Note: Snapshot PDF is the proof copy of corrections marked in EditGenie, the layout would be different from typeset PDF and EditGenie editing view.

Author Queries & Comments:

Q1 : A Quotation mark seems to be missing following "No disturbance,...". Please indicate where it should be placed.

Response: 50% "No disturbance", out of eight occasions

Q2 : The disclosure statement has been inserted. Please correct if this is inaccurate.

Response: Resolved

Q3 : The CrossRef database (www.crossref.org/) has been used to validate the references. Please check and correct any mistakes.

Response: Resolved

Q4 : Please provide missing page range,editors name and publisher name for reference "Atlas of Namibia Team, 2022" references list entry.

Response: Atlas of Namibia Team, 2022, Atlas of Namibia: its land, water and life, Namibia Nature Foundation, Windhoek, pp. 72–107

Q5 : Please provide missing issue number for reference "Baker and Leberg, 2018" references list entry.

Response: Volume 13, issue 4.

Q6 : Please provide missing issue number for reference "Granquist and Sigurjonsdottir, 2014" references list entry.

Response: Does not have an issue number: https://www.sciencedirect.com/science/article/abs/pii/S0168159114001075?via%3Dihub

Q7 : Please provide missing editors name for reference "Kirkwood et al., 2003" references list entry.

Response: Editors: Nicholas N. Gales, Mark M. Hindell, Roger R. Kirkwood

Q8 : Please provide missing issue number for reference "Kuhn et al., 2008" references list entry.

Response: Volume 63, Issue 2

Q9 : Please provide missing page range for reference "Leeney, 2014" references list entry.

Response: Leeney, Ruth. (2014). Towards sustainability of marine wildlife-watching tourism in Namibia. Journal of the Namibian Scientific Society. 62. 9-33.

Q10 : Please provide missing volume number and issue number for reference "Skinner et al., 1995" references list entry.

Response: Volume 237, Issue 1

Q11 : Please provide missing page range for reference "Spagnuolo et al., 2022" references list entry.

Response: Pages 1089-1112

Q12 : The text is blurred in figure 5. Please resupply the figure with clearer text.

Response: Response file attached "combine_images (2).jpg".

CM1 : There needs to be a separation between the first two lines (Cloudy and Dark) and the rest. On the manucript, there was a large black line to delimit them. There are two different Generalized Linear Models in this table (see caption).

CM2 : There needs to be a delimitation here, see comment on the caption.

Recommendations for the development of a carnivore viewing site at a colony of Cape fur seals (*Arctocephalus pusillus pusillus*) in southern Namibia

Marie Anna Lemerle[a,b], Ingrid Wiesel[a,b], Michael John Somers[b]

[a] Brown Hyena Research Project, Lüderitz, Namibia

[b] Department of Zoology & Entomology, University of Pretoria, Mammal Research Institute, Hatfield, South Africa

CONTACT Marie Anna Lemerle marie.lemerle@strandwolf.org Brown Hyena Research Project, P.O. Box 739, Lüderitz, Namibia; Dep. of Zoology & Entomology, University of Pretoria, Mammal Research Institute, Hatfield 0028, South Africa

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ABSTRACT

This study examined the daily and monthly activity patterns of brown hyenas (*Hyaena brunnea*) and black-backed jackals (*Canis mesomelas*) at a Cape fur seal colony in southern Namibia, to provide recommendations for developing a sustainable wildlife viewing site. Observations conducted between November 2020 and October 2022 showed that the carnivores were most active between May and October, with jackals showing peak activity around sunrise and sunset, and brown hyenas mostly visiting around midday. The animals were more active during cloudy and cool weather. With the diurnal activity of carnivores and their predation behaviour on Cape fur seal (*Arctocephalus pusillus pusillus*) pups, the area has high ecotourism potential. Brown hyenas, however, are sensitive to human disturbance, such as moving vehicles and unknown sounds and smells. Therefore, limiting the number of visitors and creating a fixed viewpoint is recommended to minimise disturbance. This study provides valuable input on how ecotourism activities could be developed at a seal colony without compromising the sensitive wildlife there.

KEYWORDS

- *Canis mesomelas*
- conservation
- ecotourism
- *Hyaena brunnea*
- predation
- seal colony

FUNDING

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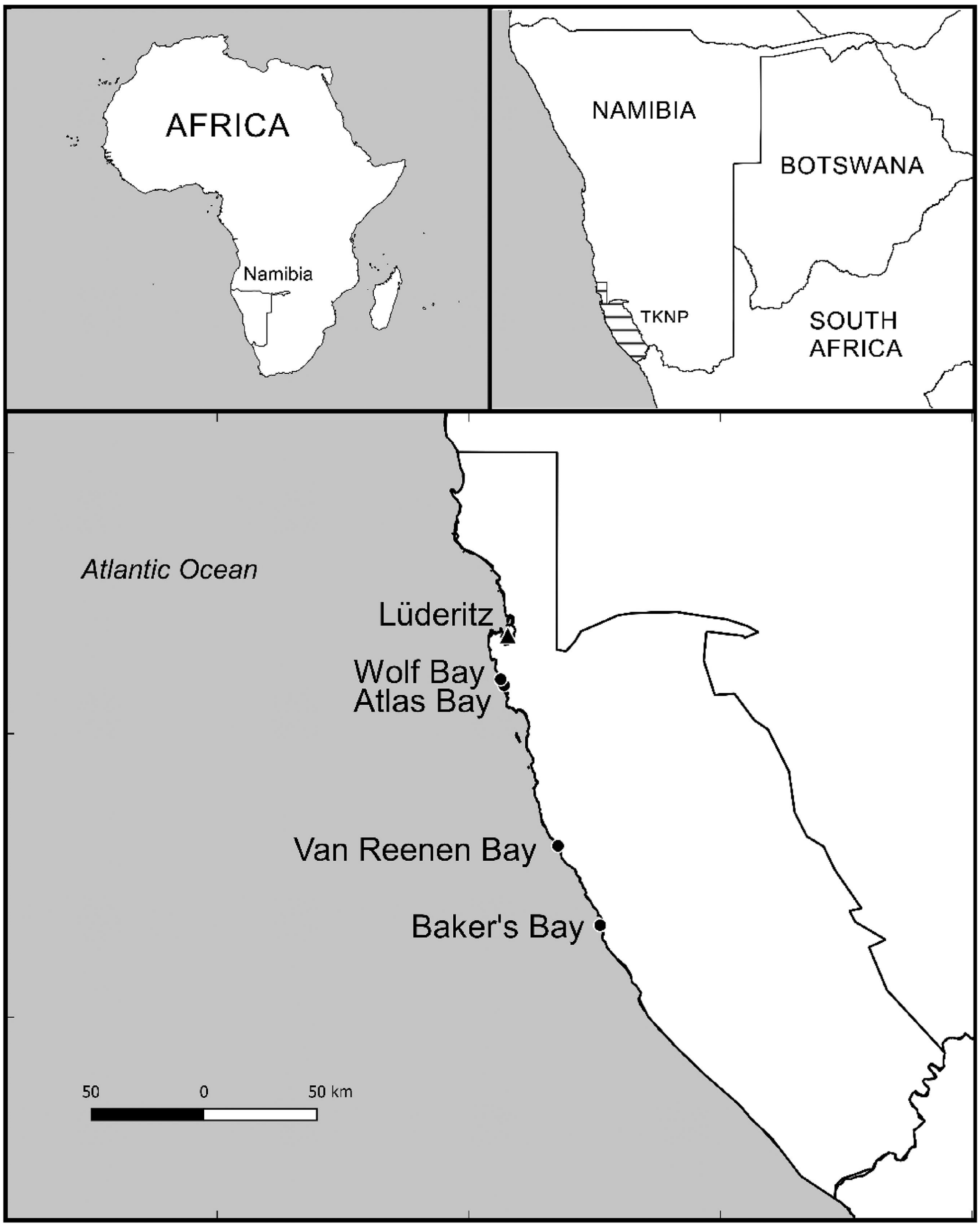
Introduction

