Mammal diversity survey
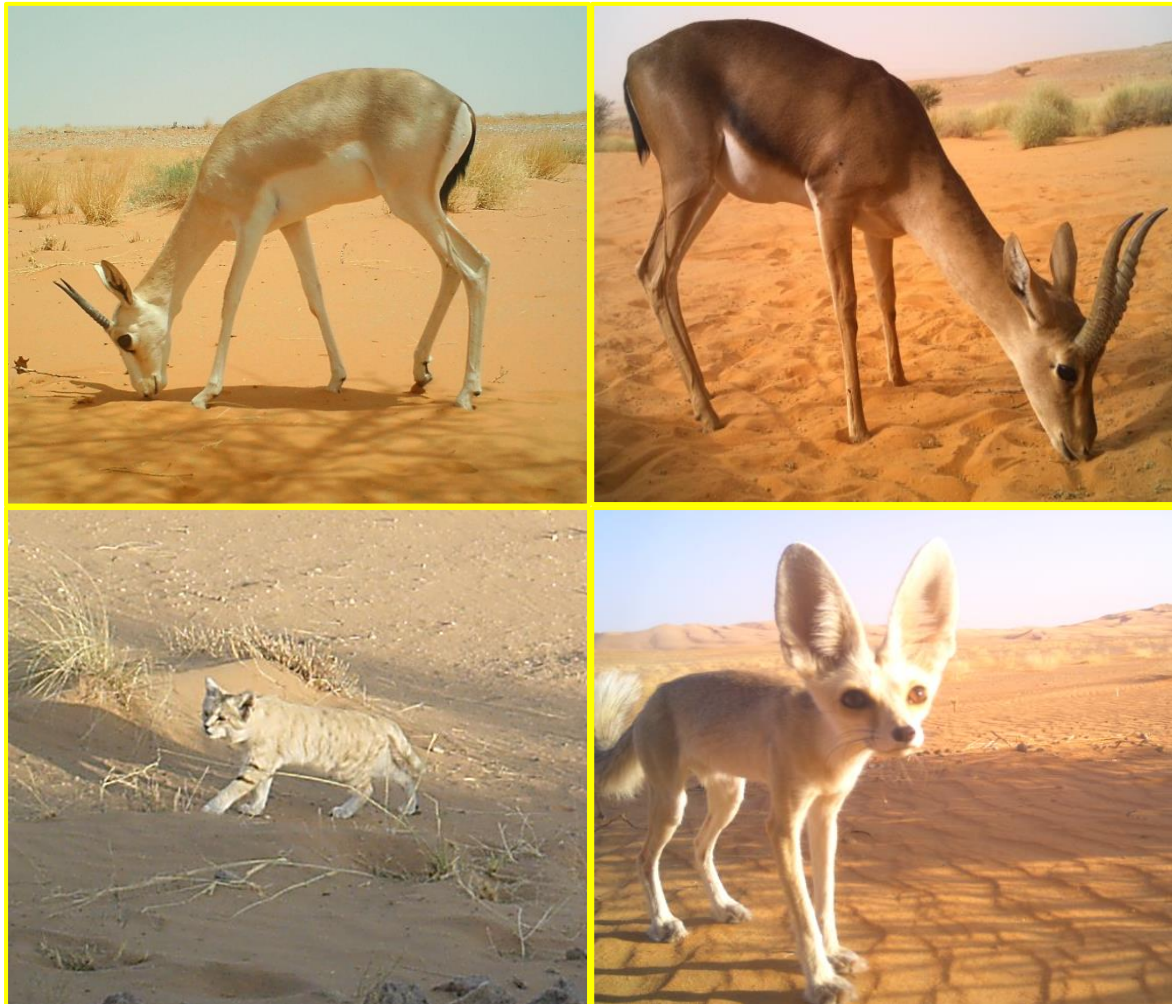
Uruq Bani Ma'arid Protected Area

Saudi Arabia

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Cover page images: Clockwise from top left: Arabian sand gazelle *Gazella subguttorosa marica,* Arabian gazelle *Gazella arabica*, Ruppell's fox *Vulpes rueppellii*, Sand cat *Felis margarita*

Contents

Summary

Uruq Bani Ma'arid is an important area for global biodiversity, in particular for the conservation of desert ungulate species. It is an unfenced, multi-use protected area where livestock grazing is permitted in a large peripheral zone around a central core reserve. This camera trap study is the largest survey of its kind in a desert environment covering the entire core of the Uruq Bani Ma'arid reserve (2,400 km^2) across the hot and cool season (12 months) and provides the first baseline data for the full array of medium-to-large sized mammals (>0.5kg) in the Uruq Bani Ma'arid protected area.

The study has shown that Uruq Bani Ma'arid continues to support a functioning community of desert adapted predators and herbivores. The persistence of re-introduced Arabian oryx within this unfenced protected area, and evidence of their continued breeding, is of global importance. This is the only unfenced population in Saudi Arabia (and probably anywhere) and has been at risk from poaching.

The study has confirmed that re-introduced Arabian sand gazelles (240 founders released 1995-1998) are well established 20 years after the original releases, using the full range of available habitats and widely distributed across the protected area. The camera trapping results show the sand gazelle population to disperse more into the interior in the cool season when the dune habitats are extensively used, withdrawing to the west of the protected area in the hot season. Similarly, the Arabian gazelle (90 founders released in 1996-97) is also now widely established in its preferred stony valleys and plateau habitat on the western side of the reserve.

The red fox is the most abundant carnivore found along the limestone escarpment habitat and adjacent interior areas at the western margin. The Rüppell's fox displayed an uneven distribution with higher detection rates deeper into the main dune system. The study also revealed a much more significant population of sand cat than previously understood, which before this camera trap survey was based on a single direct observation documented in the previous 10 years. However, the cameras also documented the presence of domestic cats (recorded only six km away from a sand cat detection) which highlights a potential risk from toxoplasma infection carried by the domestic cats. The study has confirmed a range extension of >170 km to the east of current IUCN distribution data (IUCN Red list 2018) for the wild cat. The species was only detected at one site on the limestone escarpment.

Cape hare was the most frequently recorded species by camera trapping in the protected area. Although the presence of hares in the area is well known, the documentation of their presence by this study represents a significant range extension 250 km to the east relative to previously published data.

The study also documents the presence of ratel at very low frequency within the reserve, again associated with the important escarpment habitats at the western margin.

Both caracal and the Arabian wolf have been historically recorded in Uruq Bani Ma'arid protected area (Mallon & Budd 2011). Neither was detected during the survey despite a large sampling effort covering the entire core area across the two seasons. As both species prefer the escarpment habitat which was extensively surveyed during this study, it seems likely that they have been extirpated from the protected area.

Introduction

The deserts of Saudi Arabia, like all desert ecosystems, have received much less scientific research than forest systems (Durant *et al*. 2012). There remain significant gaps in our understanding of the status of biodiversity in these systems due to historically limited systematic monitoring (Davies *et al*. 2012). This is despite desert systems being ranked in the top three richest biomes for terrestrial vertebrates (desert ecosystems contain 25% of terrestrial vertebrate species globally, Millennium Ecosystem Assessment 2005).

In Uruq Bani Ma'arid, an unfenced protected area in central Saudi Arabia, the desert ecosystem contains a number of species which are highly adapted to the extreme conditions including three endangered reintroduced species: the Arabian sand gazelle *Gazella subgutturosa marica*, the Arabian gazelle *Gazella arabica* and the Arabian Oryx *Oryx leucoryx* which was previously extinct in the wild. There is also a specialised carnivore community within the protected area including the sand cat *Felis margarita* and Rüppell's fox *Vulpes ruppellii*.

This report summarises results from an extensive camera trap survey covering the 2,400 km core area of of Uruq Bani Ma'arid during the hot and cold season. Camera trapping is a particularly suitable technique for longer term monitoring of medium-to-large sized mammals that are nocturnal, cryptic, occur in small groups, in low abundance and are often wide-ranging (Silveira *et al*. 2003, Kelly 2008, Roberts 2011, Amin *et al*. 2015); these are all common traits of desert species.

The main objective of our study was to establish baseline data on the medium-to-large mammal communities of Uruq Bani Ma'arid and to assess the status of the three reintroduced ungulates in the protected area. The small mammal community (primarily Rodentia and Chiroptera) is not covered systematically by this study.

1. Methods

1.1 Study Area

The Uruq Bani Ma'arid (19°10'N, 45°30'E) protected area is located on the western edge of Ar-Rub' al-Khali (also known as the 'Empty Quarter'), which is the largest and most arid sand desert in the world (Islam *et al*. 2011b) covering an area of approximately 300,000 km^2 (Child & Grainger 1990). The unfenced protected area was established in 1994 and includes 2,400 km^2 core area as a no grazing zone in the heart of the reserve.

Uruq Bani Ma'arid has the highest levels of biodiversity of any area within the Empty Quarter and is of great importance for the reintroduced Arabian oryx, Arabian sand gazelle and Arabian gazelle. It is also regarded as an important plant area (IPA) as it has the highest known plant species diversity (including endemic Arabian taxa) in the Empty Quarter (Hall *et al*. 2011). The high levels of

biodiversity of both fauna and flora are facilitated by a varied habitat which includes vegetated wadis, sandy plateaus, gravel plains and inter-dune corridors (Islam *et al*. 2011a).

Uruq Bani Ma'arid is located at an altitude of 720-1200 meters above sea level and lies on the plateau created by the Al-Arid escarpment which marks the western edge of the protected area (Islam *et al*. 2011b). The plateau and escarpment area is a narrow region approximately 100 km long and 10-15 km wide, and is marked by a series of shallow wadis incised into the coral limestones which drain eastward into the system of 70-100 m high and 1-2 km wide parallel sand dune formations (the 'ergs'). The dunes are separated by limestone gravel corridors (the 'shiqqats'), initially c. 1-1.5 km wide, progressively narrowing towards the east and eventually disappearing under the sand 40-60 km into the interior of the protected area. Beyond 50 km, sand cover becomes 100% and the dunes become less high and progressively less systematically structured.

The plateau and escarpment area supports the highest plant diversity within the protected area containing around 120 species, including perennial plants and four different species of small trees. In the gravel valleys between the dunes, trees become very rare beyond 30 km from the escarpment and are totally absent further than 50 km into the interior. Plant diversity and abundance diminishes eastward, with only 20-30 specialist species able to tolerate the harsh conditions of the interior dunes.

There are two main seasons: hot season or summer (May-September) and cold season or winter (October-April). The climate within the area is typical of desert systems: arid and hot in the day with hot nights in summer and occurrence of cold nights and cool windy days in winter. From 1985-2009 annual temperatures were on average 28.4˚C with monthly rainfall averaging 3.2 mm. There are no permanent water sources within the protected area. However, large rainfall events create a limited number of temporary pools, and more importantly, allow the sand to retain moisture, supporting vegetation for up to five years (Islam *et al*. 2011a).
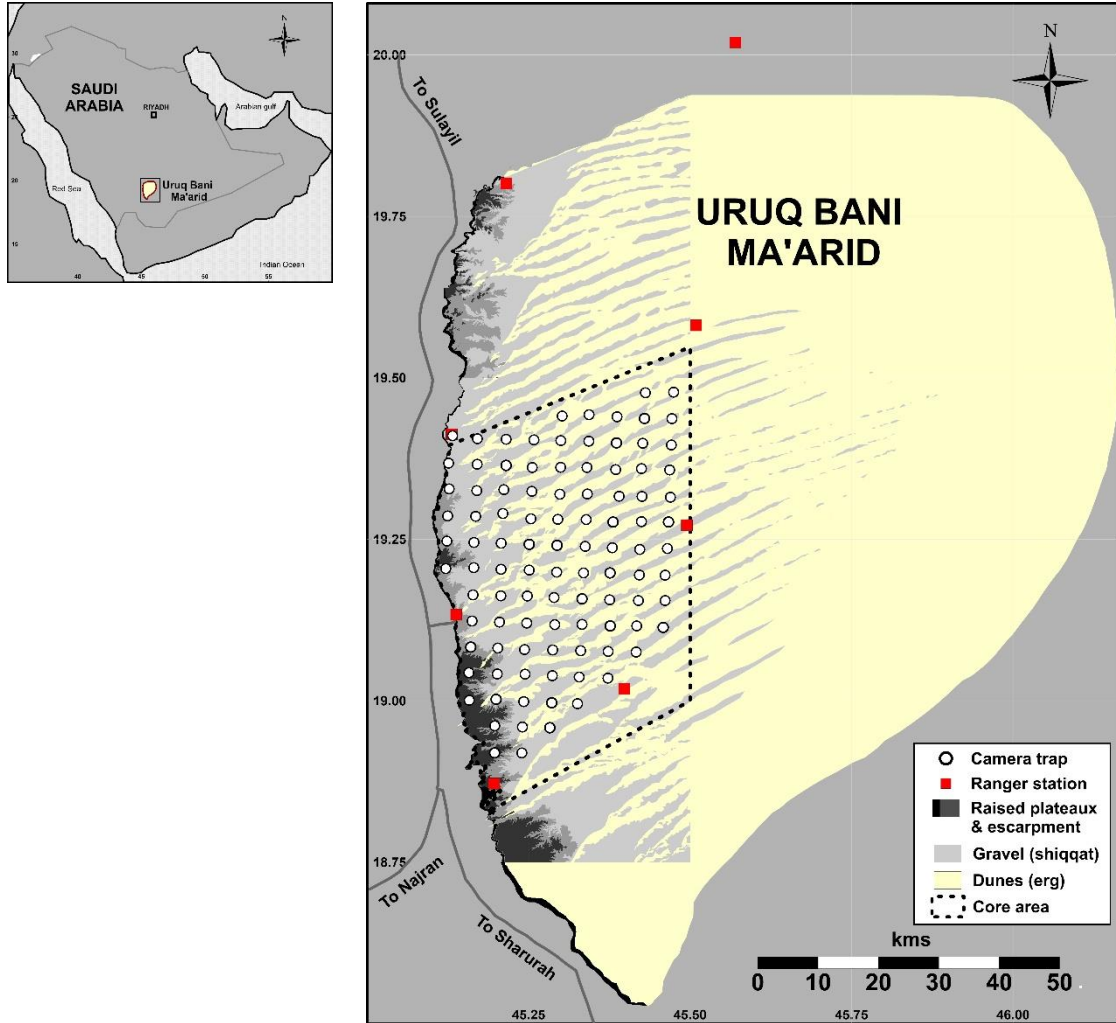
Figure 1: Location of the study area in south central Saudi Arabia (left); showing location of camera trap grid in the core of the protected area (right).

2.2 Field sampling methods

We setup a grid of 100 camera traps, centred on N 19.25 E 45.25 (decimal degrees), with camera spacing of five km between 23rd May 2015 and 30th April 2016, sampling both the hot and cold seasons. Location coordinates for each camera station are available in Annex II. Cameras were placed at a height of 35-40 cm on drainage lines, pathways and other locations likely to be used by mammals to maximize detection probability.

We used Cuddeback C123 (Cuddeback, Green Bay, Wisconsin USA) digital cameras programmed to take three pictures per trigger with no delay. Detection range was at least 15 m with 0.25 second delay between triggers and three consecutive images were taken per trigger. All other default settings were used. The cameras use an infrared flash at night (or at low light levels in the day time), intended to minimise risk of startling animals. To record the duration of camera operation and to also ensure images were easily associated with each camera location, the field teams triggered

photos showing location, time, and date data written on a white board at both completion of installation and on initiating recovery of each camera.

2.3 Data analysis

We used Exiv2 software (Huggel 2012) to extract EXIF information from each photograph (image name, date and time). Species of animals in the photographs were identified (when possible). These data were compiled in an Excel spreadsheet (Microsoft Office Professional Plus 2010) and analysed with software developed specifically for camera trap data analysis (Amin & Wacher 2017).

We calculated species sample-based rarefaction curves and estimated the medium-to-large (>0.5 kg) terrestrial mammal species richness using the non-parametric incidence-based estimator Jackknife with order one (Bunge & Fitzpatrick 1993). Smaller mammals induce sampling error through reduced likelihood of detection by the camera trap thermal sensor and accurate identification of small mammals to species level is often not possible from camera traps set up for medium-to-large mammals (Tobler *et al*. 2008).

We calculated the trap rate for each species as the total number of independent photographic "events" divided by the number of days cameras were operational x 100. We defined an "event" as any sequence of images for a given species occurring after an interval of =>60 min from the previous three-image sequence of that species (Amin *et al*. 2014).

We used the species trap rate at each camera site to generate simple seasonal distribution maps. We constructed seasonal circadian (24 hour) species activity patterns by tallying the number of events initiated in each hour across survey time period.

We modelled the effect of 'distance from escarpment' and 'habitat type' on species occurrence (MacKenzie *et al*. 2006). Habitat type (shiqqat and plateau, sand dune) at each sample point was recorded during camera setup. We calculated the camera trap distance to escarpment in meters using the NNJoin plugin in QGIS software. We constructed a detection / non-detection history, using a five-day period as the sampling occasion, for each species and camera. We treated detection probability as a constant and evaluated all covariate combinations: $\psi(.),p(.)$; ψ (habitat type),$p(.)$; ψ(distance to escarpment),$p(.)$; ψ(habitat type, distance to escarpment),$p(.)$. We ranked models by Akaike's information criteria (AIC).

