupping in December (de Villiers & Roux, 1992). While brown hyaenas rely mainly on seals as a primary food source, both as carrion and by killing seal pups (Skinner *et. al.,* 1995; Wiesel, 2006), at times, particularly outside the seal pupping season, they supplement their diet with other food items washed up along the beaches or found in the inland areas of their home range.

In order to identify food items utilised by brown hyaenas on the southwest coast of Namibia the faunal assemblages from nine dens were examined (Kuhn, 2006). The species identified in the den assemblages are compared with observations of foraging behaviour and scat analysis to further assess the diet of brown hyaenas in the region.

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STUDY SITE

All of the den sites studied are part of the Brown Hyaena Research Project based in Lüderitz, Namibia. The dens are located on the Lüderitz Peninsula and Diamond Area No. 1 (Sperrgebiet), which are located in the southwest of Namibia. Within these regions three study sites have been established. These sites are the Lüderitz Peninsula and the two areas within the Sperrgebiet, the region around Atlas Bay and Wolf Bay and the region around Baker's Bay (Figure 1). The Sperrgebiet extends over 250 km to the South African border and covers 26 000 km^2, an area which receives less than 100 mm of rainfall annually; despite the aridity, a variety of large mammals such as gemsbok (*Oryx gazella*), springbok (*Antidorcas marsupialis*), black-backed jackal (*Canis mesomelas*), and various small mammals, birds and reptiles occur there. In addition, an abundance of marine animals inhabits the shorelines apart from Cape fur seals, including African penguins (*Spheniscus demersus*). Mainland Cape fur seal breeding colonies exist in both study sites in the Sperrgebiet.

MATERIALS AND METHODS

All den designations follow those previously established by the Brown Hyaena Research Project. The nine dens surveyed were D-P 1, D-P 2, D-P 4, D-P 9, D-P 11, D-P 16, D-P 18, D-SPG 1 and D-BB 1. D-P designates dens located within the Lüderitz Peninsula study site, SPG designates dens located within the Atlas Bay/Wolf Bay study site and BB designates dens located within the Baker's Bay Study site. Analysis of all den faunal remains were done *in situ* at the den sites using various manuals and publications (Walker, 1985; Hillson, 1992; von den Driesch, 1976; Ericson & Stora, 1999 and Schmid, 1972) in order to comply with protocol set by NAMDEB Diamond Company and the Namibian Ministry of Environment and Tourism. Each specimen was identified to skeletal element and species where possible and body side. Number of identified specimens (NISP) was documented and the body sides of long bones and mandibles were used to calculate the minimum