Protected areas are described as areas of land or water dedicated to conserving biological diversity and natural resources (Dudley & Stolton, 2007). These areas are considered essential for the long-term conservation of biodiversity, ecosystems, and cultural heritage (Worboys et al., 2015). The International Union for the Conservation of Nature defines six categories of protected areas, ranging from 'Strict Nature Reserve' (Category I) to 'Protected Area with sustainable use of natural resources' (Category VI), depending on an area's management objectives(Dudley, 2008). Guidelines for access and allowed activities differ for each. For example, human presence is strictly controlled in a Category I protected areas. In a Category VI protected area, resources may be used but sustainably must be ensured (Dudley, 2008; Dudley & Stolton, 2007; Worboys et al., 2015).

In protected areas with restricted human access, wildlife only has an intrinsic value. However, wildlife can also provide monetary value through tourism. International visitors tend to be attracted by mega-herbivores and large carnivores, while local visitors and experienced wildlife viewers are especially interested in seeing rare and less easily observed species and behaviours (Eyster et al., 2023; Lindsey et al., 2007). If sustainably planned and managed, tourism can benefit protected areas and increase their value in many ways. These benefits may even extend beyond the protected areas; tourists spend money in local businesses and stimulate the creation of jobs in tour operations and hospitality (do Val Simardi Beraldo Souza et al., 2019). Therefore, tourism provides a source of income for local communities, which can help reduce the pressure to engage in counter-productive activities such as poaching or illegal logging (Ancrenaz et al., 2007; Wang et al., 2018). Moreover, tourism can provide financial resources that can be used to fund conservation efforts within the protected areas. Funding generated through ecotourism can go to local research and conservation projects, and it can encourage volunteers to participate in local projects, through which local communities can be exposed to and educated about the value of natural resources (Ancrenaz et al., 2007; Brightsmith et al., 2008). Studies show that most projects with positive well-being and conservation outcomes come from cases where Indigenous people and local communities are decision-makers (Dawson et al., 2021). Protected areas can, therefore, be educational tools, where locals and tourists learn about the importance of conservation and how to minimise negative impact on the environment (Marion & Reid, 2007). For all these reasons, there is a need to implement carefully managed, sustainable ecotourism projects inside protected areas.

In Namibia, the TsauIIKhaeb National Park (TKNP, formerly known as Sperrgebiet) was proclaimed in 2008. It is the southernmost of four coastal national parks in Namibia. The Sperrgebiet was a restricted diamond mining area, where public access was prohibited. Mining activities are still ongoing in some delimited areas within the TKNP and access therefore remains restricted, but tourists can visit a few targeted areas of the park through tour operators. The TKNP contains four mainland breeding colonies of Cape fur seals (*Arctocephalus pusillus pusillus*). Access to all seal colonies inside the TNKP remains restricted. Baker's Bay is the southernmost of the four seal colonies, with Van Reenen Bay, Atlas Bay and Wolf Bay located 35, 101 and 103 km to the north, respectively (Figure 1). It is assumed that seals colonised Baker's Bay in the 1950s, as there were few fur seals there in the 1940s (Shaughnessy, 1982). The fur seal pup population at Baker's Bay was estimated to be between 6000 and 10,000 per year between 2001 and 2003 (Kirkman, 2010). However, there has been a decreasing trend in their numbers since 1991 (Kirkman et al., 2013).

Figure 1. Location of the TKNP in Namibia, with the four mainland breeding colonies of Cape fur seals within the TKNP. The coastal town of Lüderitz is the base place where most tourists originate from.



Three maps showing the location of Namibia inside the African continent, the location of the TKNP inside Namibia, and the locations of the town of Lüderitz and of the seal colonies inside the TKNP.

Fur seal cows and pups are present at the colony all year, with cows making regular foraging trips and returning to the colony to nurse their pups (David & Rand, 1986). Bulls arrive at the colony around mid-October to mate with the cows. The pupping season lasts from November to January. Pups are born at this time of the year, with half of the pups born by early December (David, 1987). Baker's Bay also adjoins the Namibian Islands' Marine Protected Area. To date, this is Namibia's only marine protected area and primarily aims to protect various marine resources, including Cape fur seals (Currie et al., 2009). This seal colony is a hotspot for wildlife, as it represents the main food source for the local carnivores – brown hyenas (*Hyaena brunnea*), and black-backed jackals (*Canis mesomelas*). Baker's Bay is largely undisturbed by humans. Only researchers and a few other restricted area permit holders visit the area occasionally. This area is not open for tourism. However, fur seals are an important tourism drawcard in Namibia. Cape Cross Seal Reserve is the third most important tourist attraction in Namibia, after Etosha National Park and Sossusvlei(Ministry of Environment, Forestry and Tourism, 2022). In 2020, Baker's Bay was earmarked as a future tourism site in the TKNP's Tourism Development Plan(Ministry of Environment, Forestry and Tourism, 2020).