3. Results

3.1 Survey effort

We recovered 91 cameras. One camera failed in the hot season and four cameras failed in the cold season. Total camera trap days was 27,520; 10,230 trap days in the hot season and 17,290 in the cold season.

3.2 Mammal diversity

A total of ten wild terrestrial mammal species were photographed and identified, of which nine were medium-to-large mammals (>=0.5 kg, Table 1). Two domestic species were also recorded; domestic camels *Camelus dromedarius* and one positive identification of a domestic cat *Felis catus*. The lesser Egyptian jerboa *Jaculus jaculus* was the only small mammal (<0.5 kg) distinctive enough to be reliably identified from infrared camera trap images. All other rodents were classified at a family level (*Muridae*). It was often difficult to identify foxes to species level, especially in infrared images and these images were classified only at genus level (*Vulpes*).

The caracal *Caracal caracal*, Arabian wolf *Canis lupus arabs* and desert hedgehog *Paraechinus aethiopicus* were expected in the study area according to available distribution maps and literature but not detected by the camera trap survey. Also, no images of people were recorded.

Table 1. Mammal species recorded by camera trapping in Uruq Bani Ma'arid protected area, Saudi Arabia (2015-2016).

Family	Species	Common name	Hot season	Cold season	Average adult weight (kg)
Bovidae-Antilopinae	*Gazella arabica*	Arabian gazelle	Y	Y	15.0
Bovidae-Antilopinae	*Gazella subgutturosa marica*	Arabian sand gazelle	Y	Y	18.0
Bovidae-Antilopinae	*Oryx leucoryx*	Arabian oryx	Y	Y	100.0
Canidae	*Vulpes rueppellii*	Rüppell's fox	Y	Y	1.5
Canidae	*Vulpes vulpes arabica*	Arabian red fox	Y	Y	4.0
Felidae	*Felis maragarita*	Sand cat	Y	Y	2.0
Felidae	*Felis silvestris*	Wild cat	Y	N	2.0
Leporidae	*Lepus capensis*	Cape hare	Y	Y	2.0
Mustelidae	*Mellivora capensis*	Honey Badger	Y	N	10.0
Rodentia	*Jaculus jaculus*	Lesser Egyptian jerboa	Y	Y	0.1
Camelidae	*Camelus dromedarius*	Domestic camel	Y	Y	2.0
Felidae	*Felis catus*	Domestic cat	Y	N	350.0

The rarefied species accumulation curve (Figure 2) is shown alongside the raw data species accumulation rate for medium-to-large (>=0.5 kg) terrestrial mammal species, the main target group for camera traps placed at ground level (Tobler *et al*. 2008). The jackknife species richness estimate was ten species.
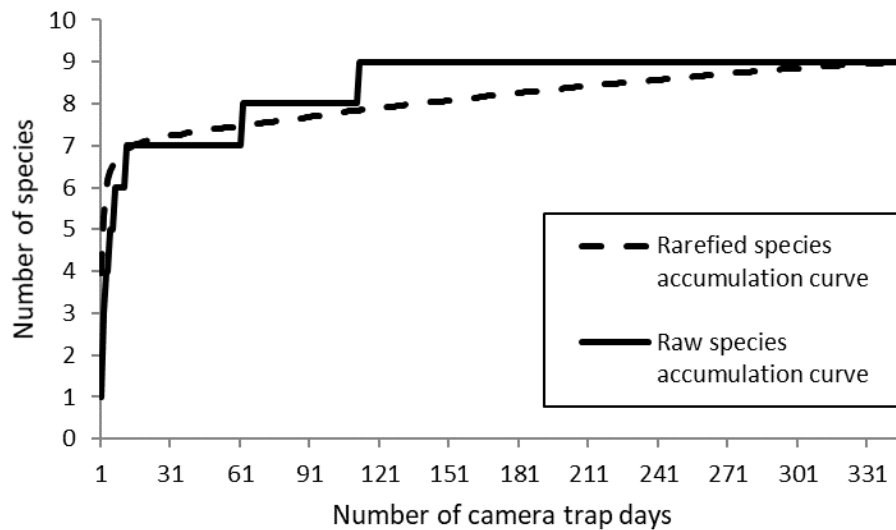
Figure 2. Raw and rarefied species accumulation curves for medium-to-large terrestrial wild mammals in the core area of Uruq Bani Ma'arid protected area, Saudi Arabia.

### 3.3 Species distribution and activity patterns

This section summarises the camera trap survey results for each recorded species. The results are grouped by ungulates, carnivores, lagomorphs, mustelids and rodents. Accounts for the two domestic species encountered are also provided. The number of images and events, proportion of sites detected, trap rate, modelled occurrence plots for 'distance from escarpment' and 'habitat type', 24-hour activity plot, daily trap rate plot, and distribution map are provided for each species and season. All species images are from the survey.

Species occurrence plots for a season are shown where there was sufficient data to perform occupancy modelling.

Distribution maps for each species and season were generated using the species trap rate at each camera site. On the map, the camera trap rates are depicted as circular symbols at each camera site. The symbol size was weighted linearly.

1) ARABIAN GAZELLE (*Gazella arabica*)

Global conservation status: Data Deficient (IUCN SSC Antelope Specialist Group 2017)
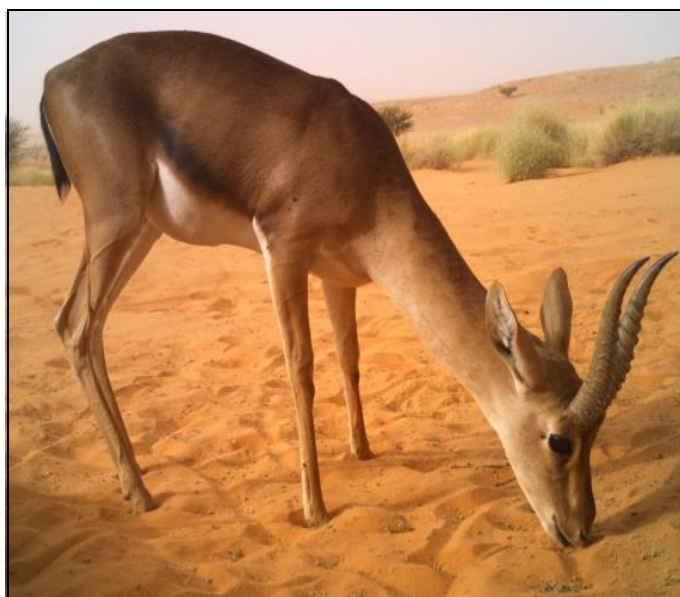
- The Arabian gazelles photographed at Uruq Bani Ma'arid study all descend from 90 animals re-introduced to the protected area by KKWRC 19 years previously in 1996 and 1997.
- The predominantly western distribution of detections indicates habitat preference for stony valleys and plateau which has been retained after generations of captive breeding, though with some indication of wider dispersal in the cooler season.
- A crepuscular activity pattern is displayed with more day time events in the cool months and more nocturnal activity in hot months.
- Camera trap evidence confirms that this re-introduced population is well established in appropriate habitat after 20 years.
- Note that habitat preference affects capture rate in this cross-habitat sampling array.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	18 (96)	162	5367	0.19	1.58
Cold season (01/10/15 – 30/04/16)	27 (95)	241	5460	0.28	1.39

24 hour activity pattern

Hot season

Cold season

Distribution

Hot season

Cold season

Core area use by distance from escarpment

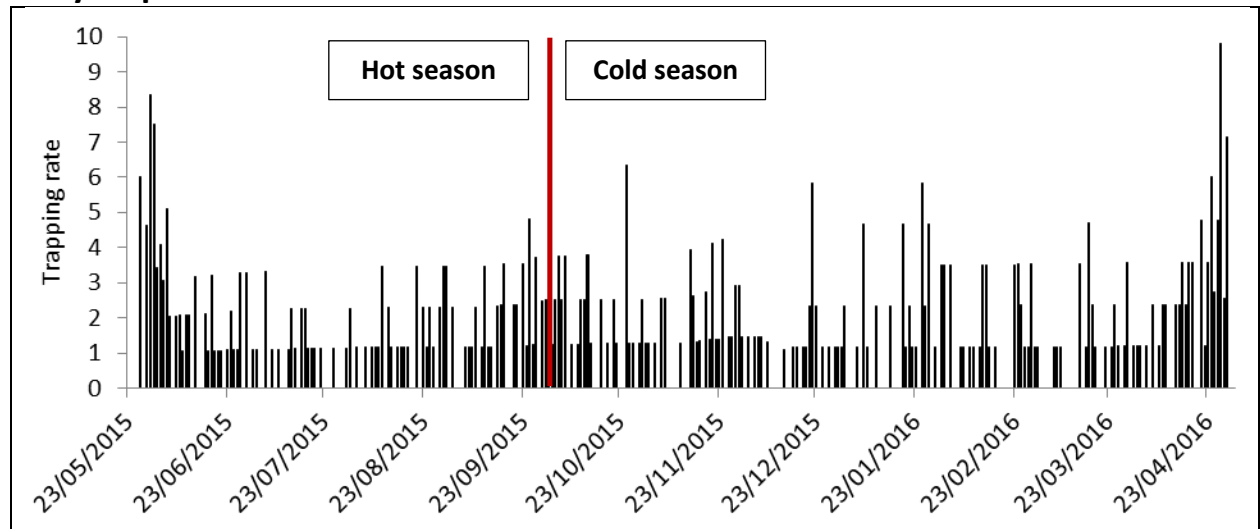## Habitat use

Daily trap rate

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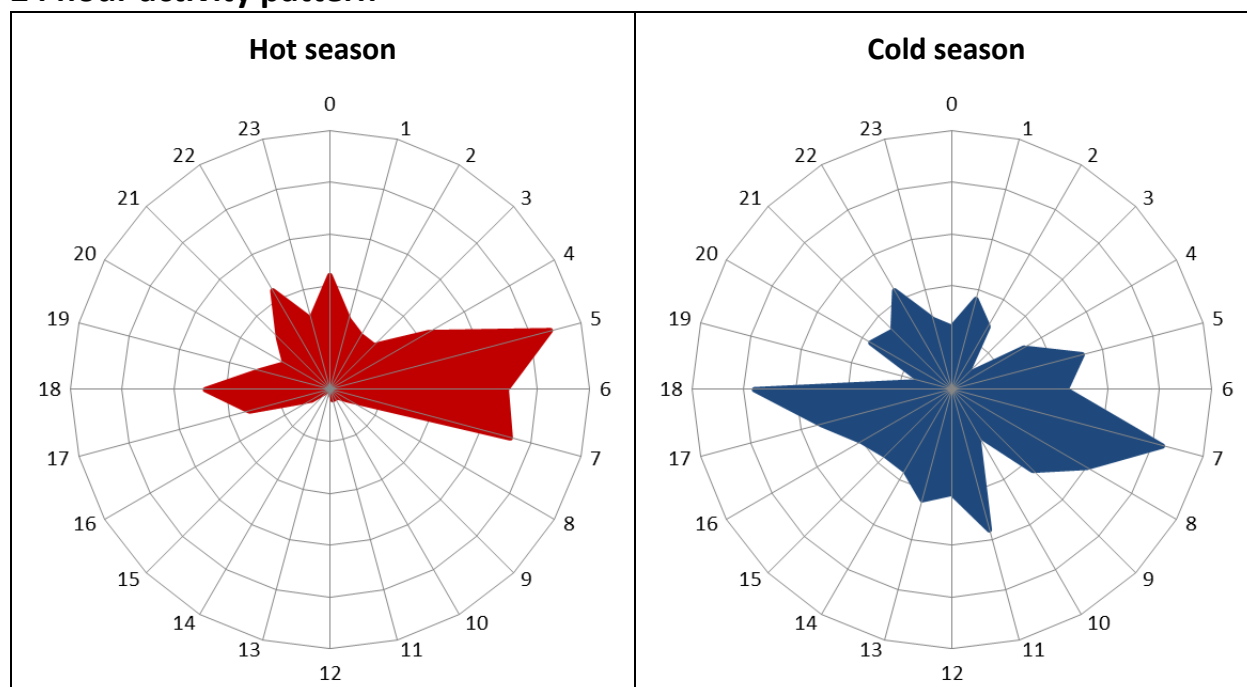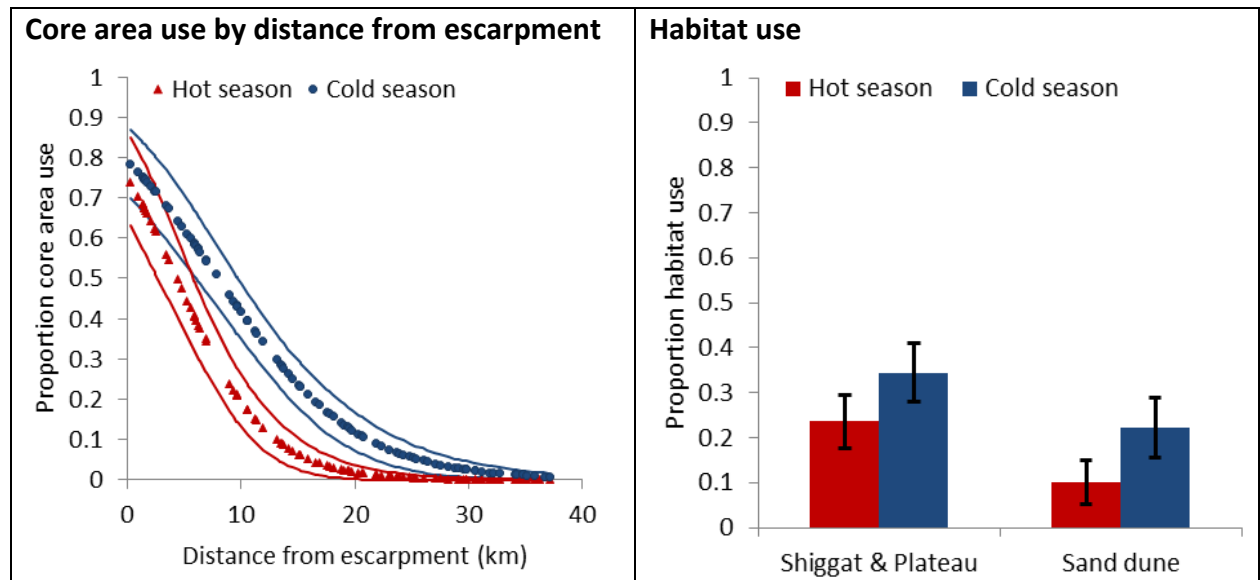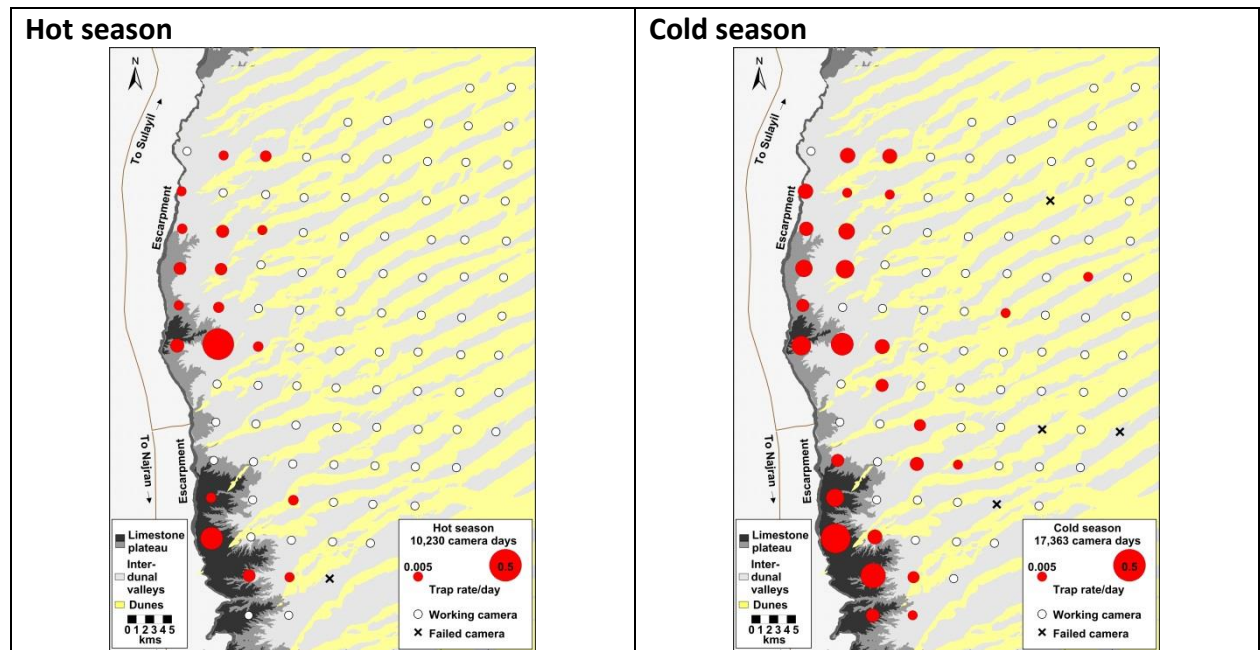
2) ARABIAN SAND GAZELLE (*Gazella subgutturosa marica*)