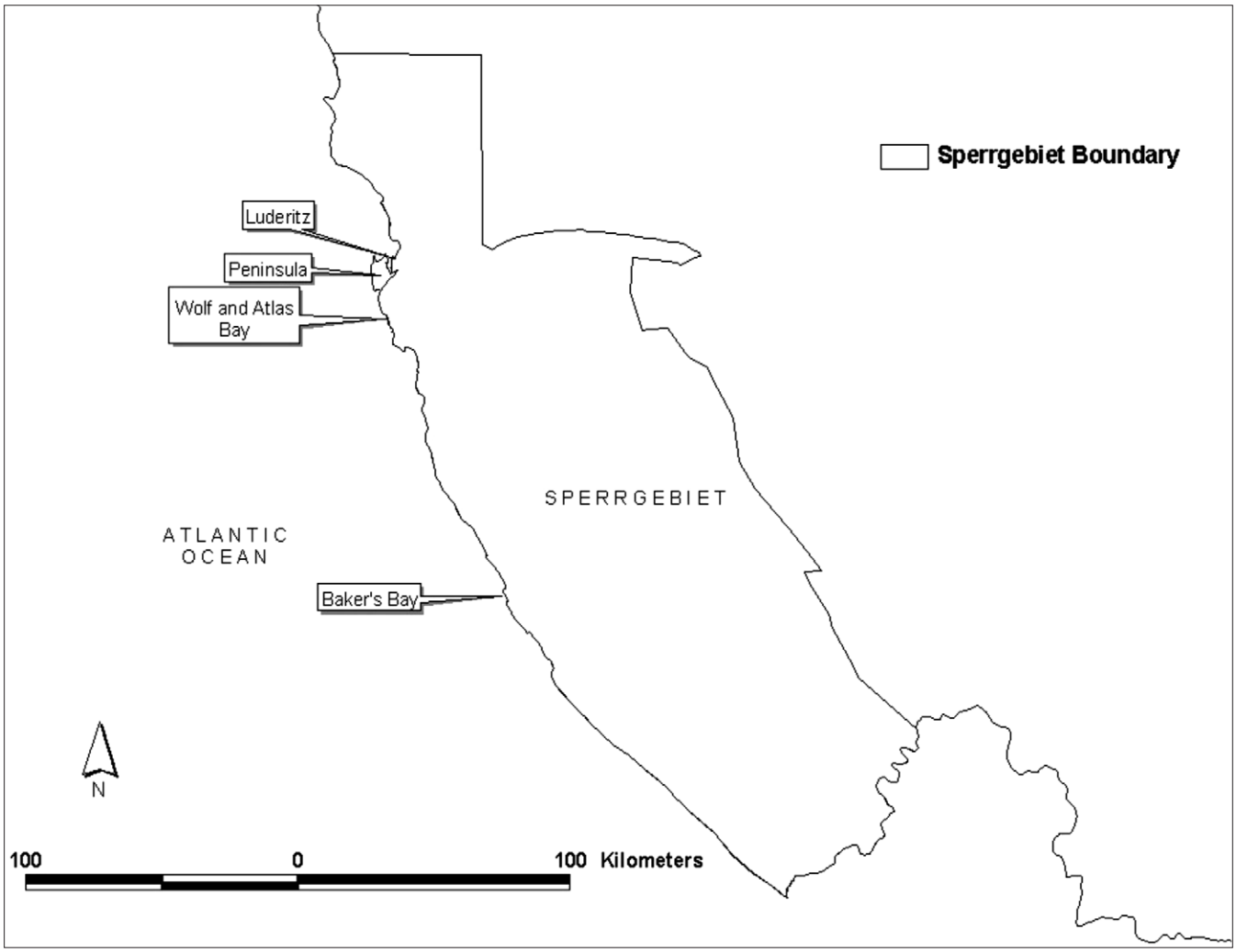

Figure 1. Map showing the study sites.

number of individuals (MNI).

Scat samples were collected from latrines. They were washed by sieving, using apertures of 212, 1000 and 2000 μm, and dried in a hot air oven at 50°C overnight. Occurrence of seal, avian, canine and fish remains was recorded (Wiesel, 2006).

One brown hyaena was fitted with a global positioning system (GPS) collar (Televilt, Sweden) in each of the two study areas at Wolf/Atlas Bay (SPG) and at Baker's Bay (BB) and to two brown hyaenas in the Peninsula (P) study area. A lactating female LHb30f's and the female LHb21f's home range included all dens marked with D-P. The male LHb210RC's home range included the den site marked with D-SPG and the male BBHb9m's home range included the den site marked with D-BB. All recorded GPS positions were plotted in ArcView 3.3 to establish the importance of the coast as a foraging area, including taking seasonal variation into account. The distance of each den to the nearest mainland seal colony and nearest south-west facing beach, where large numbers of seal carcasses are washed up due to the prevailing ocean current, was calculated. Foraging areas which provide food sources other than seals were identified by calculating Adaptive Kernel Volumes (calculating the 10 to 90% probability of locating an animal in these specific areas) and were used to explain the occurrence of bone remains at den sites.