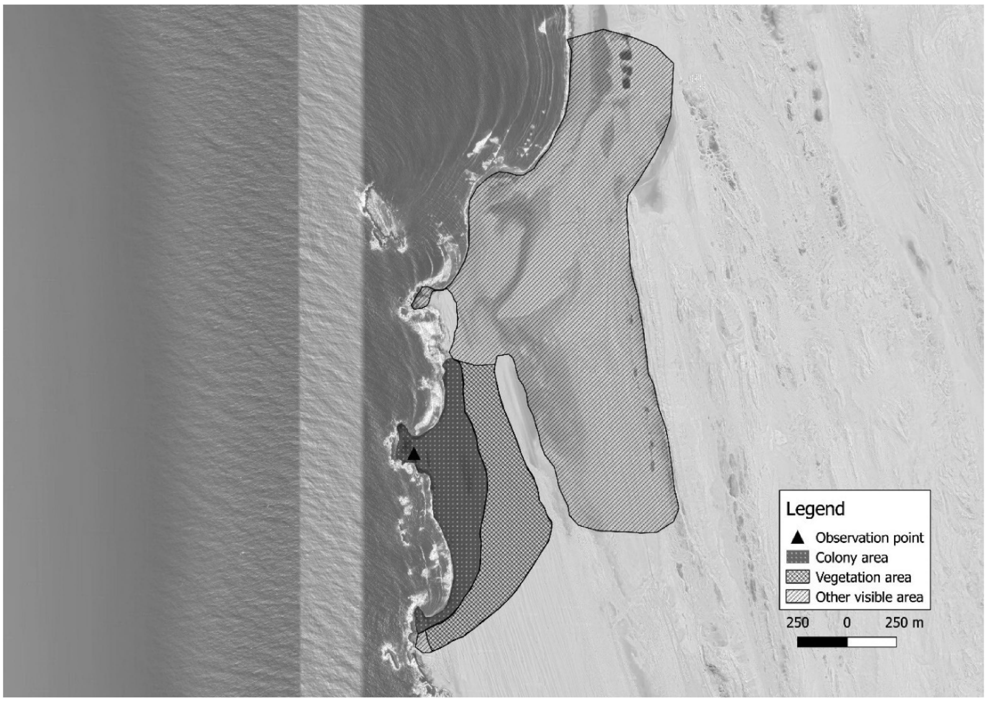
Lindsey et al. (2007) conducted a study on wildlife viewing preferences of visitors to protected areas in South Africa. Their results show that tourists from all over the world are generally interested in seeing large predators, and between 60% and 70% expressed high levels of interest in viewing hyena species. This study also indicates that tourists, especially African visitors, consider the scenery as an important aspect of their visit to a protected area. Tourists in Amboseli National Park in Kenya were similarly interested in carnivores and rare species, but also in seeing interactions between animals (Okello et al., 2008). Baker's Bay meets all these criteria and has high ecotourism potential. Tourism development in the TKNP would economically benefit the coastal towns of Lüderitz and Oranjemund, as tourism can lead to community development and poverty relief, if pro-poor tourism policies are implemented (Njoya & Seetaram, 2018; Odhiambo, 2021). However, Baker's Bay is a fragile ecosystem, and tourism must be sustainably and carefully managed. The carnivores rely on this seal colony for food, and any disturbance of the seals could negatively affect them. In Alaska, brown bears (*Ursus arctos*) rely on the coast and salmon feeding sites at certain times of the year. Fewer bears come to the feeding site and they spend less time fishing when tourists are there (Fortin et al., 2016). Brown bears also show temporal avoidance of areas where tourists are active and become more nocturnal. New Zealand fur seals (*Arctocephalus forsteri*) at breeding colonies exhibit some alert, avoidance or aggressive behaviour when being approached (Boren et al., 2002). In Iceland, harbour seals (*Phoca vitulina*) are more vigilant during the tourism season and show some avoidance by hauling out further away from land (Granquist & Sigurjonsdottir, 2014). In Baker's Bay, fur seals are not habituated to humans, and therefore tourists could negatively impact their behaviour and survival.

This paper gives recommendations for developing a long-term sustainable ecotourism programme that will enhance the tourists' wildlife sighting experience at Baker's Bay. Monthly and daily activity patterns of local carnivores were determined, as ~~was~~ were the external factors influencing them. From this, recommendations can be made about the best sighting times with respect to meteorological conditions, depending on what species and behaviours tourists wish to observe. Moreover, the reactions of brown hyenas to different types of human disturbances were also analysed to gauge stress response and inform future policy on the development of tourism in the area.

Materials and methods

Observations of brown hyenas were conducted at Baker's Bay seal colony for 4–12 days every month from November 2020 to the end of October 2022. Observations were done from sunrise to sunset (from 06h00–07h30 until 18h00–19h00, depending on seasonal day length). No data were recorded before 07h00 from March to August, and no data were recorded after 18h00 between May and July. The observer was positioned on top of a rocky outcrop located in the centre of the colony and overlooking the entire colony (Figure 2).

Figure 2. Map of the seal colony, the vegetation area, and the additional area visible from the observation point.



Aerial view of the study area showing the location of the observation point, the colony area, the vegetation area and the other visible area.

The area for behavioural observations was defined as the beach around the seal colony, delineated by the start of the hummock dunes and vegetation area, approximately 150 m away from the fur seals (Figure 2). Brown hyenas seen from the observation point, but outside the observation area, were also recorded. However, brown hyena presence at the seal colony was only recorded once they entered the observation area and until they left. Brown hyenas were individually identified by the stripe patterns on their forelegs, ear notches, and injuries (e.g. missing a foot) (Spagnuolo et al., 2022). Individual's identities were always confirmed with photographs.

The total number of hyenas in the observation and adjacent areas was recorded for each 30-minute period throughout the day. In addition, the average number of hyenas and jackals for all 30-minutes of observation was calculated for each 3-month period to show seasonal differences in brown hyena and black-backed jackal activity. The year was split into 3-month periods to cover the main stages of seal pup development over the year: November-January, February-April, May-July and August-October. The average number of hyenas and jackals was also calculated per hour to show the most active times of the day throughout the study period.