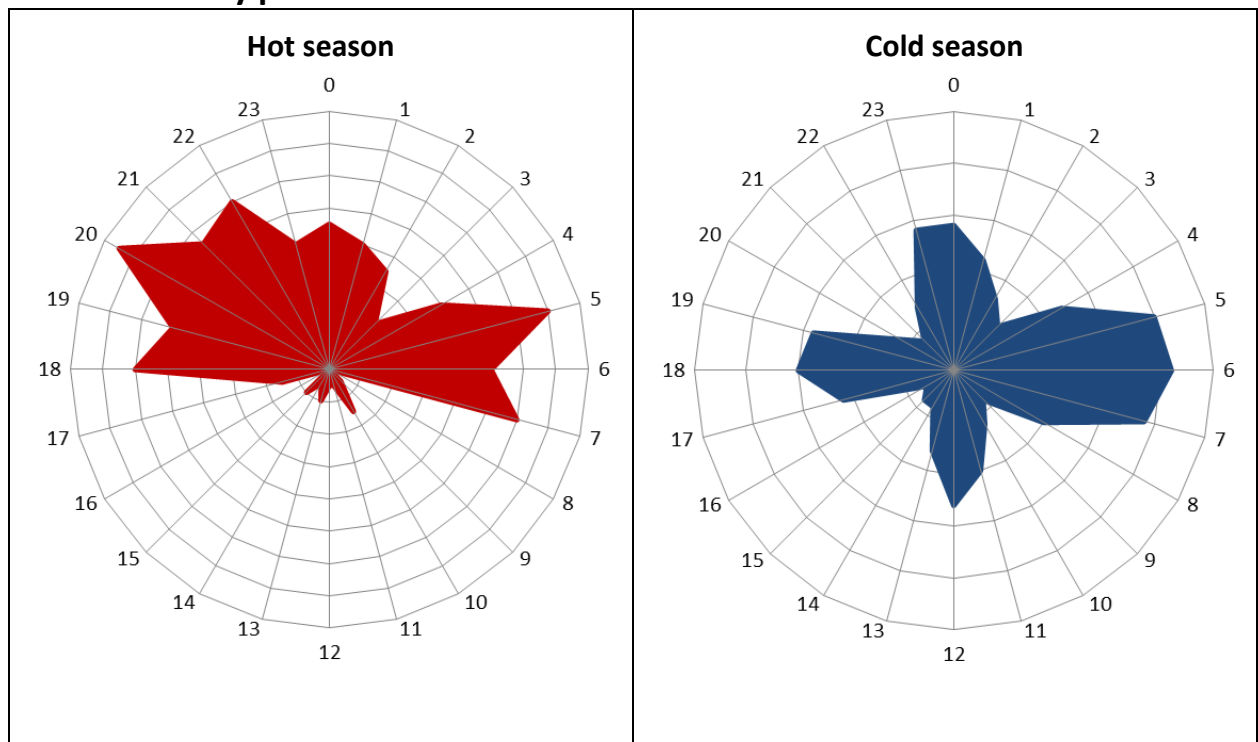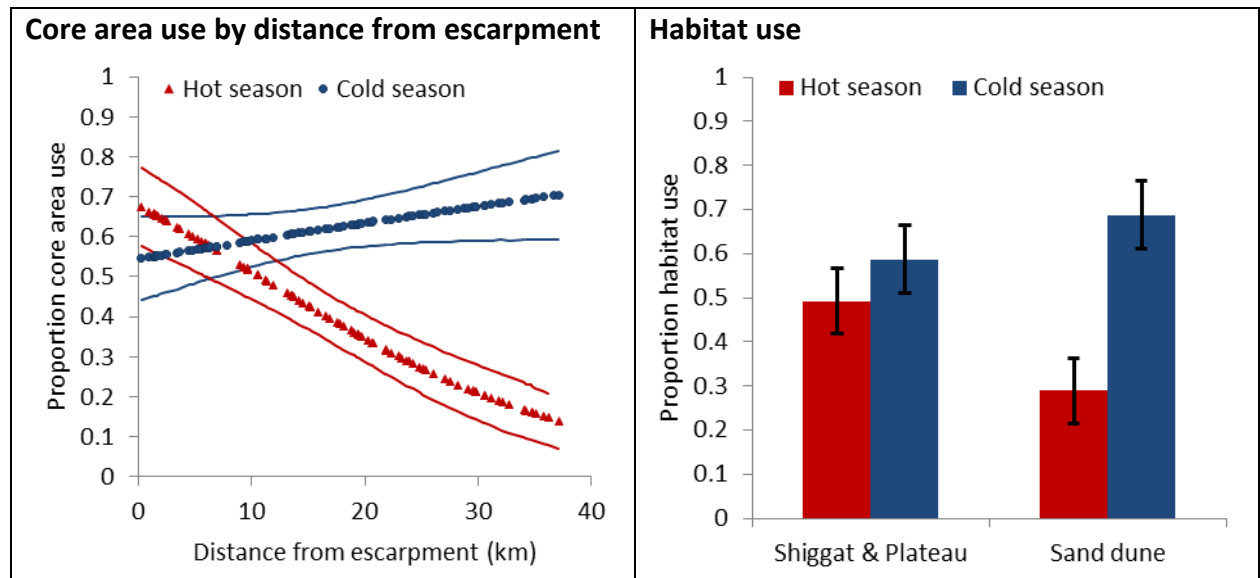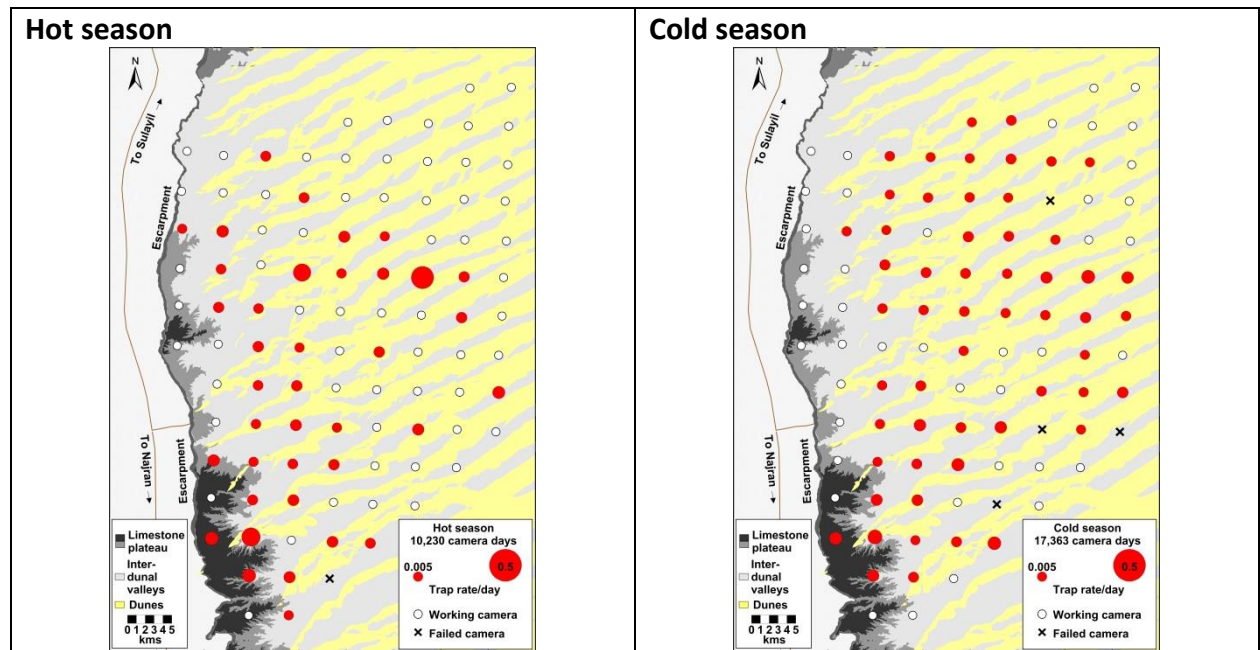Global conservation status: Vulnerable (IUCN SSC Antelope Specialist Group 2017)

- The Arabian sand gazelles photographed at Uruq Bani Ma'arid all descend from 240 animals re-introduced to the protected area by KKWRC in 1995, 1996 and 1998.
- Camera trap images indicate sand gazelles limit day time activity to the cooler months and are mainly nocturnal in the hot season.
- Seasonal distribution across the camera grid shows a strong tendency to disperse into the interior in the cool season where the dune habitats are extensively used, withdrawing to the west in the hot season.
- The wide distribution of the sand gazelle in the camera array reflects lower habitat dependence relative to Arabian gazelle.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	38 (96)	154	3168	0.40	1.51
Cold season (01/10/15 – 30/04/16)	55 (95)	244	5187	0.58	1.41

24 hour activity pattern

Distribution

Hot season

Cold season

Core area use by distance from escarpment

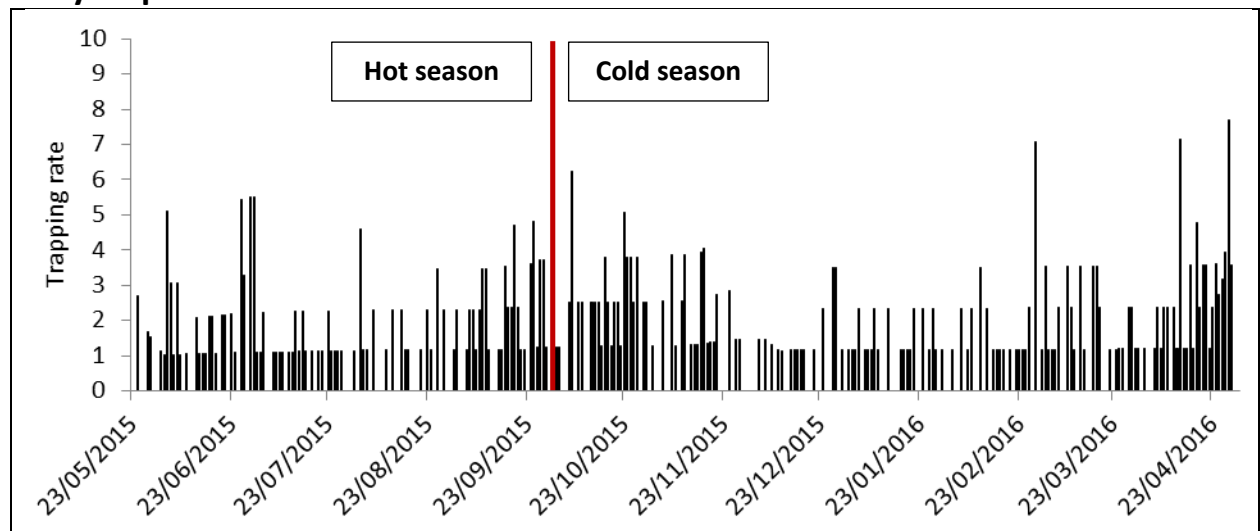## Habitat use

Daily trap rate

3) ARABIAN ORYX (*Oryx leucoryx*)

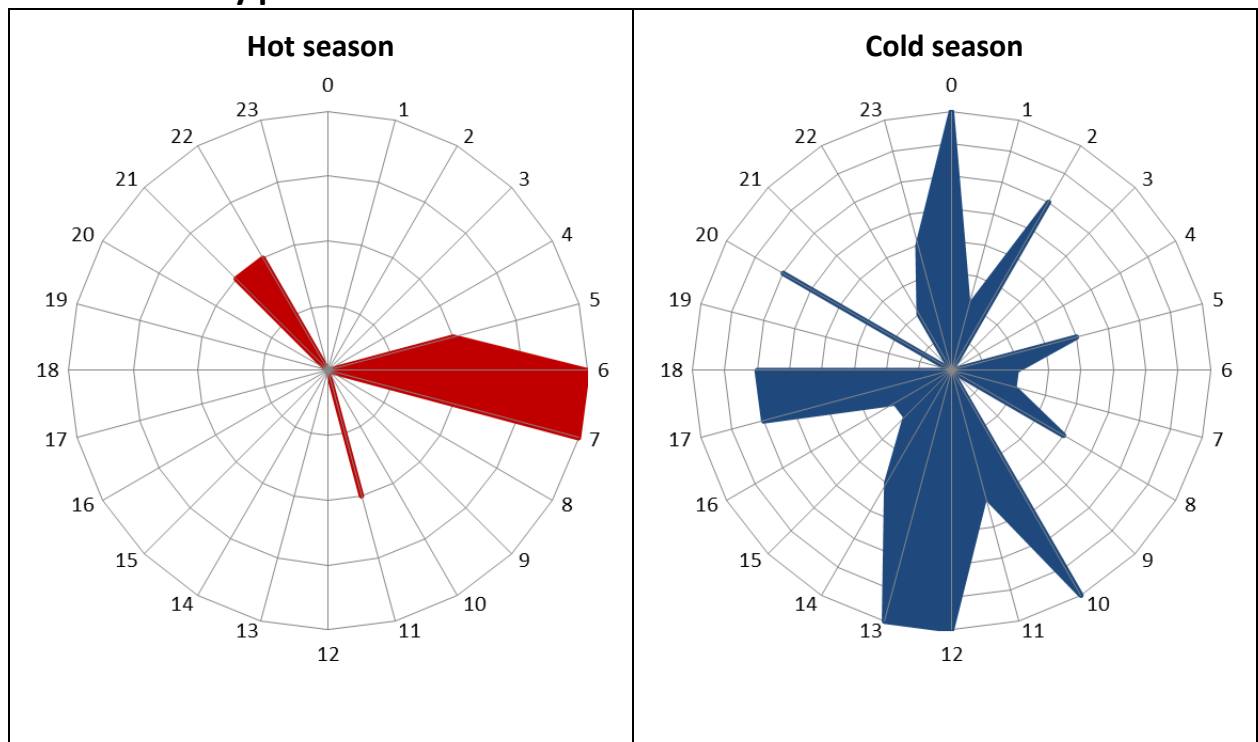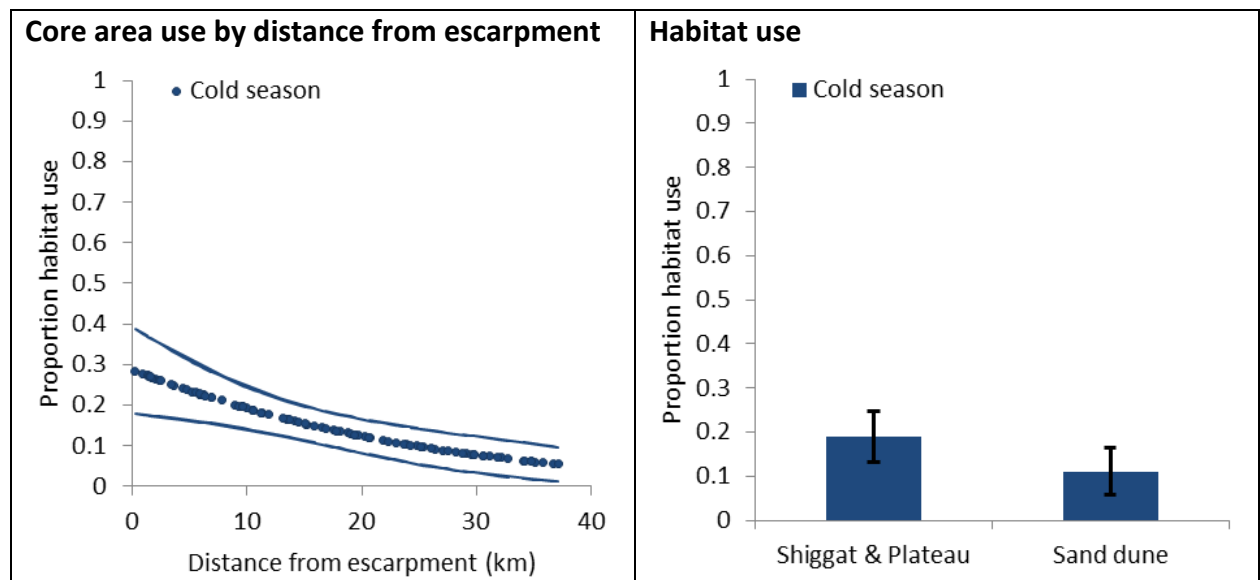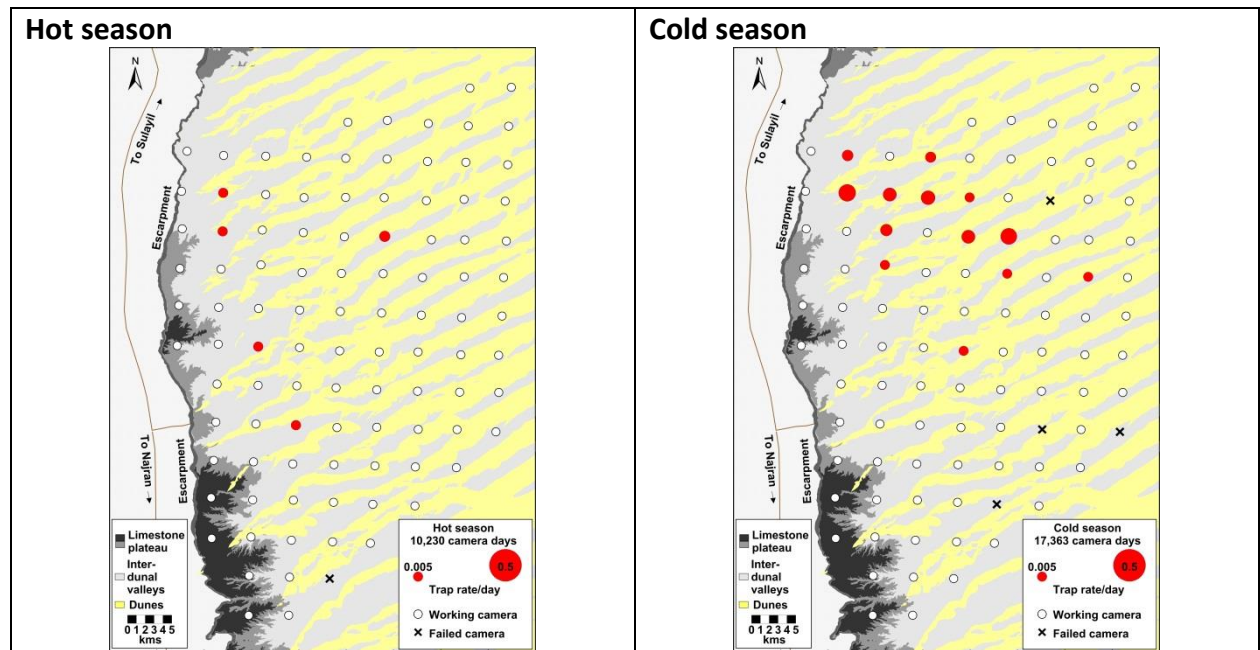Global conservation status: Vulnerable (IUCN SSC Antelope Specialist Group 2017)