RESULTS

A total of 16 135 bones and bone fragments were analysed from the nine dens. Faunal remains identified as dogs (*Canis familiaris*) are from domestic canids and remains that could not be positively identified as jackal. Cat remains could be from either domestic cat or African wild cats (*Felis sylvestris*), which was recently identified in the region when one was caught on the beach near the town of Lüderitz and subsequently identified by experts at the Ministry of Environment and Tourism (unpublished). Previously the range of Africa wild cat was thought to exclude the coastal beaches (Skinner & Chimimba, 2005). A break down of individual dens is illustrated in Table 1 where each individual den shows species identified, number of identified specimens per species (NISP), minimum number of individuals per species (MNI) and the percentage of these identified. Seal remains were the most common species identified for all of the dens in question, ranging from 35.1–96.5% of the identified specimens. The number of species or class (includes class size, avian, fish, reptiles and cetaceans) identified, aside from seals, ranged from three to 18 species. While the dens with lower numbers of identified species had low NISP's, the number of species identified does not appear to directly correlate with assemblage size. This is evident in den SPG-1 where there were eight identified species and had an NISP of 1493, while den D-P 18 had 18 identified species and an NISP of 653.

Scat analyses

A total of 99 scat samples was collected between 1997 and 2001. Identified species from scat analyses included seals, canids, fish and birds. Composition of remains found in scats

Figure 2. Seal pup skull with typical bite marks.

differed between Peninsula and Wolf/Atlas Bay scats (χ^2 test, d.f. = 3, $P < 0.0001$) and between Wolf/Atlas Bay and Baker's Bay scats (χ^2 test, d.f. = 2, $P = 0.0001$) (Table 2).

Identification of foraging areas

Peninsula

The largest number of GPS positions of LHb30f was found in the area around a lagoon to the southwest of Lüderitz and around the southwest facing bay, Grosse Bucht, during the time of seal pup shortage (August and September). During the seal pupping season in December, most GPS positions were recorded around Grosse Bucht (Figure 3).

Most GPS positions of the lactating female LHb30f were recorded around the den site to the south of Lüderitz during the time of seal pup shortage. However, in December, when seal pup availability was high, a concentration of GPS positions was also recorded around Grosse Bucht.

Sperrgebiet

Most GPS positions of LHb210RC were recorded along the coastline including the area around both mainland seal colonies at Wolf Bay and Atlas Bay between August and September (Figure 5). No data were available for the December period.

Baker's Bay

Most recorded GPS positions of BBHb9m were found along the coastline south of the Baker's Bay seal colony and in inland areas of BBHb9's home range between August and September (Figure 6). In December, during the seal pupping season, concentrations of GPS positions were only found along the coast.

Importance of coast

A larger number of GPS positions were recorded in coastal areas (coast to 1 km inland) than in other areas of each hyaenas' home range (Table 3). The difference was significant (χ^2 test, d.f. = 3, $P < 0.0001$).

A larger number of GPS positions were recorded in the coastal area during the seal pupping season in December, when seal pup availability (live and as carrion) was higher than between August and September, when seal pup availability was low. The proportion of positions recorded in this area in December was 65.5%, 31.1% and 35.5% and 46%, 12.6% and 14.2% in August and September for LHb21f, LHb30f and BBHb9m respectively.

Distance to coastal foraging areas

Dens were between 3.4 and 8.3 km away from the nearest south-west facing beach and between 0.7 and 14.6 km away from the nearest mainland seal colony (Table 4). Seals made up 23 –90% of the MNI of all species remains identified from each den. The percentage of seal MNI's at dens decreased with increasing distance to the food source (Pearson's product moment $r^2 = 0.7434$, $P = 0.006$).