To determine the seasonal influence of weather on brown hyena activity, several meteorological parameters were recorded every two hours throughout the day using a Kestrel 4000 Pocket Weather Tracker. Minimum and maximum wind speed, wind temperature and air temperature (taken in wind-protected conditions) were recorded. The mean wind speed (the mid point between the maximum and minimum wind speed) was used in the analysis. General weather conditions (sunny, cloudy, rainy, or foggy) were recorded throughout the day every 30 min. When observations started just before sunrise (when there was enough light but the sun was not up yet), the weather was recorded as 'dark'. Data collected during low-visibility weather conditions (e.g. thick fog) were not included in the analyses if the entire colony area could not be seen.

To investigate potential disturbances from humans, brown hyenas' reactions to human disturbances were recorded opportunistically throughout the research period. The sources of potential disturbance were categorised into the self-explanatory categories: parked car, occupied parked car, moving car, person next to car, motionless person, moving person and flying drone. Drones were rarely used by qualified drone pilots under permit. The distance between the disturbance and the hyena was recorded. Hyena responses to the above disturbances were recorded as follows:

- 'No disturbance': The hyena ignores the disturbance or looks at it for a few seconds before resuming its previous behaviour.
- 'Mild disturbance': The hyena is uncomfortable near the disturbance; it changes direction and walks or trots away from it.
- 'Strong disturbance': The hyena runs away from the disturbance.

The data were analysed in R and tested for normality with the Shapiro–Wilk test. The monthly and hourly activities for hyenas and jackals at the seal colony were tested using a Friedman test because of the non-normal distribution of the data and the repeated measures. Differences between variables (3-month periods and time of the day) were tested using post-hoc Wilcoxon tests. *P*-values were Bonferroni corrected to control for multiple testing. The difference in brown hyena numbers between morning and afternoon (before and after 12h00) was determined using a Wilcoxon rank sum test.

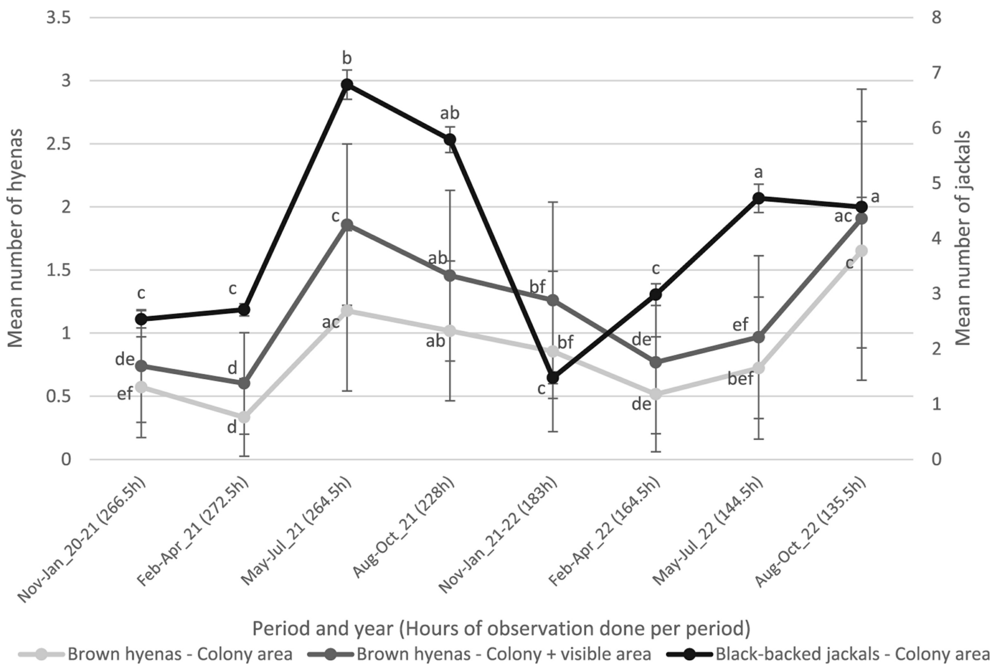
Because the data were not normally distributed, Spearman tests were used to determine if there were correlations between the air and the wind temperatures, and between the numbers of jackals and hyenas inside the colony. The statistical tests were done using R. The effects of the weather on brown hyena and black-backed jackal numbers were analysed with Generalized Linear Models (GLM). Due to the discrete values and the overdispersion of data, a negative binomial regression was used in this analysis. The GLM analysis was done with the package glm.nb, and the prediction graph was done using ggpredict.

As weather conditions were recorded throughout the day, while wind speed and temperature were recorded independently every two hours, two models were used. One model compared the number of hyenas and jackals depending on the weather conditions 'Sunny', 'Cloudy' and 'Dark'. 'Foggy' and 'Rainy' weather conditions were removed from the analysis because they only occasionally happened for short periods, and conditions were then not optimal for observations (bad visibility and observer's need to find shelter away from the observation point in the case of rain). The second model compared the number of brown hyenas and black-backed jackals in relation to air and wind temperatures, and to wind speed. Air and wind temperature were combined in the model, as they are collinear variables. For all the statistical analyses, alpha was set at 0.05.

Results

A single observer did a total of 1, 672 h of observations between November 2020 and October 2022. In addition, between 144.5 and 272.5 h of observations were done for each 3-month period, with data collected every month. Over the study period, 920 brown hyena visits were recorded at the seal colony, of which 773 encounters (84%) involved brown hyenas that could be individually identified based on natural marks. Altogether, 36 individuals were identified, which visited the seal colony at least once. The average number of brown hyenas in the colony per 3-month period significantly differed over time (Friedman rank sum test: Friedmanχ^2 = 168.04, df = 7, p < 0.001). The same results and pattern were observed when including all brown hyena sightings inside and outside the colony area (Friedman rank sum test: Friedmanχ^2 = 194.28, df = 7, p < 0.001; Figure 3).