Specific notes

- The Arabian oryx photographed at Uruq Bani Ma'arid descend from >120 animals re-introduced to the protected area by National Wildlife Research Centre between 1995 and 2004.
- The largest group detected was five individuals; all were adults, one was fitted with a radio-collar.
- Four juveniles were seen with adults in four different events between November and May.
- Trap rates were significantly higher during the cold season indicating greater activity during this period.
- Results indicate the oryx population is more restricted than the gazelle populations, and much lower detection and trap rates suggest a much smaller population.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	5 (96)	8	384	0.05	0.08
Cold season (01/10/15 – 30/04/16)	13 (95)	44	5714	0.14	0.25

24 hour activity pattern

Distribution

Hot season

Cold season

Core area use by distance from escarpment

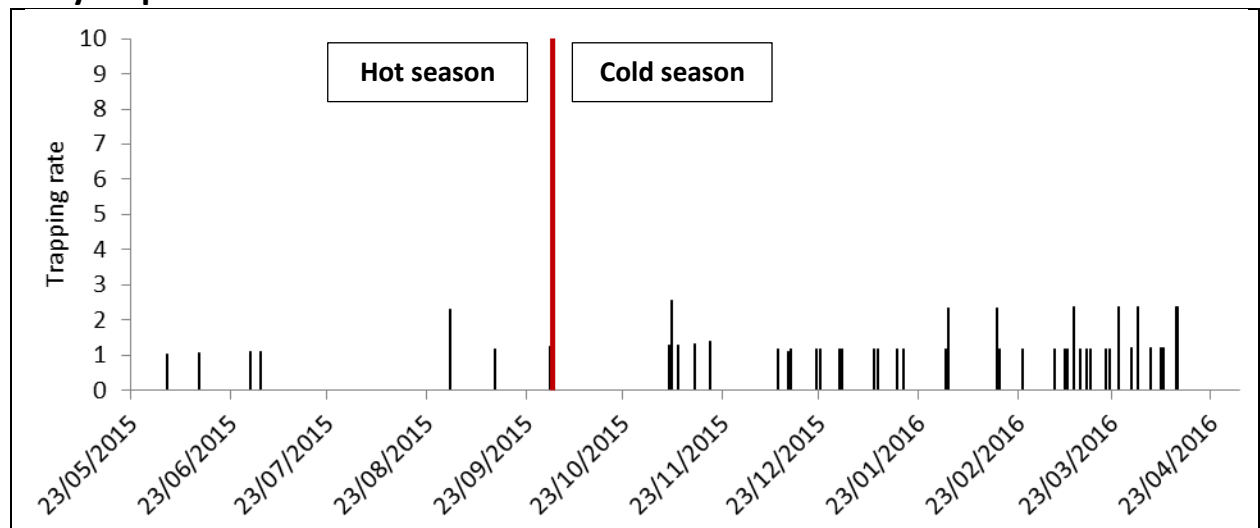## Habitat use

Daily trap rate
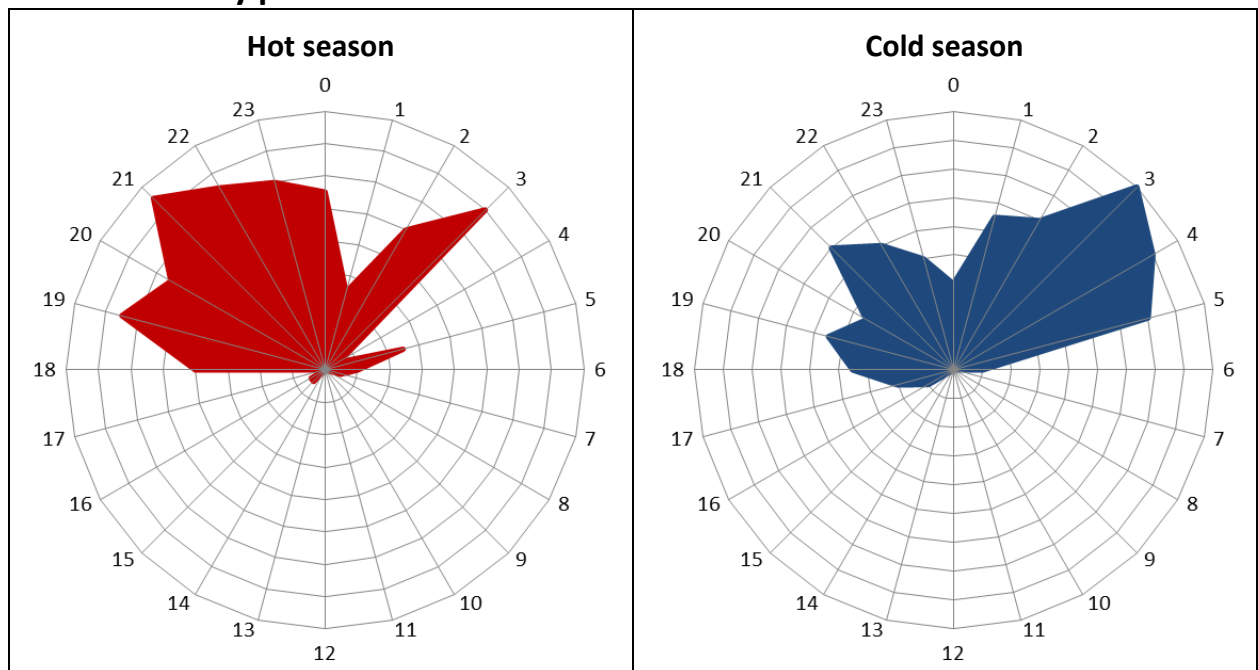

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4) RÜPPELL'S FOX (*Vulpes rueppellii*)

Global conservation status: Least Concern (Mallon *et al*. 2015)

Specific notes
- This arid land specialist displayed an uneven distribution with higher trap rate at cameras deeper into the main dune systems in the east of Uruq Bani Ma'arid.
- Activity was predominantly nocturnal with some encounters at dawn and dusk and few images in full daylight.
- A significant increase in the number of images and events obtained in the hot season is unexplained but it is noted that cub peaks occur during this period (Lenain 2000).
- Distinguished from sympatric red fox by lighter build, proportionately larger ears and lack of black on ears and throat, though this is often impossible to differentiate in poor quality images.
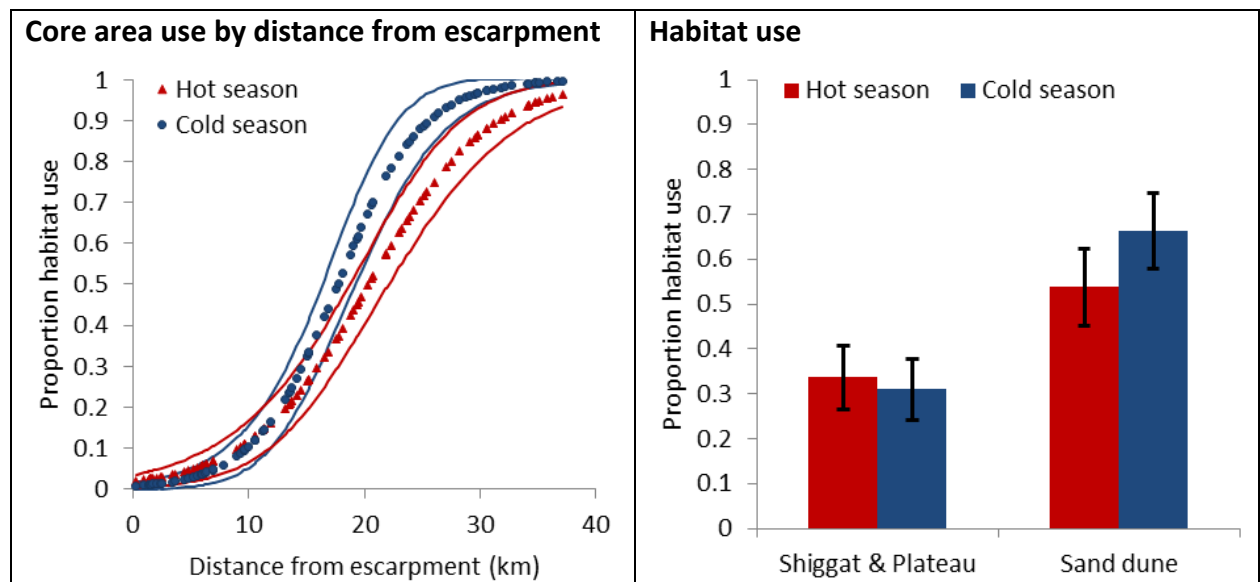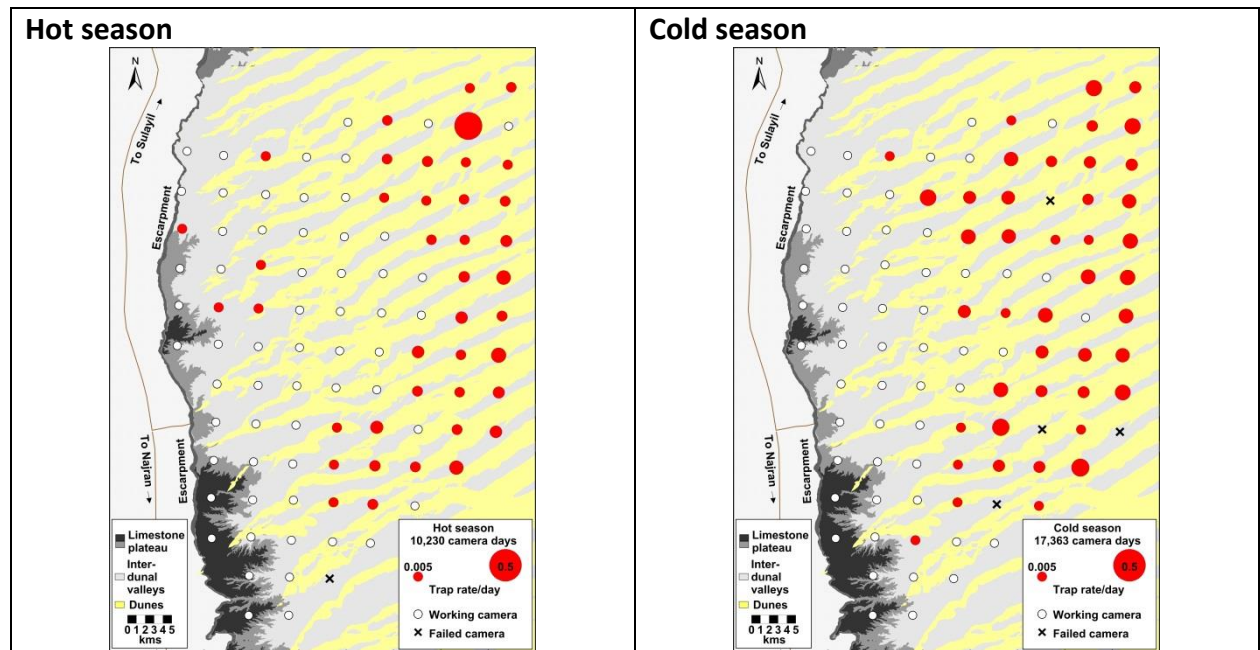
Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	40 (96)	123	1828	0.42	1.20
Cold season (01/10/15 – 30/04/16)	43 (95)	138	792	0.45	0.80

24 hour activity pattern

Distribution

Hot season
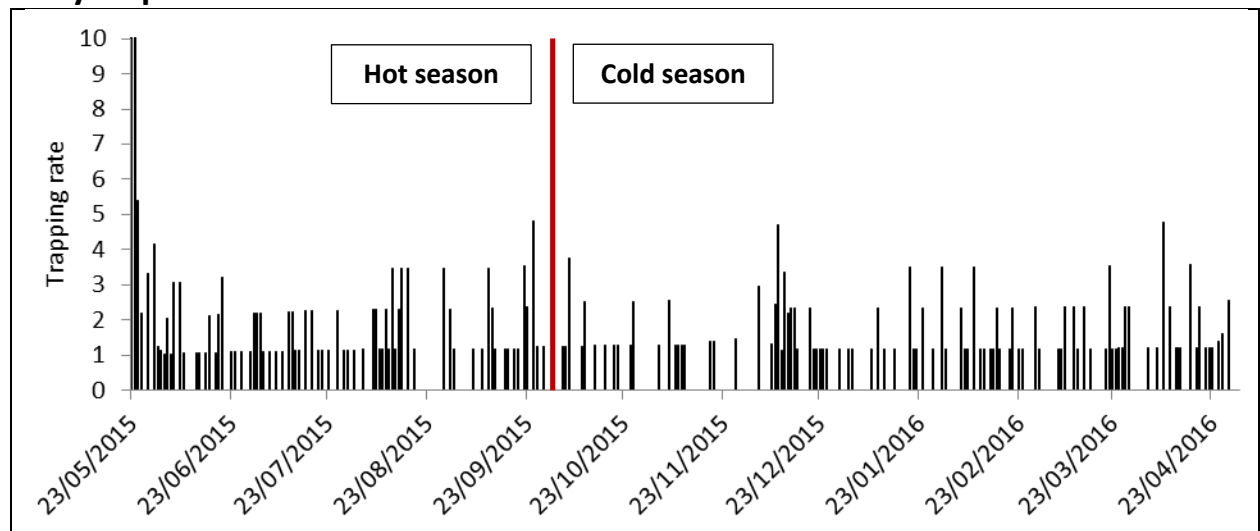

Cold season

Core area use by distance from escarpment

Habitat use

Daily trap rate

5) ARABIAN RED FOX (*Vulpes vulpes arabica*)