DISCUSSION

Observations by researchers have confirmed both killing and scavenging of young seals by brown hyaenas. More recently, the fact that they kill and devour seal pups along the Namibian coast throughout the year has been well established (Wiesel, 2006). While seal remains make up 23–90% of the den MNI, it is the variety of other species identified within the assemblages (from 10–77% of the respective MNI) that is of interest. Other species identified in the assemblages range from three to

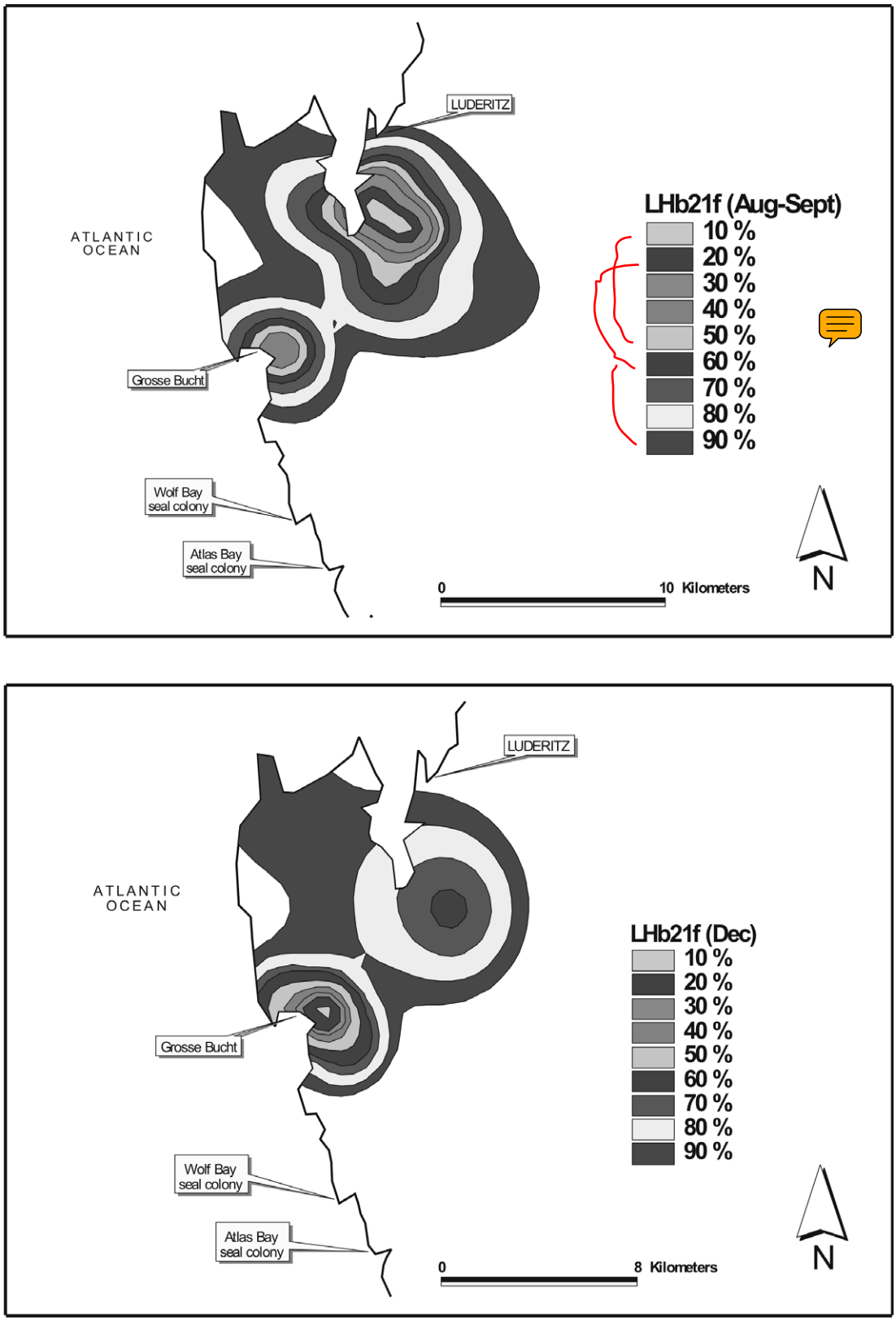

Figure 3. Adaptive Kernel Volume Contour home ranges for LHb21f in August and September (top) and during the seal pupping season in December (bottom).