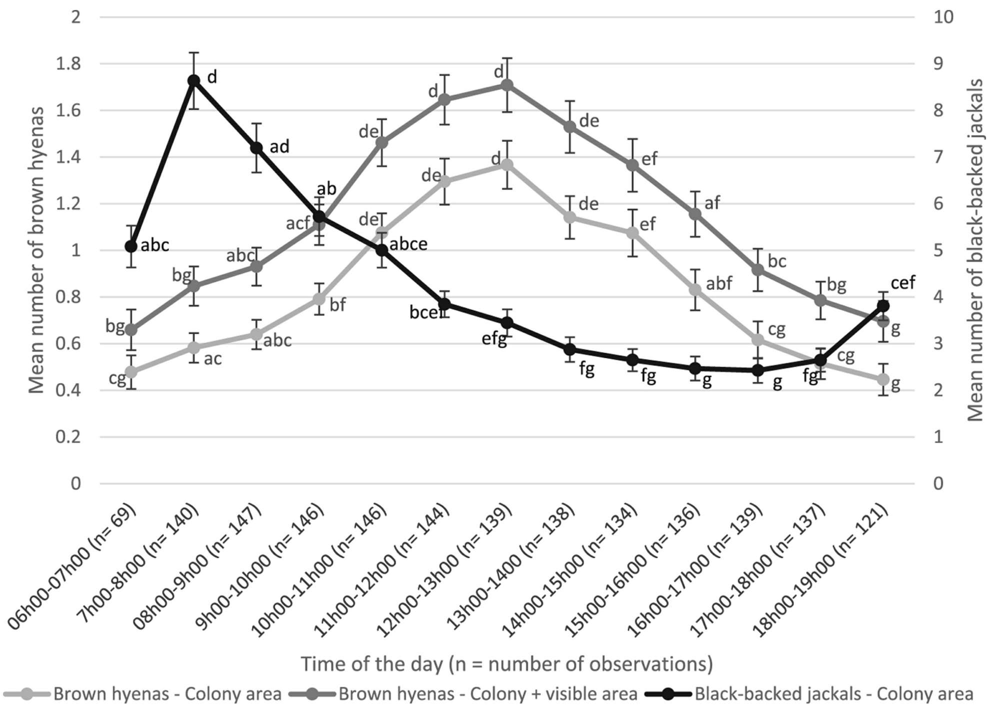
Figure 3. Mean number of brown hyenas and black-backed jackals at the seal colony and in the visible area per 3-month period, calculated as their average number per 30-minute slot for each 3-month period. The error bars represent the standard deviation for each period. The letters correspond to the result of the post-hoc Wilcoxon test (periods with letters in common are not significantly different; one series of letters for the 'Brown hyenas – colony area', one series of letters for the 'Brown hyenas – colony + visible area' and one series of letter for the black-backed jackals).



Graph showing the number of brown hyenas and black-backed jackals at the seal colony for each 3-month periods.

There were also significant differences in the number of brown hyenas at the seal colony throughout the day (Friedman rank sum test: Friedman χ^2 = 58.77, df = 12, p < 0.001). The number of hyenas increased from sunrise, with a peak activity between 12h00 and 13h00, and decreased afterwards until sunset (Figure 4). There was no significant difference in brown hyena numbers in the morning (before 12h00) compared to the afternoon (after 12h00) (Wilcoxon rank sum test: W = 364710, p = 0.38). Similar results were observed with the number of brown hyenas inside the colony area and the visible area (Friedman rank sum test: Friedman χ^2 = 64.84, df = 12, p < 0.001; Figure 4).

Figure 4. Mean number of brown hyenas and black-backed jackals per 1-hour period throughout the day, inside the colony area and inside the visible area. The number of jackals was counted on the hour. The error bars represent the standard deviation for each period. The letters correspond to the result of the post-hoc Wilcoxon test (periods with letters in common are not significantly different; one series of letters for 'Brown hyenas – colony area', one series of letters for 'Brown hyenas – colony + visible area' and one series for the black-backed jackals). No data was recorded before 07:00 from March to August, and no data was recorded after 18:00 between May and July.



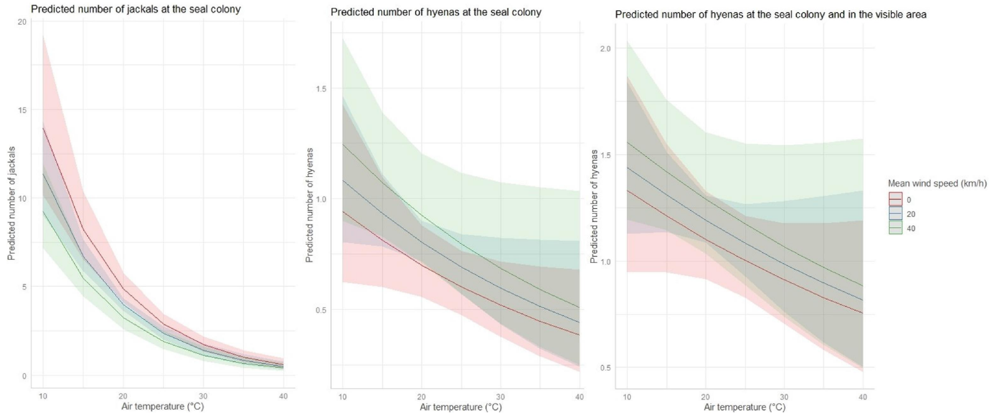
Graph showing the number of brown hyenas and black-backed jackals at the seal colony for each hour between 06:00 and 19:00.

Black-backed jackals were present at the seal colony throughout the year, but their numbers per 3-month period varied significantly (Friedman rank sum test: Friedman χ^2 = 412.91, df = 7, p < 0.001; Figure 3). Black-backed jackals were mostly present at the seal colony in the morning (with a peak of activity at 07h00), and their numbers decreased until the middle of the afternoon before increasing again in the evening (Friedman rank sum test: Friedman χ^2 = 142.09, df = 13, p < 0.001, post-hoc Wilcoxon test; Figure 4). Overall, there was a positive correlation between the number of black-backed jackals and number of brown hyenas present at the seal colony throughout the two years of observations (Spearman's rank correlation: rho = 0.18, p < 0.001).

There was a significant positive correlation between air temperature and wind temperature (Spearman's rank correlation: rho = 0.87, p < 0.001). The results of the GLM analysis show that the number of brown hyenas was negatively influenced by overall temperature, but not by mean wind speed. There were significantly fewer hyenas inside and around the colony in the early morning just before sunrise and during sunny weather, compared to during cloudy weather. However, significantly more jackals were present at the colony just before sunrise and in cloudy weather. Overall temperature and mean wind speed influenced their numbers (Figure 5, Appendix 1).