Global conservation status: Least Concern (Hoffman & Sillero-Zubiri 2016)
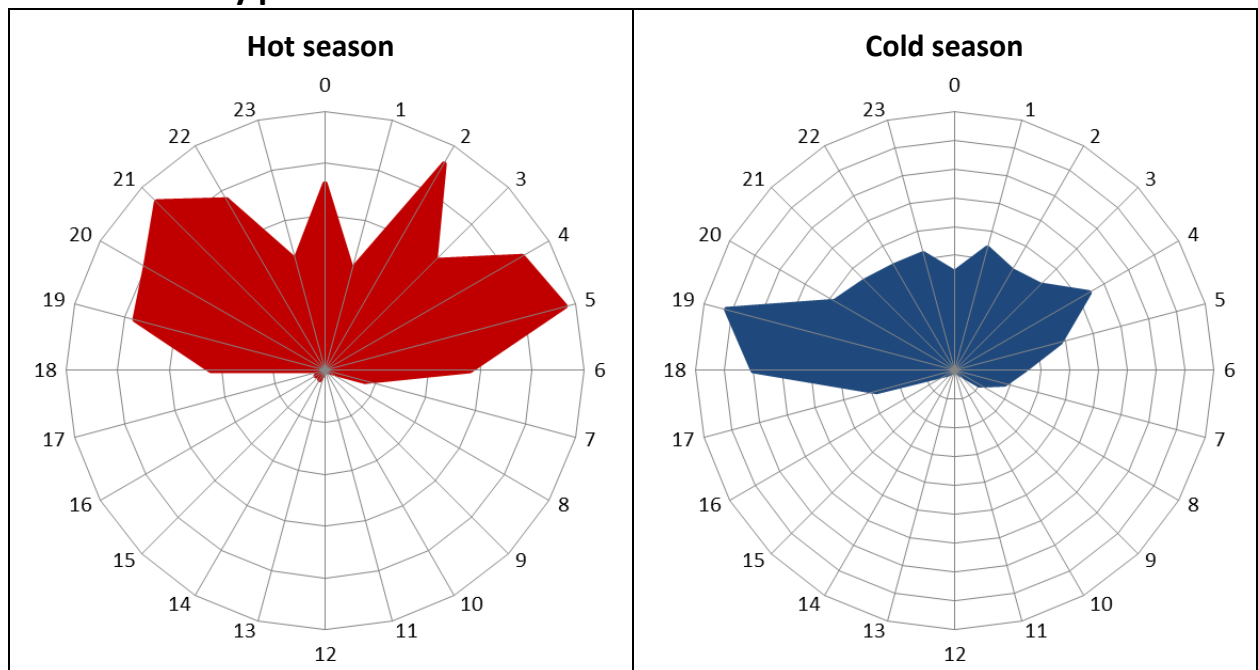
Specific notes
- The most frequently detected carnivore in the study.
- Usually single but occasional pairs and on one occasion three individuals apparently foraging together were recorded.
- Occupancy and trap rate were higher in the western escarpment habitat of the protected area, the opposite pattern to Rüppell's fox.
- Unlike Rüppell's fox, the red fox's distribution doesn't change seasonally.
- A predominantly nocturnal species, with only 11% of the total events occurring between 06:00 and 17:00.
- Seasonal variation in coat condition contributes to difficulty in separating from Rüppell's fox in some images.
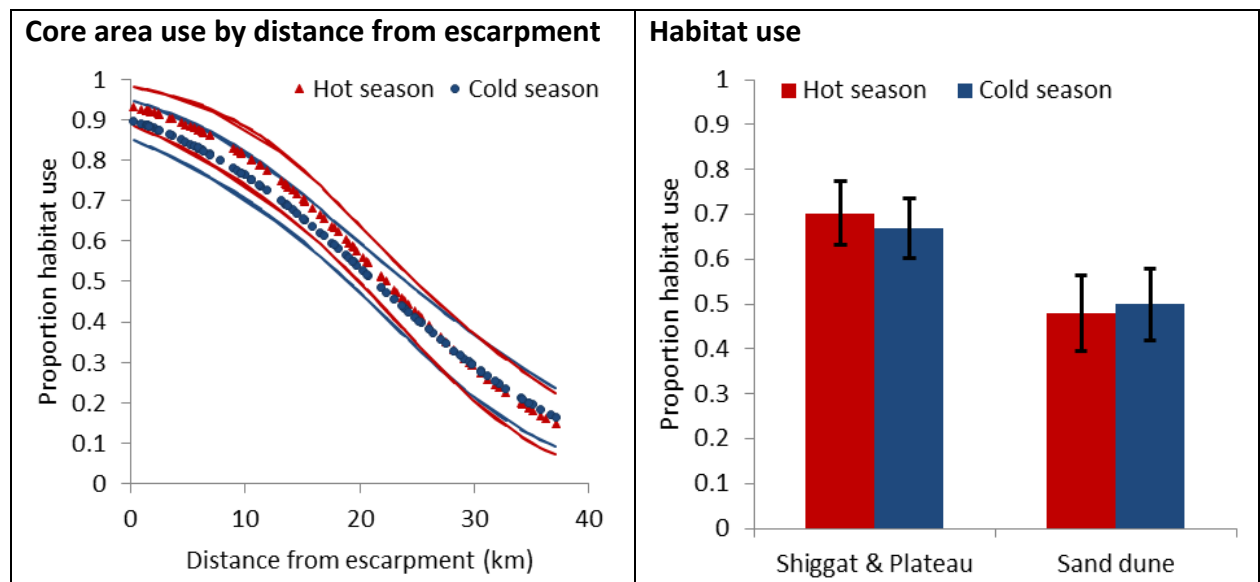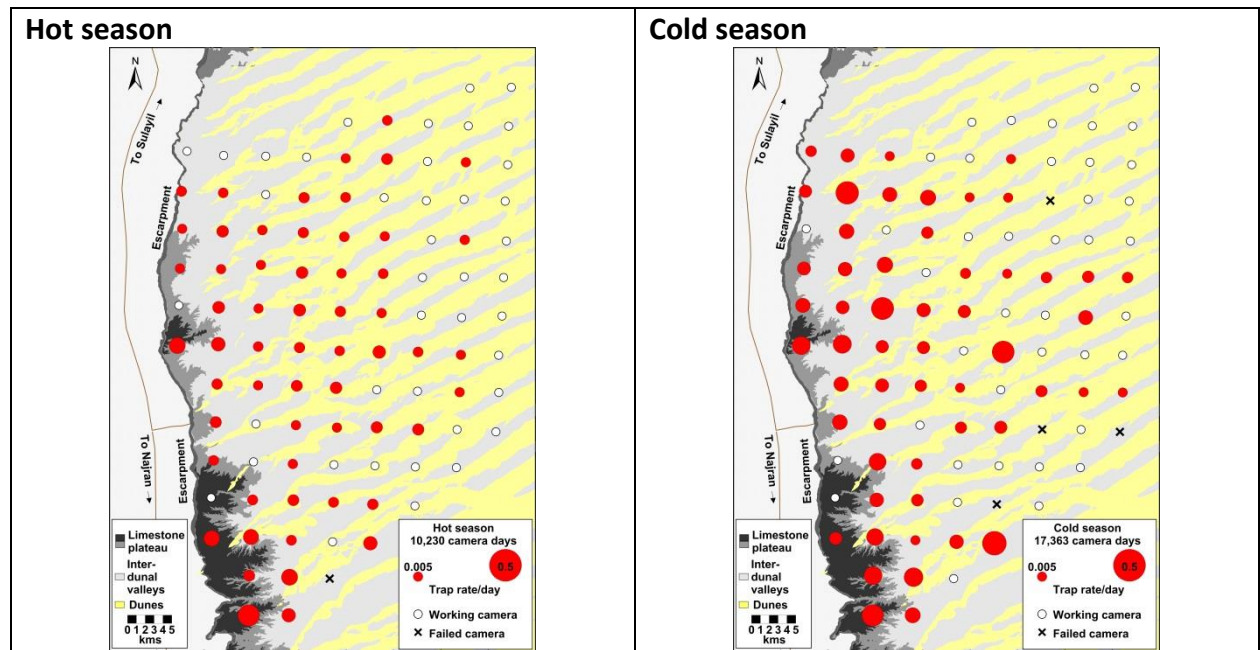
Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	58 (96)	235	1996	0.60	2.30
Cold season (01/10/15 – 30/04/16)	55 (95)	331	2730	0.58	1.91

24 hour activity pattern

Distribution

Hot season

Cold season

Core area use by distance from escarpment

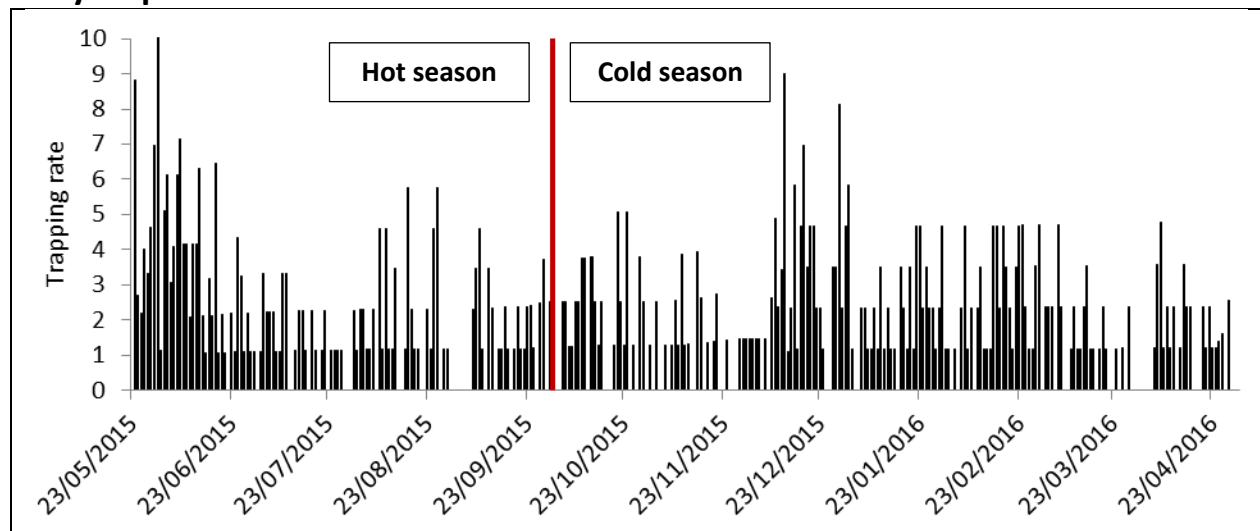## Habitat use

Daily trap rate

6) SAND CAT (*Felis margarita)*

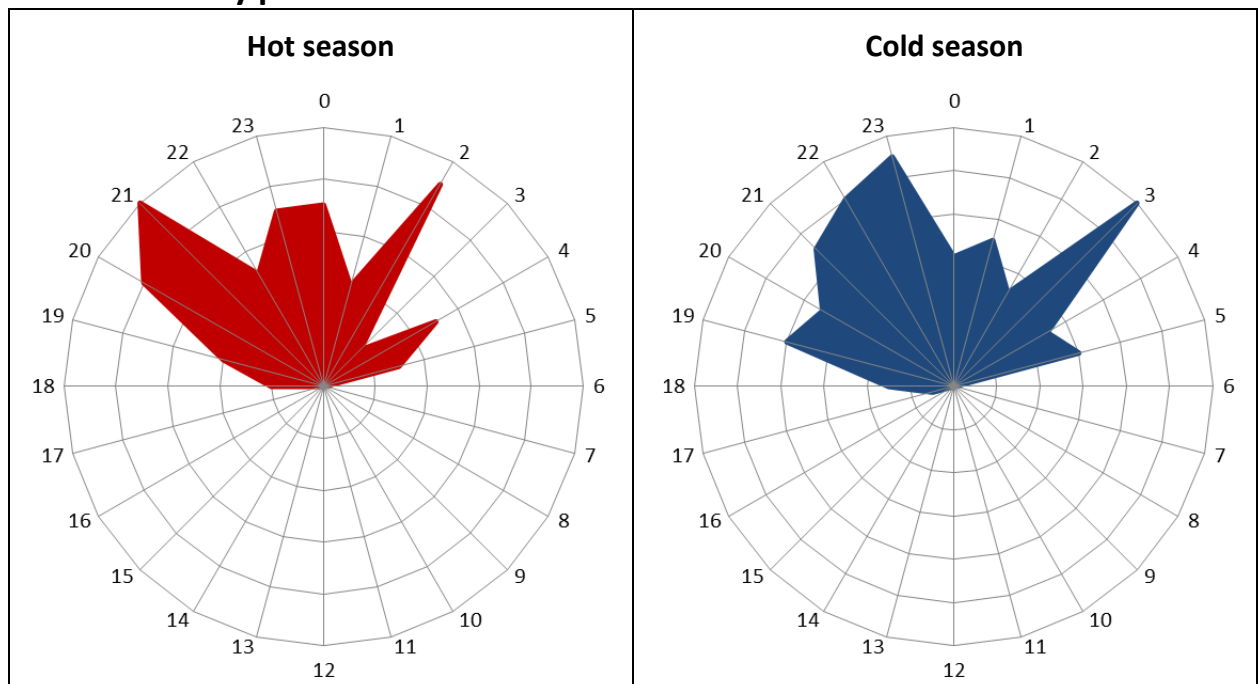Global conservation status: Least Concern (Silwa *et al*. 2016)

Specific notes

- The most frequently recorded and widely distributed felid in Uruq Bani Ma'arid.
- Camera trapping has revealed a much more significant population than previously understood. Only one direct observation was documented in previous 10 years.
- Timing of camera trap events show a nocturnal activity pattern.
- The nearest domestic cat detection was six km away from a sand cat detection highlighting potential disease risk from toxoplasma (Cole & Wilson 2015).
- Kittens of varying ages were observed between May and August.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	18 (96)	66	723	0.19	0.65
Cold season (01/10/15 – 30/04/16)	24 (95)	90	846	0.25	0.52

24 hour activity pattern

Distribution

Hot season	Cold season

Core area use by distance from escarpment

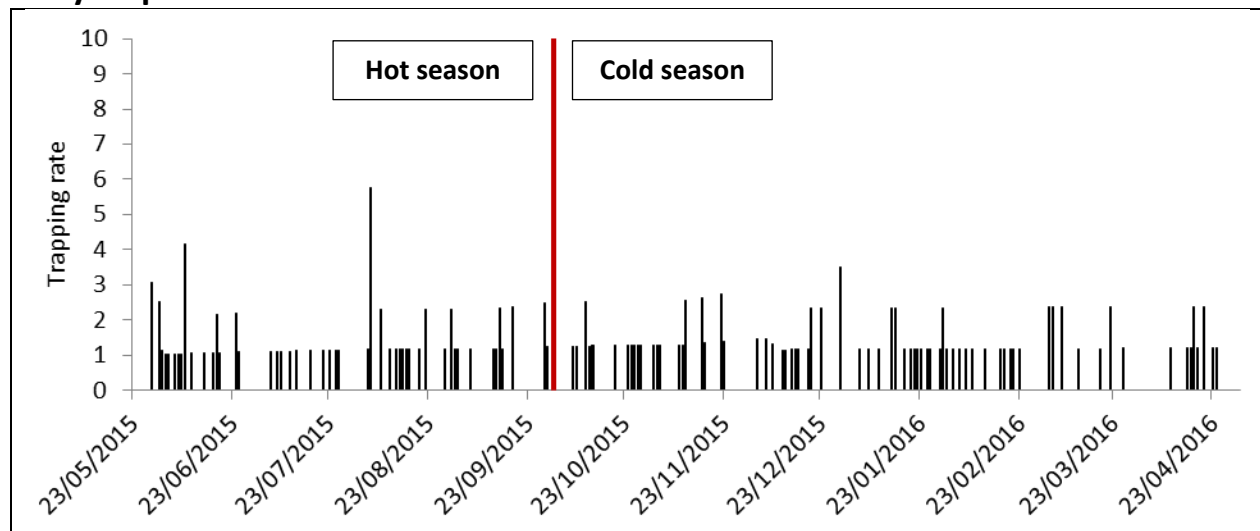## Habitat use
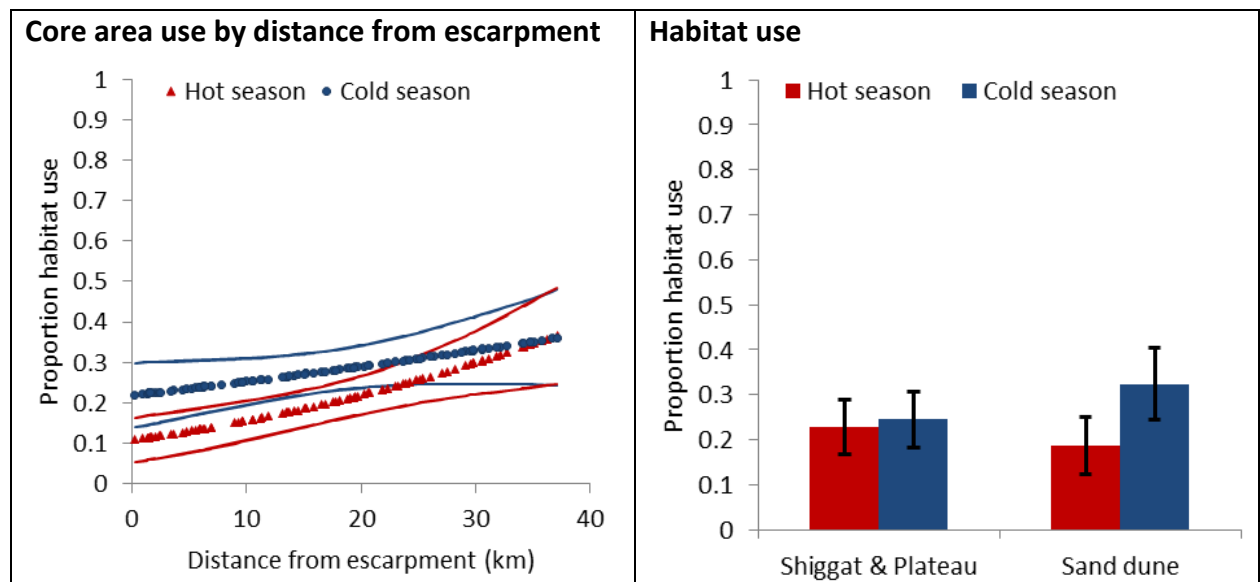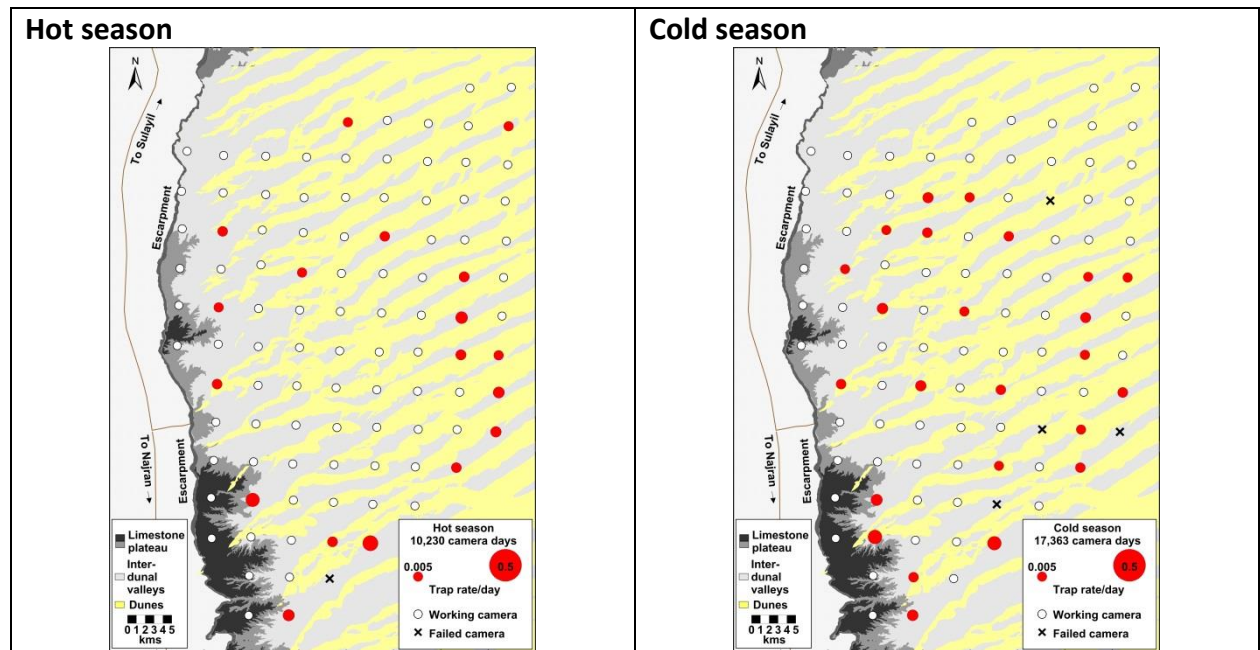
Daily trap rate
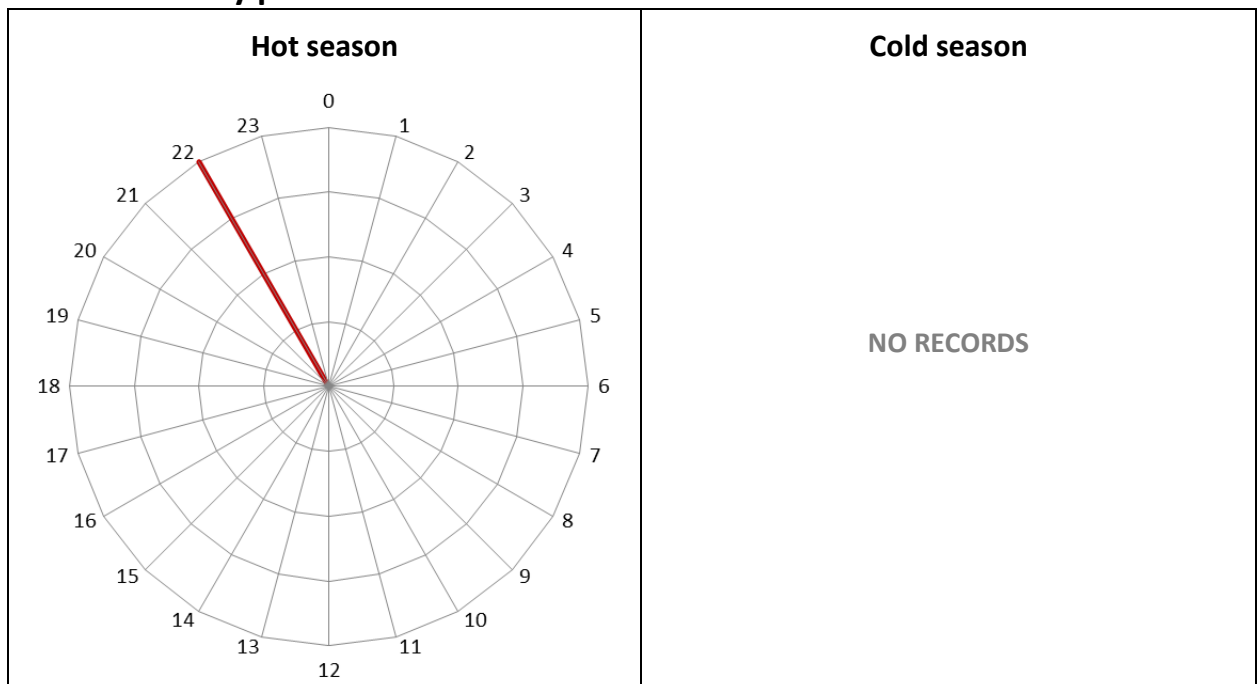
7) WILD CAT (*Felis silvestris*)