14 mammal species plus three classes of avian, one bovid size class, small mammals, reptiles, cetaceans, mustelids and fish. Even in the den with a seal MNI comprising 90% of the assemblage seven species other than Cape fur seals were identified in the assemblage. The identified species reflect the species inhabiting the region, from birds such as flamingos (*Phoenicopterus* spp.) and penguins to larger terrestrial mammals such as gemsbok. The identified species included domestic cats and dogs (as indicated by the presence of collars in the assemblages) as well as representatives of the wild canid (and possibly wild felid) populations. This deduction is indicative not only of the species inhabiting the region, but also reflects the relative abundance of the species in the region as well. Horse (*Equus caballus*) remains are the only faunal remains introduced into

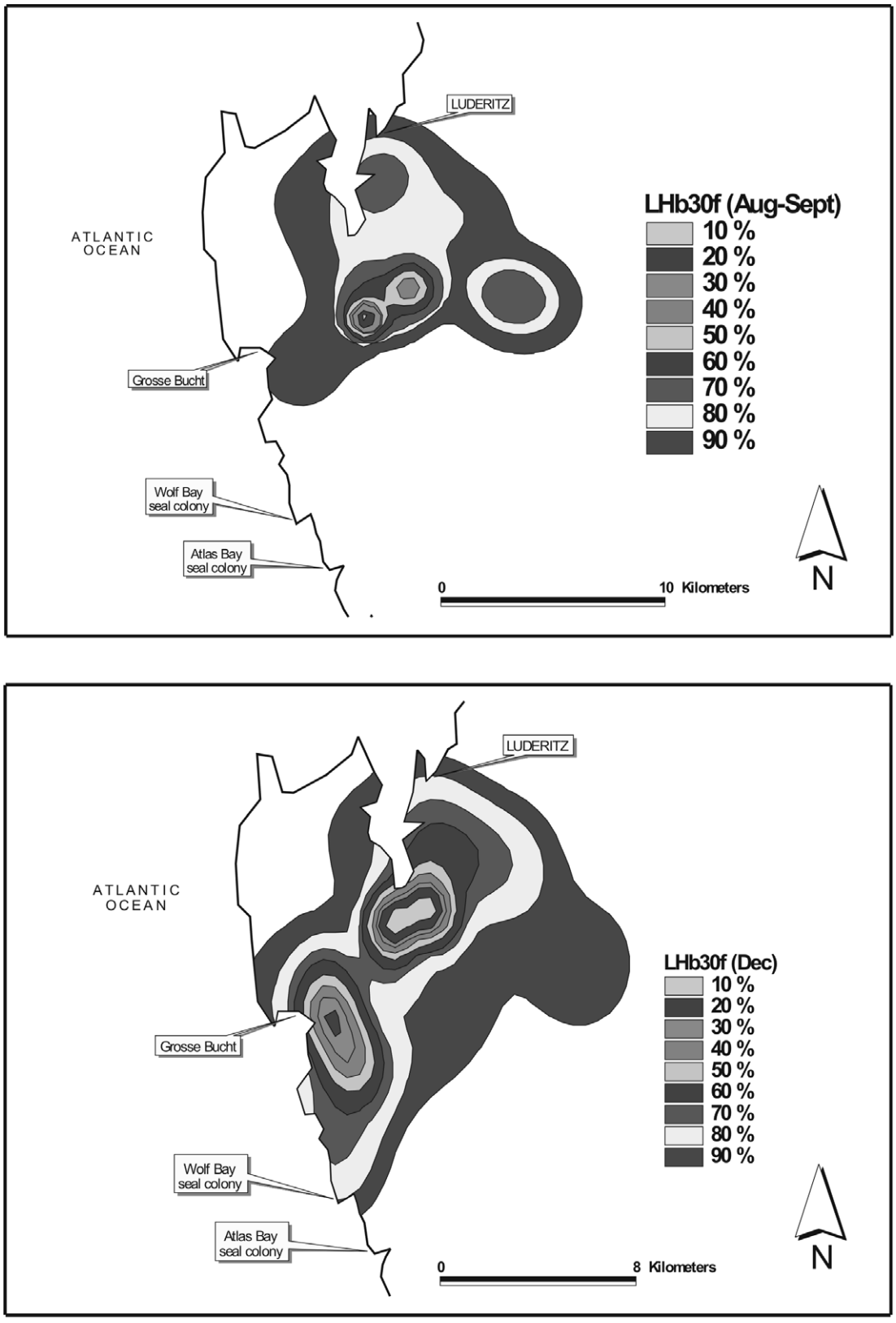

Figure 4. Adaptive Kernel Volume Contour home ranges for LHb30f in August and September (top) and during the seal pupping season in December (bottom).