Figure 5. **[Q12]**Predicted number of brown hyenas and black-backed jackals in relation to air temperature (°C) and mean wind speed (km/h) (model: glm.nb). The solid line represents the mean predicted number of hyenas and jackals,

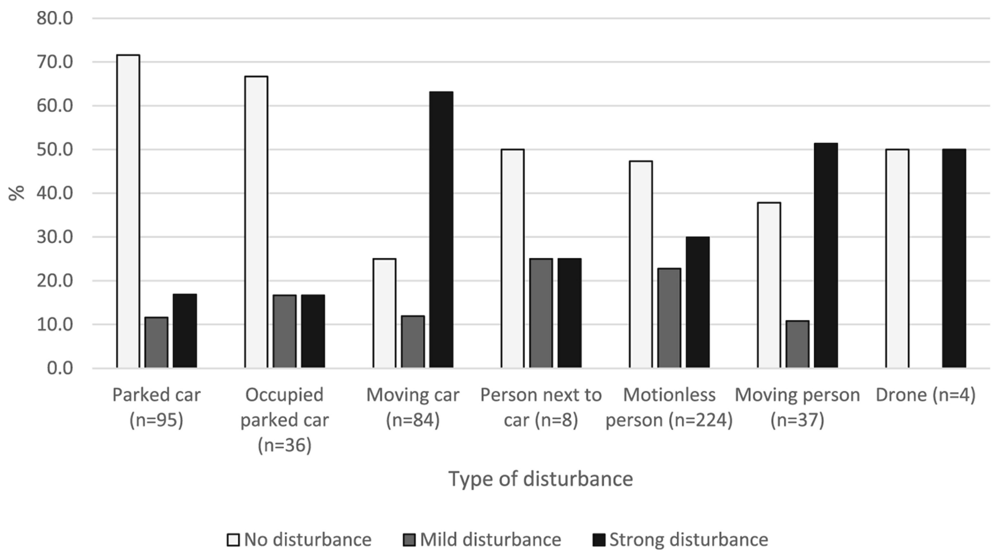
and the shaded area represents the 95% confidence interval.



Three graphs showing the predicted numbers of brown hyenas and black-backed jackals at the seal colony depending on the air temperature and the mean wind speed.

During the study, the reactions of brown hyenas to human disturbances were recorded 489 times. Out of the seven disturbance categories, ‘Person next to car’ and ‘Drone’ had small sample sizes of $n = 8$ and $n = 4$, respectively. The highest proportions of strong responses to human disturbance were seen for ‘Moving car’ and ‘Moving person’ (62.7% and 52.6% ‘Strong disturbance’ respectively). The weakest responses were to ‘Parked car’ and ‘Occupied parked car’ (70.8% and 66.7% ‘No disturbance’, respectively). Mixed reactions were observed for ‘Motionless person’ (22.8% ‘Mild disturbance’ and 29.9% ‘Strong disturbance’). Brown hyenas had mixed responses to ‘Person next to car’ (50% ‘**[Q1]**No disturbance, out of eight occasions) and ‘Drone’ (50% ‘No disturbance’ and 50% ‘Strong disturbance’, out of four occasions) (Figure 6). Brown hyenas also reactive to sounds. On 12 occasions, noise was made by the observer (camera trigger, dropping an object or opening the car window), and brown hyenas always reacted to it. On three of these occasions, hyenas stopped and looked in the direction of the sound, but appeared relaxed. The rest of the time, they showed mild or strong disturbance behaviour in response to unknown sounds.

Figure 6. Level of disturbance (‘No disturbance’, ‘Mild disturbance’ or ‘Strong disturbance’) exhibited by brown hyenas when faced with different types of human disturbances.

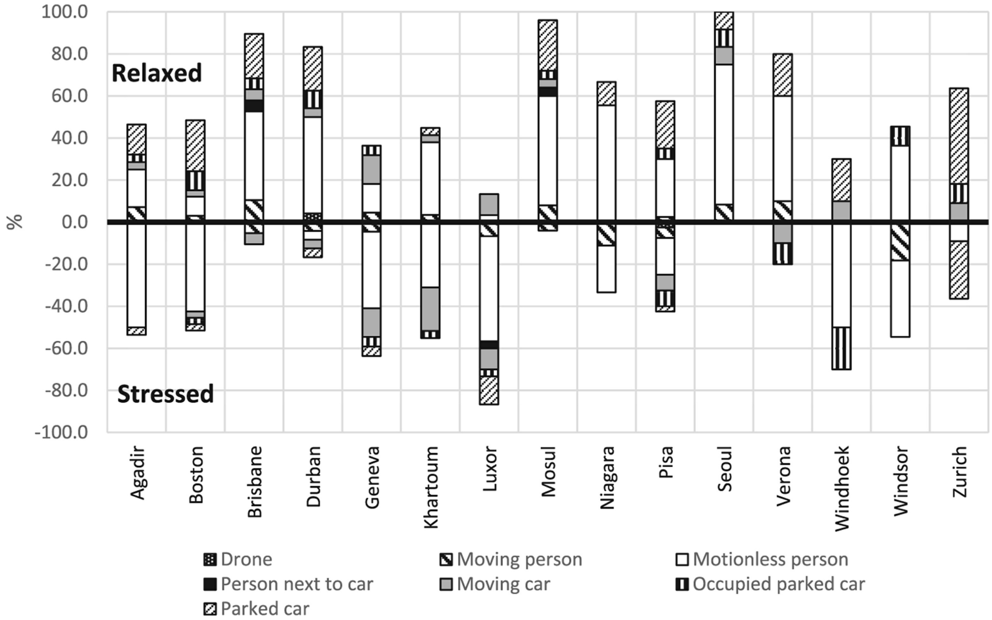


Histogram graph showing the level of disturbance exhibited by brown hyenas for each type of human disturbance.

The distance between a motionless person and the level of disturbance of the hyena was positively correlated (Spearman’s rank correlation: rho = 0.34, $p < 0.001$). However, there was no correlation for the other types of disturbances (Spearman’s rank correlation: $p > 0.1$). Individual brown hyenas reacted differently when facing a human disturbance. Some individuals, like ‘Seoul’, were always relaxed around disturbances, while others such as ‘Luxor’ were stressed on most occasions (Figure 7).

Figure 7. Reaction of different brown hyena individuals to different types of human disturbances (in %). The top

part represents the occasions where the individual showed 'No disturbance', and the bottom part where the individual exhibited 'Mild disturbance' or 'Strong disturbance' behaviours.



Histogram graph showing the level of disturbance exhibited by several brown hyena individuals depending on the type of disturbance.