Global conservation status: Least Concern (Yamaguchi *et al*. 2015)

Specific notes
- The detection of wild cat in the protected area represents a range extension of >170 km relative to the IUCN distribution map of 2018 (Barichievy & Wacher 2016).
- There is a population of feral cats associated with some of the ranger camps, and several possible wild cat events had to be classified as *Felis* sp. due identification difficulty.

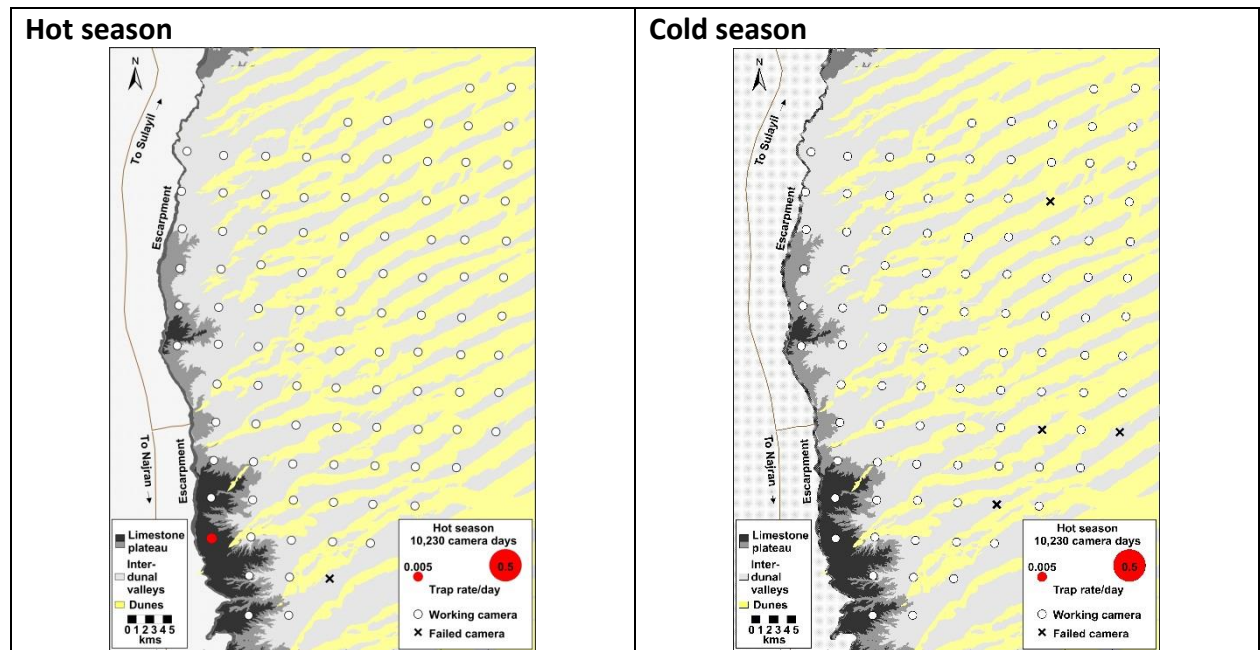## Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	1 (96)	2	6	0.01	0.02
Cold season (01/10/15 – 30/04/16)	0 (95)	0	0	0	0

24 hour activity pattern

Hot season	Cold season
	NO RECORDS

Distribution

Hot season	Cold season

Core area use by distance from escarpment	Habitat use
INSUFFICIENT DATA FOR OCCUPANCY MODELLING	INSUFFICIENT DATA FOR OCCUPANCY MODELLING

Daily trap rate
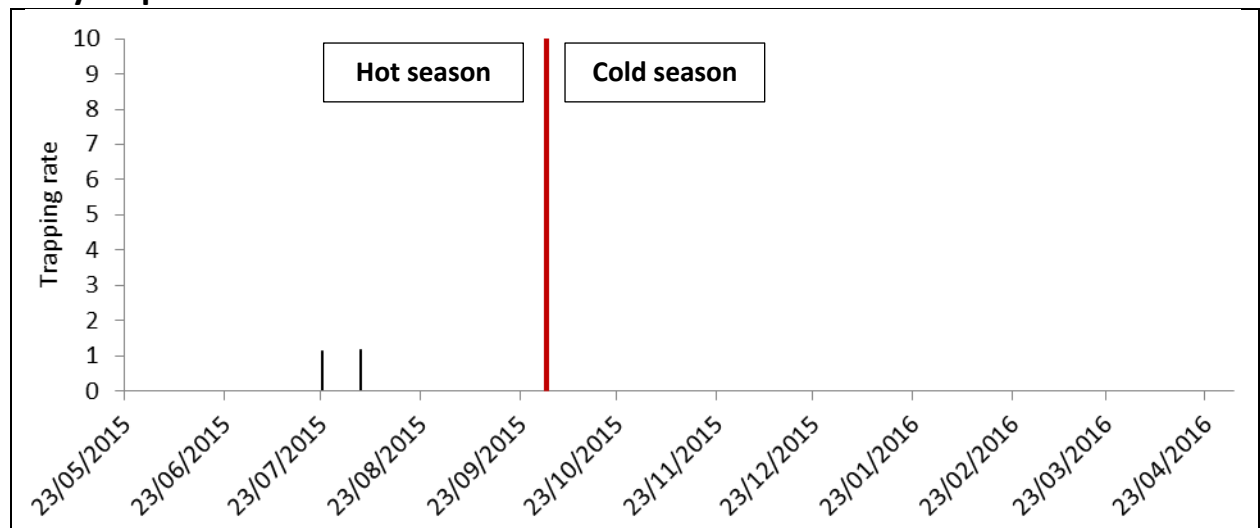
8) HONEY BADGER (*Mellivora capensis*)

Global conservation status: Least Concern (Do Linh San *et al*. 2016)
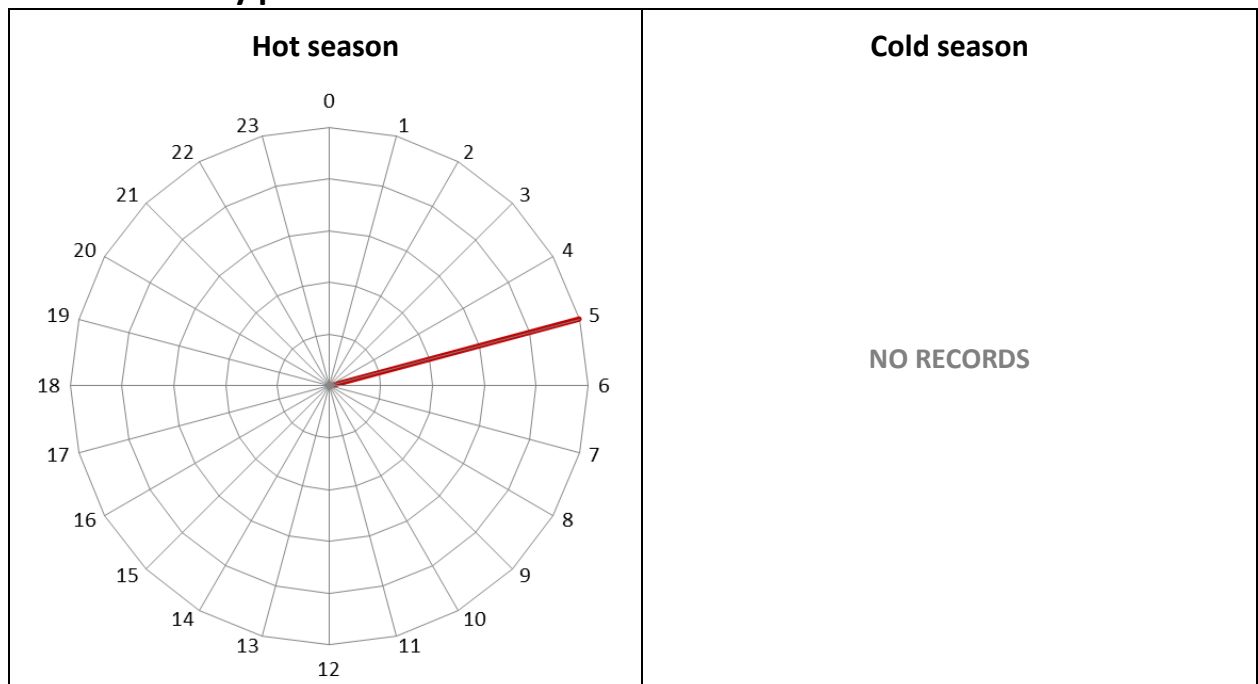

Specific notes
- Only one event recorded during this study.
- Has also been recorded near the escarpment in the northern part of the protected area in a separate camera trap survey but very few detection events overall despite prolonged and widespread camera sampling suggests low abundance, a situation normal for this species in arid habitats (Begg *et al*. 2013).
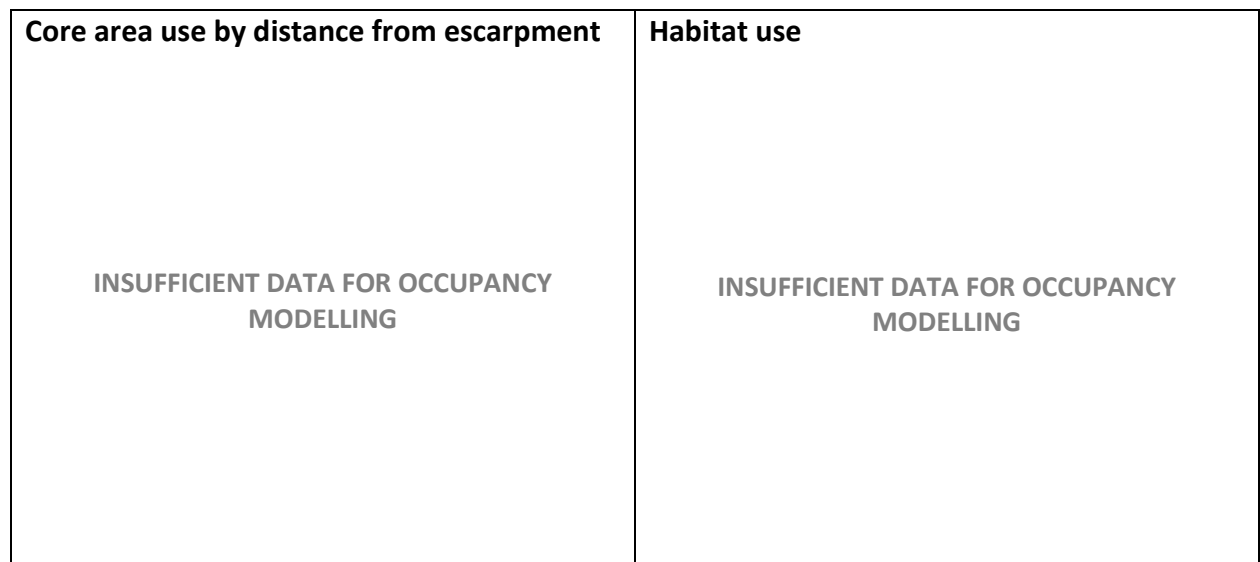
Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	1 (96)	1	6	0.01	0.01
Cold season (01/10/15 – 30/04/16)	0 (95)	0	0	0	0

24 hour activity pattern

Hot season

Cold season

NO RECORDS

Distribution

Hot season	Cold season

Core area use by distance from escarpment	Habitat use
INSUFFICIENT DATA FOR OCCUPANCY MODELLING	INSUFFICIENT DATA FOR OCCUPANCY MODELLING

Daily trap rate
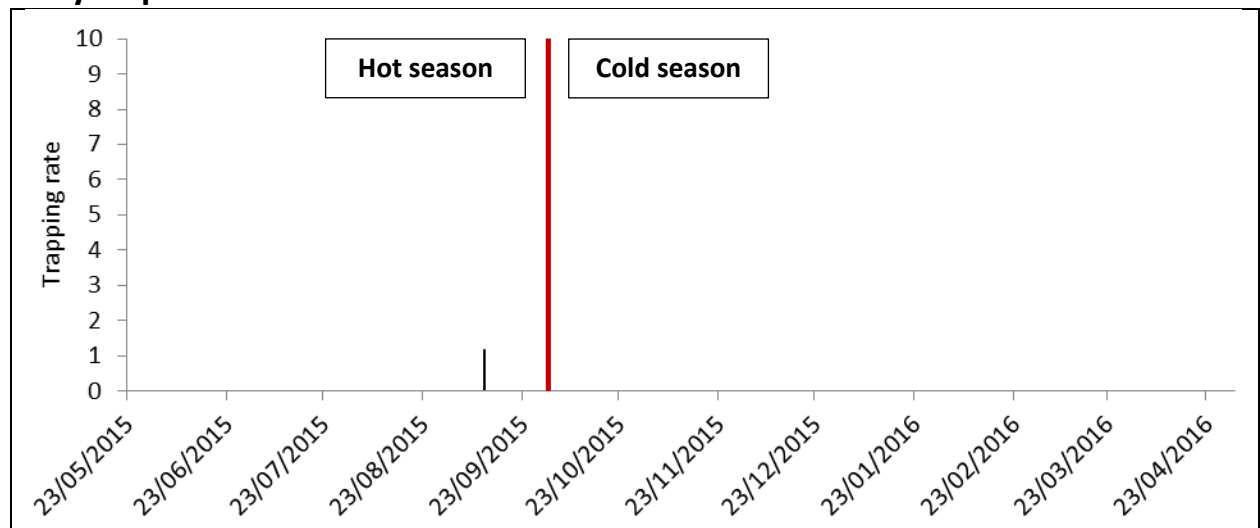
9) CAPE HARE (*Lepus capensis*)