the study site as horses were routinely used as bait when darting attempts were made. Baboon (*Papio cynocephalus ursinus*) bone identified at the Baker's Bay den gives an idea of foraging range in addition to data from the GPS collars as the nearest baboon troops are located in mountain ranges approximately 30–40 km inland from the beaches (I.W., pers. obs.). However, baboon troops have been observed as close as 15 km from the coast. These ranges fall within the range of movement of coastal brown hyaenas obtained from GPS telemetry.

The spatial behaviour of the hyaenas reflects differences in movement between the time during and outside the seal pupping season. A significantly longer time was spent in coastal areas during the seal pupping season in December than outside the pupping season. Live, newborn seal pups and pup

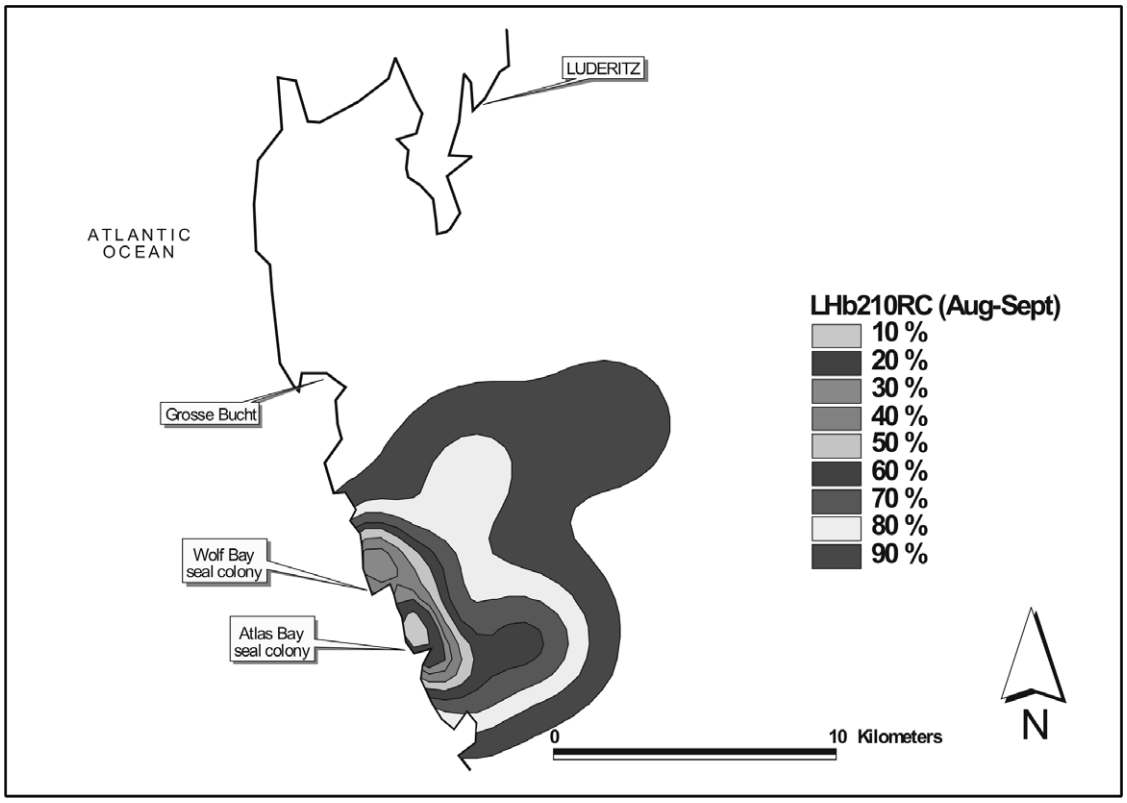

Figure 5. Adaptive Kernel Volume Contour home ranges for LHb210RC in August and September.