Discussion

Monthly activity of brown hyenas and black-backed jackals

Baker's Bay is one of the places where brown hyenas, a rare nocturnal and elusive species in other parts of Africa, can easily be observed hunting seal pups in the daylight. The best time for potential visitors to observe brown hyenas and black-backed jackals at Baker's Bay seal colony is between May and October, as this is the period when carnivore numbers were the highest. Because carnivore numbers are higher during this period, visitors will also be more likely to observe intraspecific behaviours (e.g. brown hyenas neck-fighting) and interspecific behaviours (e.g. brown hyenas and black-backed jackals competing for food) (Brown Hyena Research Project uUnpublished data). For visitors more interested in watching predation behaviour on seal pups, the best sighting period would be during the seal pupping season (between November and January) when the pups are still small and easy prey for brown hyenas and black-backed jackals. During this period, carnivore numbers are lower, but they are more likely to hunt seal pups. During the fur seal pupping season and until May, food is abundant for the local carnivores (Skinner et al., 1995). Indeed, newborn fur seal pups are vulnerable and, apart from stillbirth, are susceptible to starvation or heat stress (Wiesel, 2010). Between 16.9% and 35.9% of the pups are estimated to die shortly after birth (De Villiers & Roux, 1992). In Baker's Bay, brown hyenas feed mostly on fur seal pups; fur seal remains were found in 71% of their scats (Kuhn et al., 2008). Brown hyenas kill seal pups throughout the year, but they are more successful when the seal pups are smaller (Brown Hyena Research Projectu unpublished; data). However, brown hyena activity at the seal colony does not seem to be correlated to the fur seal pupping season, as some peak activity occurred during periods of food scarcity between July and November (Skinner et al., 1995). During periods of food abundance, carcasses wash up on the coast and are available outside of seal colonies (Skinner et al., 1995), reducing the need for carnivores to visit the colonies.

Moreover, more adult fur seals are present at the colony during the pupping season, including bulls defending their territories (David & Rand, 1986). Their presence might make it more difficult for brown hyenas and the jackals to approach the beach to hunt and look for carcasses. Both bulls and cows (with and without a pup) were observed lunging at brown hyenas and black-backed jackals that got too close (less than two metres away) (M. Lemerle pers. obs.). Some brown hyena visits at the seal colony may have been missed, especially if a brown hyena's visit was short and/or if the observer was already focused on another brown hyena or another event happening within the seal colony. It is also possible that a returning brown hyena that could not be identified was counted twice in the same 30-minute slot. This is unlikely to have happened often, and it would therefore have had a negligible impact on the results. Depending on the weather and the observer's availability, the length of observations varied each month, and several years of observations would be necessary to confirm any activity patterns.

Daily activity of brown hyenas and black-backed jackals

During the day, the best time to observe brown hyenas at the seal colony is around midday. Hyenas were mostly active between 10h00 and 15h00. However, sunrise and sunset times are best to observe black-backed jackals. In most places, brown hyenas are predominantly nocturnal (Hofer & Mills, 1998; Mills, 1990). At Cape Cross (120 km north of Swakopmund, a town along Namibia's central coast), the only Namibian seal colony with important tourism activities (almost 50,000 visitors in 2011 (Leeney, 2014)), brown hyenas are only described as transients (Jenner et al., 2011). In Cape Cross, jackal activity peaks were recorded at 09h00 and 18h00 (Hiscocks & Perrin, 1988), and jackal group size, territory size and density were correlated to the distance to the food source (Jenner et al., 2011). In such locations with abundant food, black-backed jackal groups are larger and do not show territoriality like in the rest of the Namib Desert (Nel et al., 2013). At the Van Reenen Bay seal colony, jackals were also more present in the morning and evening than in the afternoon, and their lowest numbers were observed in December (Wiesel, 2006). Around midday, most fur seal cows go to sea to cool off, leaving their pups on the beach (David & Rand, 1986), which coincides with the peak activity of brown hyenas at the Baker's Bay seal colony. With no human activity in the area, brown hyenas can take advantage of the absence of the fur seal cows to become diurnal foragers. Just as for brown hyenas, the seal colony is an important food resource for black-backed jackals. However, mesocarnivores have been found to show temporal avoidance of large carnivores (Finnegan et al., 2021), which may be why jackal activity decreases as brown hyena activity increases during the day. Records of brown hyenas killing black-backed jackals at Baker's Bay and Van Reenen Bay seal colonies (M. Lemerle and I. Wiesel pers. obs.) support the notion that black-backed jackals tend to avoid conflict with brown hyenas.

Influence of the weather on brown hyenas and black-backed jackal activity

Potential visitors to Baker's Bay will be more likely to observe brown hyenas and black-backed jackals on cooler and cloudy days. Jackals were also more active on windy days. On the Namibian coast, cold onshore winds from the cold Benguela current can blow during the day and occasionally at night (Atlas of Namibia Team, 2022). Across much of their range, brown hyenas are mostly nocturnal and sensitive to heat. In the Kalahari, they leave fresh carcasses at sunrise due to the rising temperatures, even when they had hardly fed on them (Owens & Owens, 1978). Black-backed jackals, on the other hand, are sensitive to the cold winds elsewhere along Namibia's coast and tend to seek shelter in the thick vegetation outside the seal colony or move inland where it is warmer (Nel et al., 2013). They tend to stay on the coast on days when hot easterly winds blow from the desert towards the coast (Nel et al., 2013). In this study, more jackals were at the seal colony in cooler weather and in weaker winds. Observations were conducted in all types of weather, but the observer often avoided strong winds and sand storms. This could have biased the results. The observation point did not provide any shelter, and such weather made observations very difficult and damaged the research equipment.

Brown hyena reaction to human disturbance

Brown hyenas appeared to be most disturbed by moving vehicles and moving people, and were more relaxed around parked cars and motionless persons. They were sensitive to unknown sounds and smells. On 65 out of 224 occasions, they only reacted to the unknown smells by walking downwind from the motionless persons, without seeing them.

Individuals reacted differently to disturbances, and very old individuals appeared to be the most relaxed (M. Lemerle pers. obs.). Baker's Bay is located within a restricted area, 120 km from the closest town. Therefore, brown hyenas are not used to human presence. However, human disturbance has been shown to affect the behaviour and habitat use of carnivores by reducing their occupancy (Baker & Leberg, 2018). Disturbances also impact carnivores by interfering with their activity patterns, such as reducing the diurnal activities of large carnivores and alter temporal niche partitioning between species (Frey et al., 2020; Ngoprasert et al., 2007). For example, coastal brown bears show temporal avoidance and become nocturnal visitors to the salmon feeding sites because of tourism (Fortin et al., 2016). Animals are also sensitive to drones and other flying objects; they show an increased heart rate and modified behaviour when exposed to their noises (Ditmer et al., 2015; Weisenberger et al., 1996). Clans of brown hyenas in Baker's Bay show a temporal partitioning at the seal colony, with some groups visiting the food source at night and others during the day (Brown Hyena Research Project unpub-ished data). Disturbance could cause a shift in the brown hyena activity patterns and expose them to more difficulties to use the seal colony as a food resource. Therefore, it is crucial that the population does not get affected by tourism during the day.