Global conservation status: Least Concern (Drew *et al*. 2008)

Specific notes

- The most frequently encountered species found consistently throughout the study area.
- Predominantly nocturnal and completely so in the hot season.
- The detection of Cape Hare throughout Uruq Bani Ma'arid represents a significant range extension, approximately 250 km eastwards relative to the current IUCN distribution map.
- The much higher trap rate recorded in the hot season requires investigation.
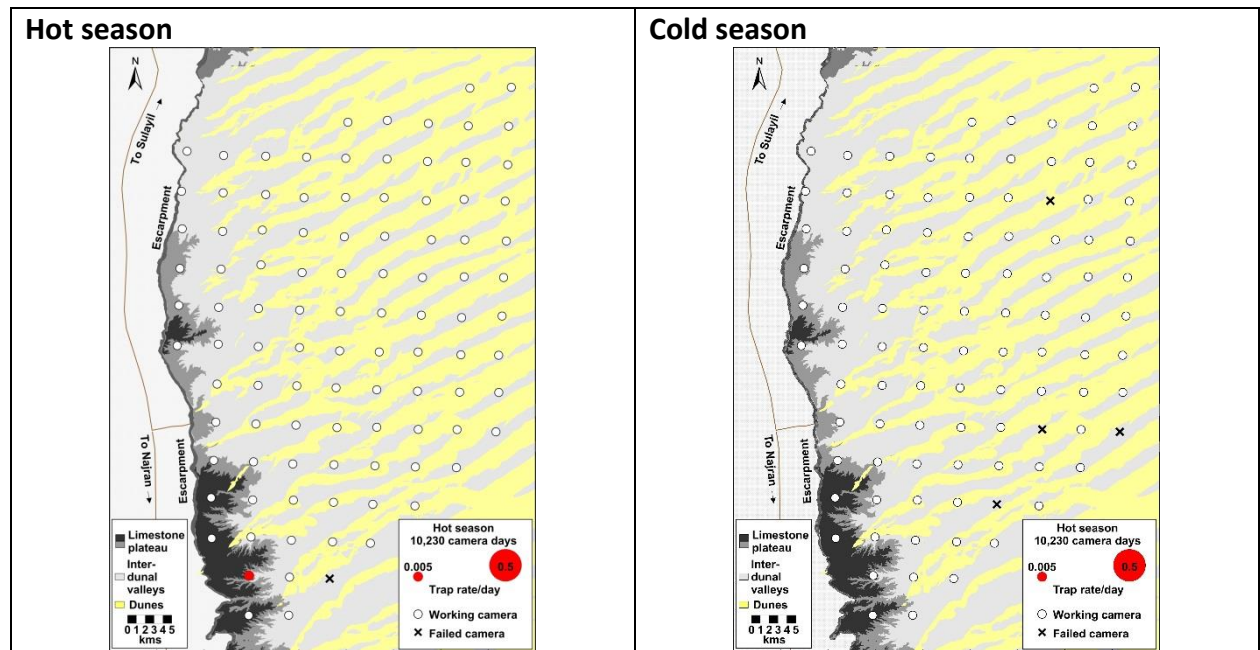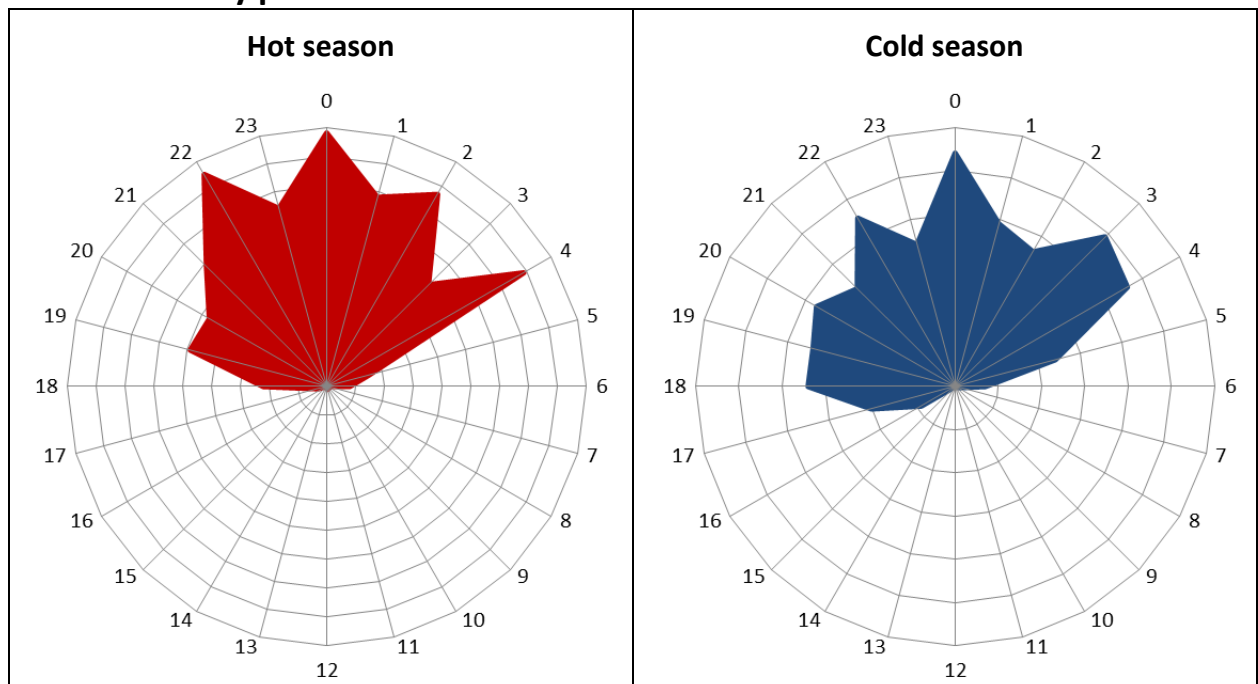
Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	80 (96)	716	7626	0.83	7
Cold season (01/10/15 – 30/04/16)	80 (95)	501	3379	0.84	2.90

24 hour activity pattern

Distribution

Hot season

Cold season

Core area use by distance from escarpment

Habitat use

Daily trap rate

10)   LESSER EGYPTIAN JERBOA (*Jaculus jaculus*)

Global conservation status: Least Concern (Amori *et al*. 2016)

Specific notes
- All jerboas have been identified as *Jaculus jaculus* as the only jerboa species present according to IUCN distribution maps, though it is noted that specific details are not clearly identifiable in all images.
- Low number of detections and events are likely due to small size; adults weighing 45-70 grams, which is much less than the weight to reliably trigger cameras.
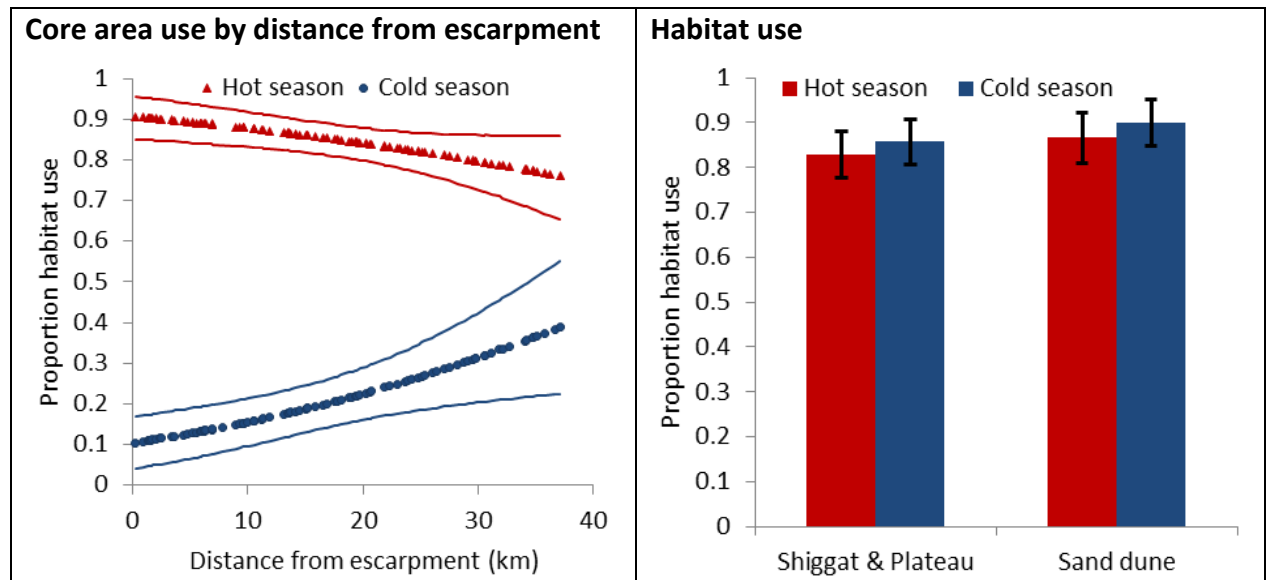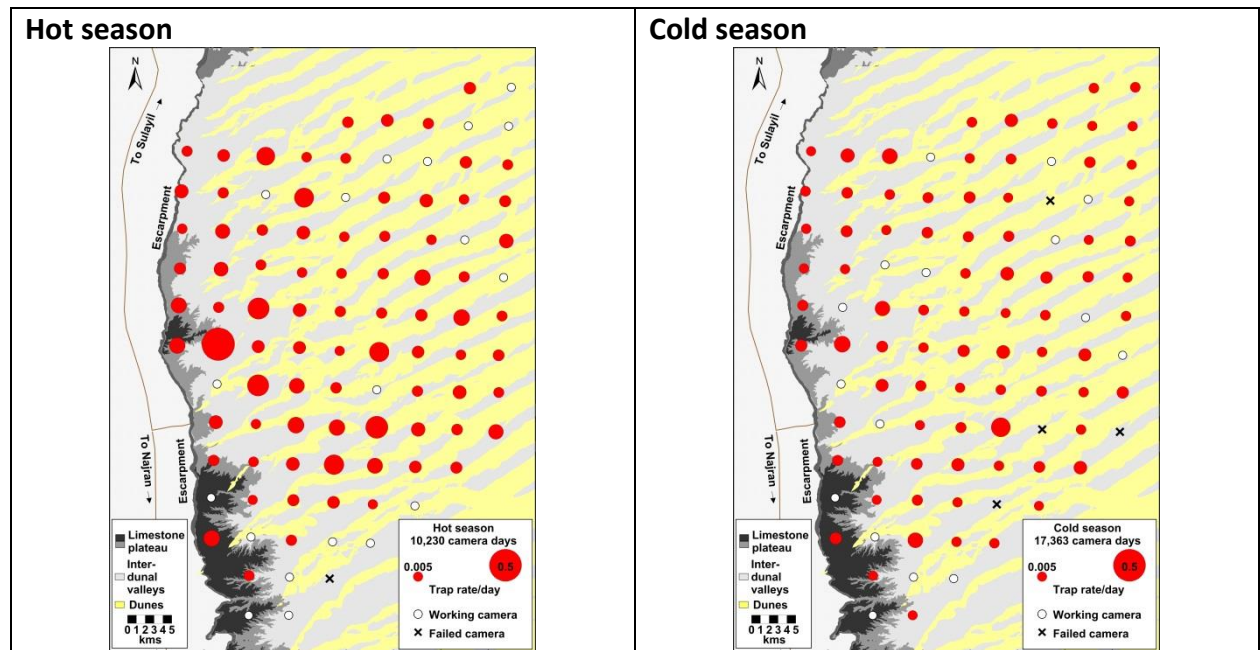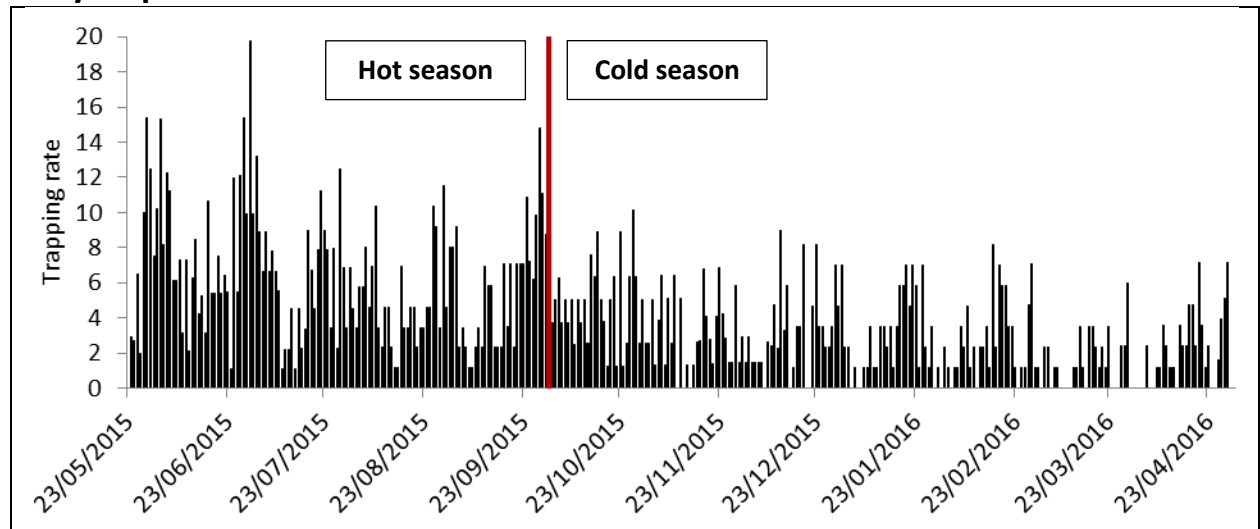- As expected, a strictly nocturnal activity pattern is displayed.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	5 (96)	6	18	0.05	0.06
Cold season (01/10/15 – 30/04/16)	12 (95)	19	63	0.13	0.11

24 hour activity pattern

Distribution

Hot season	Cold season

Core area use by distance from escarpment

Habitat use
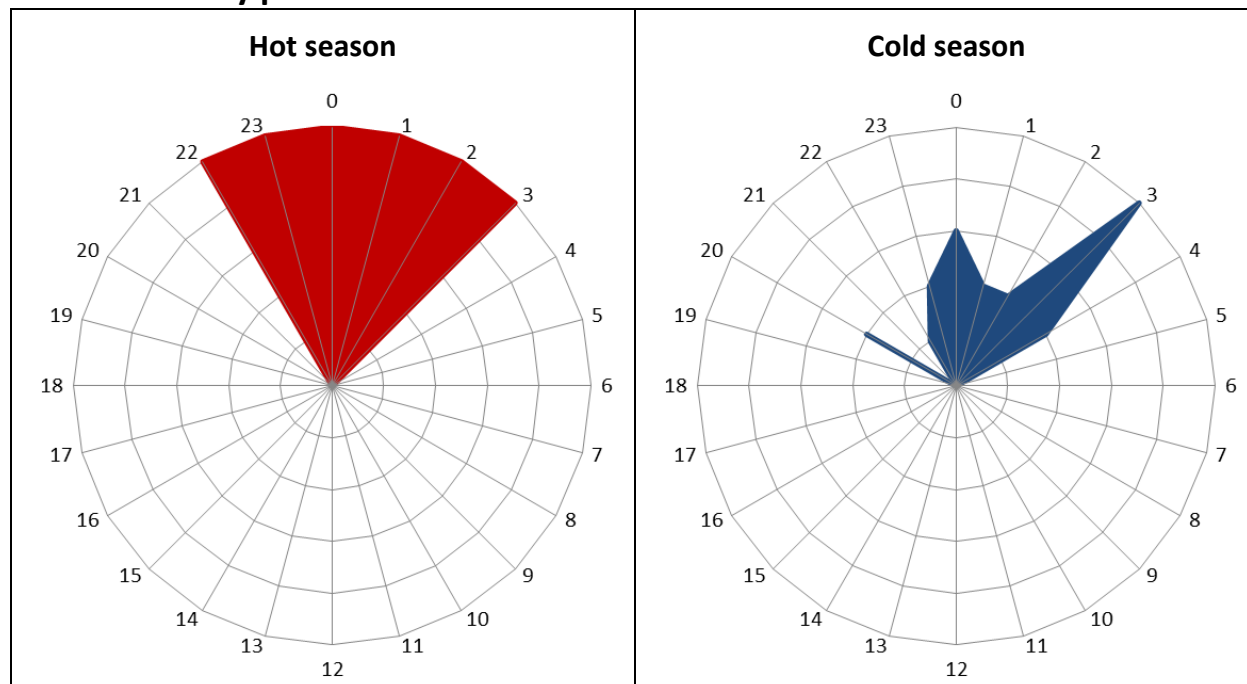
Daily trap rate
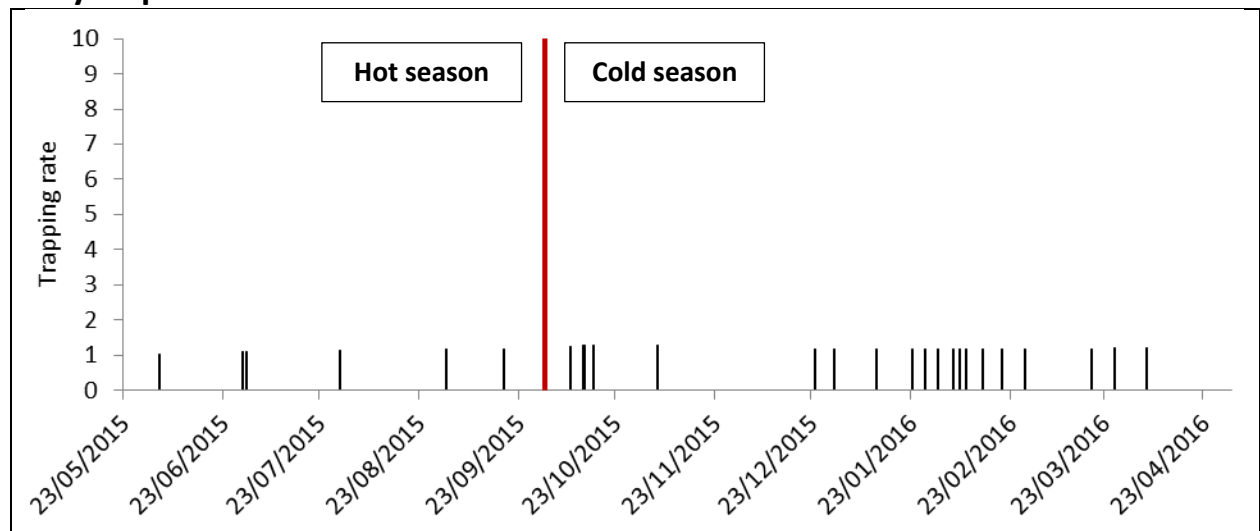
11)   Rodent species (*Murid sp.*)