carcasses, at the colonies and washed up predominately along south-west facing beaches, are available during this time and provide an easily accessible and reliable food source. In winter (August/September) seal pup non-violent mortality is almost zero and few carcasses wash up along the coast. Seal pups also spend a lot of time at sea and are considerably more mobile than earlier in the season. During this time, the hyaenas spend more time in other areas of their home range. This indicates that other food sources are important for brown hyenas in the coastal areas of the Namib Desert.

Analysis of the scat samples also revealed that food sources at the three study sites differed. All scat samples collected in the Wolf/Atlas Bay area contained predominately seal remains, with few other species identified. The hyaenas inhabiting this area have access to two large mainland seal colonies, with an annual pup production of 9200–39500 for Wolf Bay and 13600–62800 for Atlas Bay between 1990 and 2004 (Kirkman *et al.*, 2007). The Atlas Bay seal colony lies entirely within the home range of one brown hyena clan. The seal colony at Baker's Bay is considerably smaller with an annual pup production of 4500–9600 between 1990 and 2004 (Kirkman *et al.*, 2007). This colony is in an area where the home ranges of two different clans overlap. The sharing of this relatively small food resource may lead to a wider diet breadth than found for Wolf/Atlas Bay hyaenas verified by scat samples collected in the Baker's Bay area which indeed showed a wider variety of different species consumed. Permanent water holes in this area attract gemsbok, springbok and ostriches amongst others. Packs of stray dogs are found occasionally in the Sperrgebiet, which helps explain the occurrence of domestic dog remains in the assemblages.

Scats collected on the Lüderitz Peninsula showed the greatest range of species. Hyaenas inhabiting this area seldom visit the seal colony at Wolf Bay during the seal pupping season to forage. The southwest facing beach at Grosse Bucht, the lagoon to the southeast of Lüderitz and the town of Lüderitz itself are their main foraging areas. Apart from domestic animals that can be found in and around town, many birds aggregate in this study area. Penguins, cormorants (*Phalacrocorax* spp.) and kelp gulls (*Larus dominicanus*) breed on offshore islands and corpses often wash up along the beaches. Furthermore, flamingos aggregate at the lagoon in summer.

A greater distance to seal food sources leads to a lower seal MNI at the prospective dens. The Peninsula dens were the furthest away from any such food source and hence had the lowest seal MNI, whereas the den near the Atlas Bay seal colony (D-SPG1) had the highest seal MNI. The relatively low seal MNI found at the Baker's Bay den (D-BB1) may be a result due to a combination of two factors: low annual pup production and home range overlap of two different clans.

CONCLUSION

The present study shows the behavioural variation that can be found within a species. Brown hyaenas on the Namibian coast habitually forage and kill seal pups amongst the seal colonies and are active at all times of day or night. Although there is an abundance of seals, as evidenced by the number of pups killed and not completely consumed, the brown hyaenas scavenge upon a variety of species inhabiting the region and the faunal assemblages reflect these species, both wild and domestic, that can be found in the region at this time. The identified species in the bone assemblages not only support the scat data that seals are not the only prey items consumed, but show the specific range of species consumed by brown hyaenas in this region. The greatest behavioural difference observed from previous studies (Mills & Mills, 1977; Mills, 1990; Maude, 2005) is that brown hyaenas in this region forage at all hours, and routinely make kills (in this case seal pups).