This study provides valuable insights into the behaviour of carnivores in a unique ecological context. However, several limitations should be considered. The study relied on a single observer and observation point, as well as varying lenghts of daily and monthly observations due to harsh weather conditions, which may have introduced bias into the data. Observations should be continued to monitor the behavioural response of fur seals and local carnivores to tourism developments in the area. Nocturnal observations of brown hyenas at the seal colony (e.g. in full moon conditions or with nocturnal vision equipment) would elucidate diel activity of carnivores at this central food resource.

Conclusion

Baker's Bay has high scenic value, with mountains, rocky shores, and sand dunes by the ocean. With this scenery and its diurnal and dense population of brown hyenas, Baker's Bay has a high potential for tourism. Brown hyenas are rare and elusive in other parts of Africa and people are willing to travel long distances to observe such rare species and their behaviours (Booth et al., 2011). Few studies investigate which behaviours tourists are the most interested in observing in the wild. In zoos, visitors spend more time watching animals exhibiting active behaviours such as running or manipulating objects (Luebke et al., 2016). When animals are active, visitors feel more positive emotions and connection with them (Myers et al., 2004), which makes visitors more aware and engaged in conservation efforts (Luebke et al., 2016). In Baker's Bay, brown hyenas are often seen feeding on carcasses, interacting with Cape fur seals and predating pups, competing with black-backed jackals and interacting with other brown hyenas (social behaviours such as fighting, greeting or mating). Tourists are the most satisfied when they are able to easily see rare wildlife, when they can be in close proximity to the animals, and when they have memorable sightings such as kills (Curtin, 2010; Prideaux et al., 2006). Therefore, knowing the local carnivores' habits and activity patterns helps to enhance the visitors' experience.

Based on this study, the best time of year to observe brown hyenas at the seal colony is between May and October. Hyena activity is usually at its peak between 10h00 and 15h00. As brown hyenas are more active on cooler days, chances of seeing them are higher during cold and cloudy weather. Jackal numbers were also the highest between May and October, and they were more active around sunrise and sunset. However, jackals remain easy to observe throughout the year and at any time of the day because their numbers are high, and they are curious animals that do not hesitate to approach vehicles and people. Nonetheless, tourism at Baker's Bay should be managed, as tourism can negatively affect wildlife, especially in an area where carnivores rely on a single food source. Tourism could impact the social and feeding dynamics of local carnivores and be detrimental to their survival. For example, brown hyena activity is low at the Cape Cross seal colony (Jenner et al., 2011) due to high tourism activities.

The presence of tourists could also impact the Cape fur seals. The seals could avoid their usual haul-out spots and haul out further from their colony to avoid humans (Granquist & Sigurjonsdottir, 2014). Fur seals react when tourists approach them closer than 50 m (Boren et al., 2002; Kirkwood et al., 2003), and they are also sensitive to smells (Kirkwood et al., 2003). It is importan t~~ce~~ that tourists do not cause any disturbance to the seal population in Baker's Bay. Impacts on the breeding colony would directly impact the local populations of brown hyenas and black-backed jackals.

Because brown hyenas are highly susceptible to moving vehicles, we recommend only allowing guided tours, with a maximum of two vehicles travelling to the area daily. As hyenas are more relaxed around motionless persons, tourists should stand or sit and observe the wildlife in designated viewing areas located at least 50 m~~etres~~ away from the seals. An elevated hide could be built and used as a fixed viewpoint for tourists. A hide would prevent the seals and the carnivores from seeing moving persons, allowing the tourists to have a better view of the seal colony from a vantage point. With a fixed viewing point and defined access routes, brown hyena corridors to the food source can also be left undisturbed. This is important as some individuals travel over 50 km from their territory to forage at the seal colony (Brown Hyena Research Project unpubl ished~~:~~ data). People should also keep noise to a minimum, and the use of drones should be forbidden. With such guidelines and proper monitoring of the activity and behaviour of brown hyenas, Baker's Bay could become the top destination for observing this elusive species and its hunting behaviour on seal pups.

Additionally, the site could offer educational opportunities for visitors to learn about the important role of these carnivores in the ecosystem and the need to protect their habitat. To ensure the long-term sustainability of ecotourism in Baker's Bay, all tour guides must strictly follow a list of best practices guidelines such as not driving off-road, staying in delimited tourism areas, and not approaching wildlife. Fur seal and carnivore behaviour must be monitored regularly to ensure that tourism does not impact them and threaten their survival.

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Disclosure statement

No potential conflict of interest was reported by the author(s[Q2]).

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Appendix 1. Results of the two Generalized Linear Models (negative binomial distribution).

	Estimate			Standard Error			*P*-value		
	Number of brown hyenas inside the colony	Number of brown hyenas inside the colony and the visible area	Number of jackals inside the colony	Number of brown hyenas inside the colony	Number of brown hyenas inside the colony and the visible area	Number of jackals inside the colony	Number of brown hyenas inside the colony	Number of brown hyenas inside the colony and the visible area	Number of jackals inside the colony
Cloudy	0.094	−0.127	0.190	0.069	0.058	0.059	0.17	0.03	0.001
Dark (before sunrise)	−0.563	−0.709	0.910	0.156	0.142	0.117	<.001	<.001	<.001
Wind speed	0.006	0.003	−0.010	0.005	0.005	0.004	0.31	0.56	0.01
Wind temperature	0.071	0.046	0.032	0.089	0.067	0.052	0.42	0.40	0.53
Air temperature	0.204	0.134	−0.289	0.067	0.049	0.037	0.002	0.006	<.001

Wind temperature*Air temperature	−0.009	−0.006	0.004	0.004	0.003	0.002	0.02	0.03	0.02

The first model (top) compares the number of brown hyenas and black-backed jackals depending on the weather conditions (between 'Sunny', 'Cloudy' and 'Dark'), 'Sunny' serves at the reference categorical value. The second model (bottom) [1] compares the number of hyenas and jackals depending on the air and wind temperatures, and on the wind speed.

Attachment Files

1 combine_images (2).jpg *: Combination of the three graphs with clearer text.*