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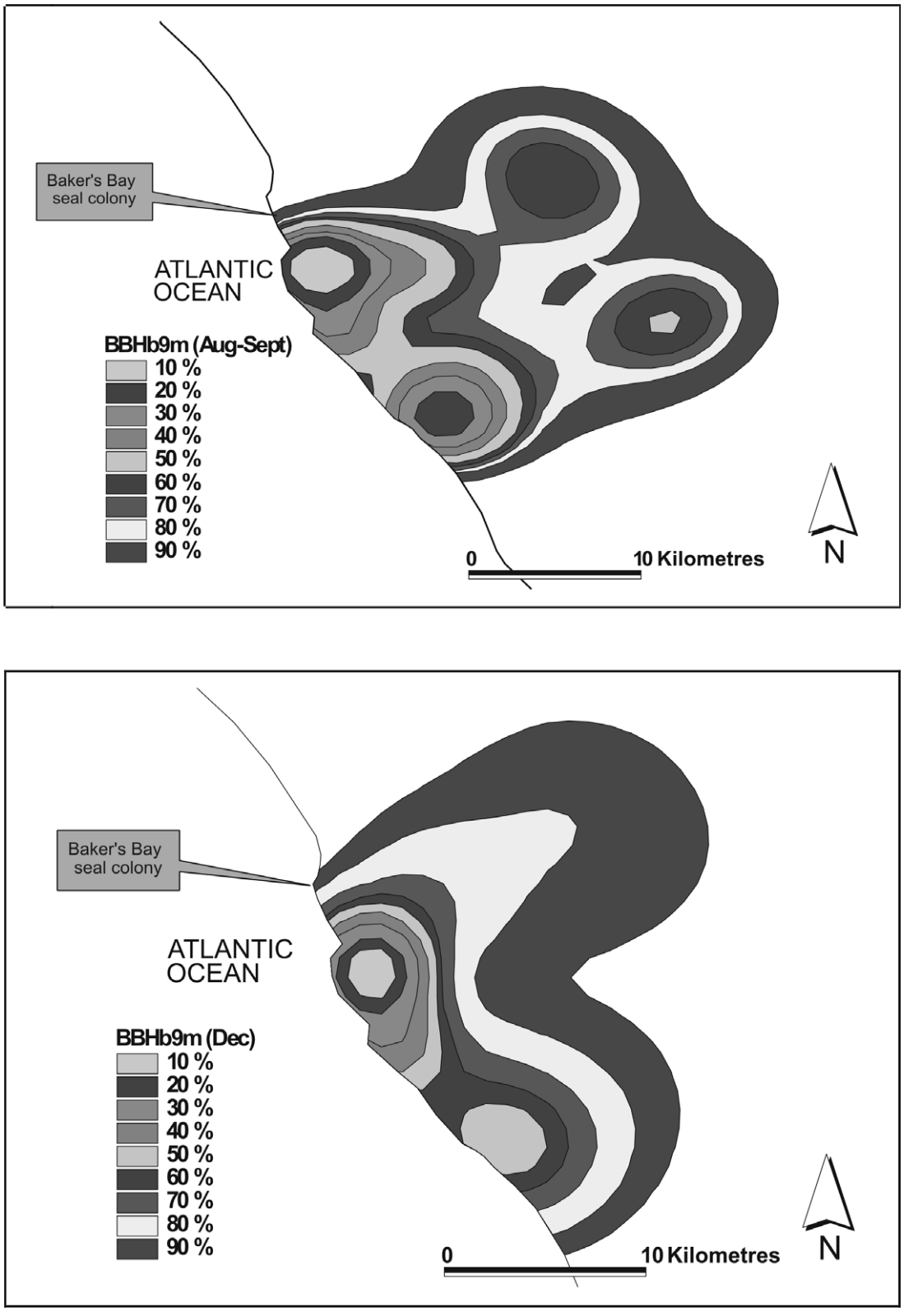

Figure 6. Adaptive Kernel Volume Contour home ranges for BBHb9m in August and September (top) and during the seal pupping season in December (bottom).

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