Global conservation status: N/A

Specific notes
- It is not possible to accurately identify most images of small desert mammals, especially in infra-red flash images from cameras set for larger species.
- Small mammals (gerbils and mice; <0.5 kg and largely nocturnal) activate camera motion-in-heat sensor inconsistently when deployed for medium sized mammals, and they were not a target species group for this camera trap study.
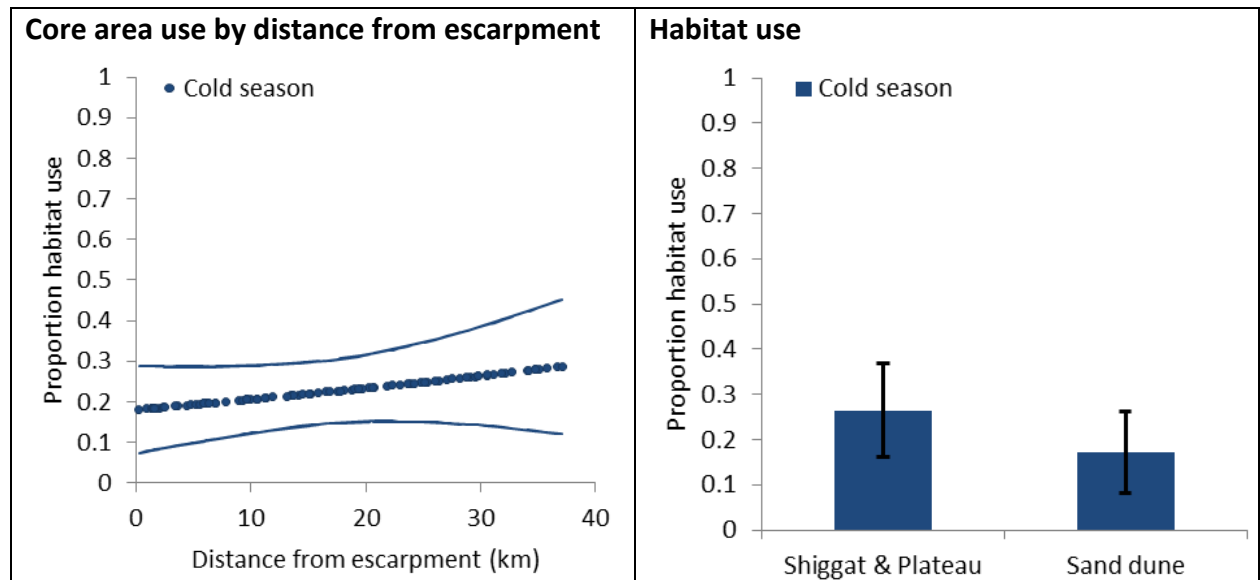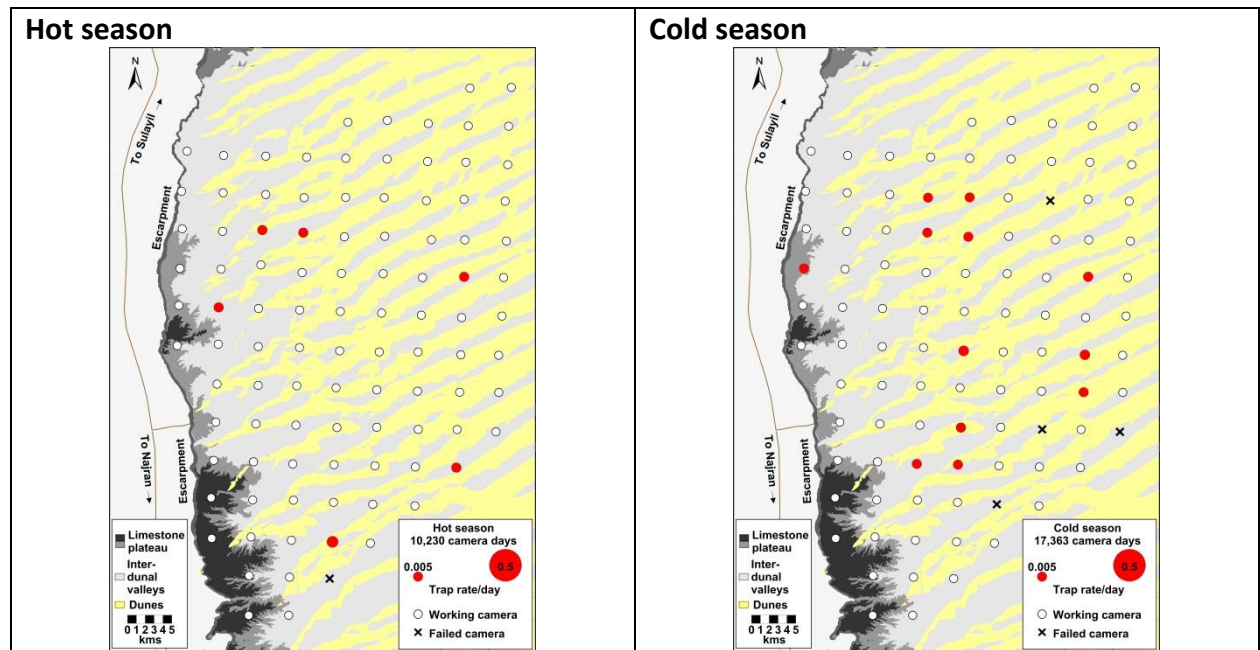- Camera trap events display a nocturnal activity pattern.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	26 (96)	217	1348	0.27	2.12
Cold season (01/10/15 – 30/04/16)	17 (95)	113	408	0.18	0.65

24 hour activity pattern
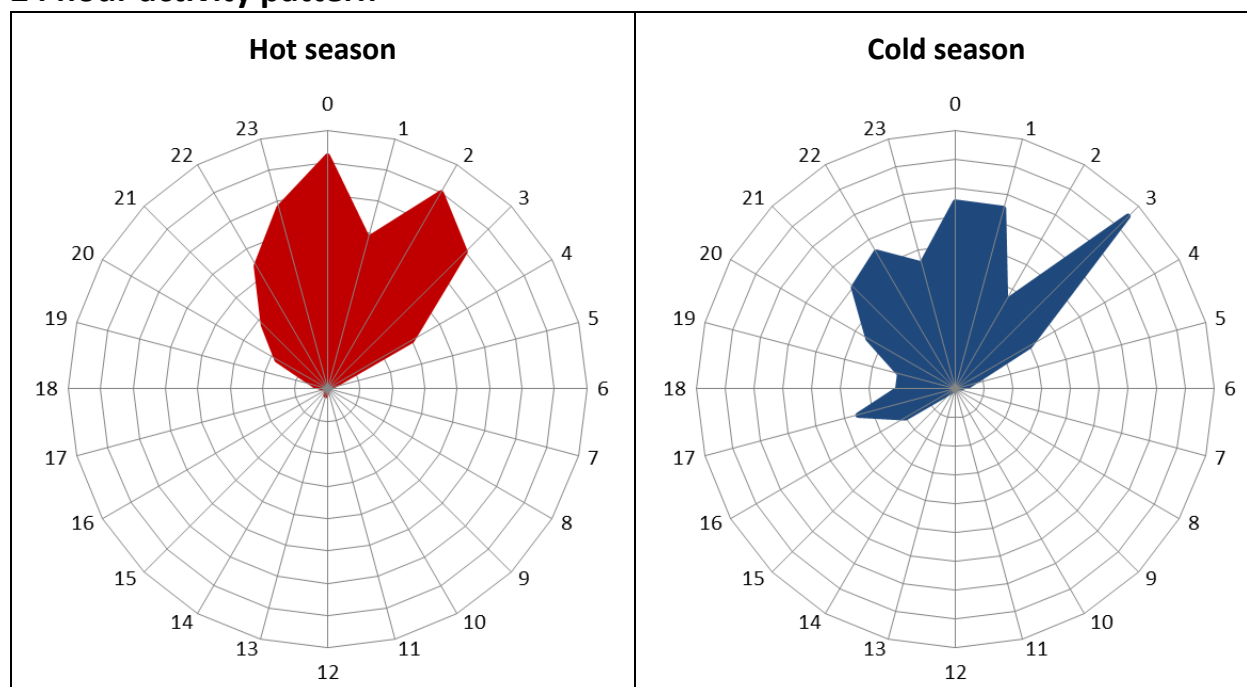
Distribution
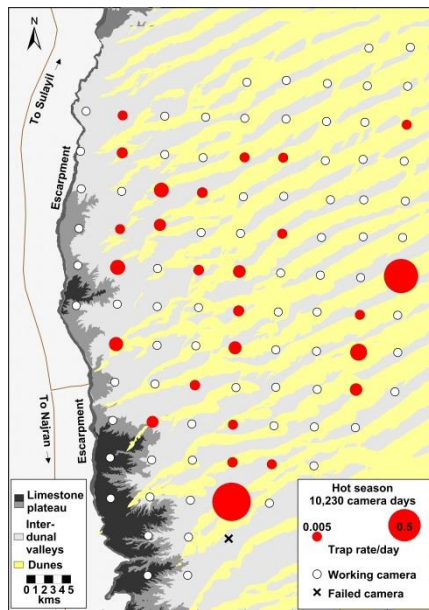
Hot season	Cold season
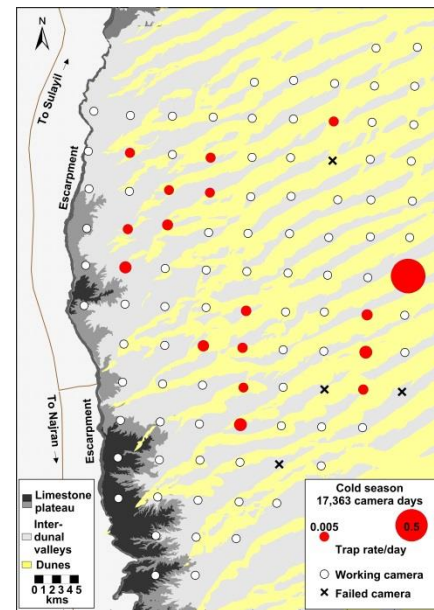
Core area use by distance from escarpment
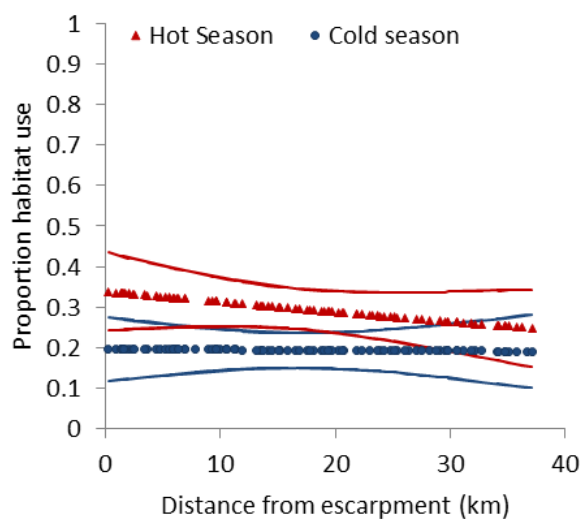
Habitat use
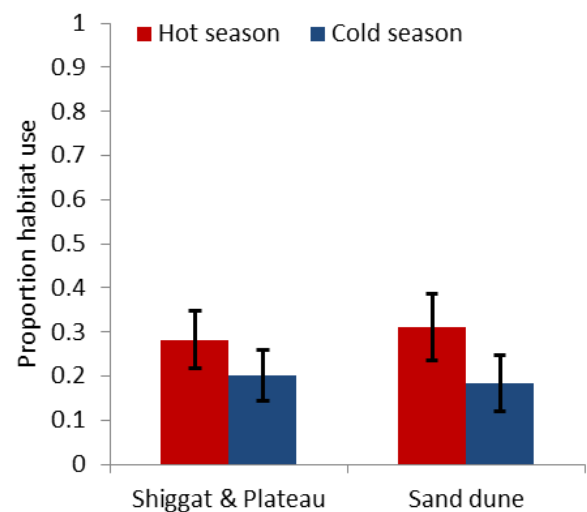
Daily trap rate
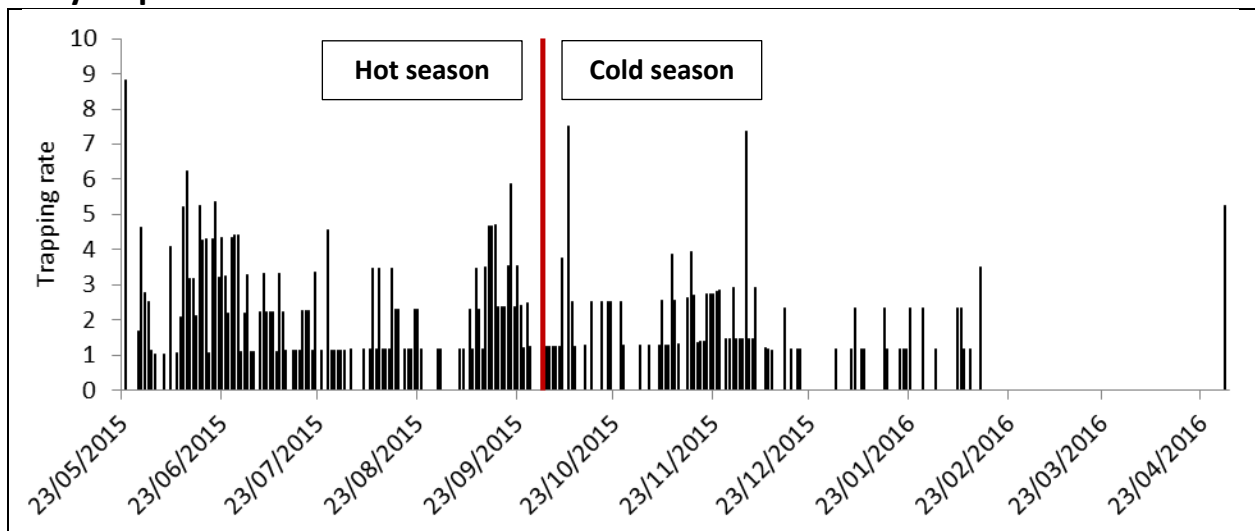
12) DOMESTIC CAT (*Felis catus*)

Global conservation status: N/A
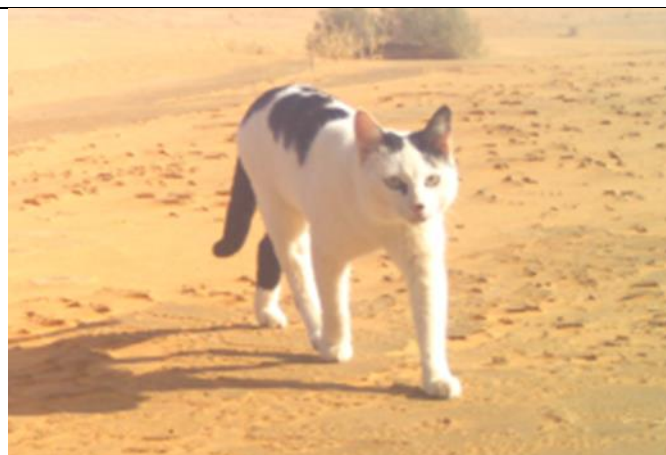
Specific notes

- Due to the presence of both domestic and wild cats, and probable presence of tabby forms of domestic cat, positive identification of domestic cat was only possible during one daylight event. Other events are conservatively attributed to domestic cat though some may have involved wild cat.
- There is a known population of feral cats within the protected area located mainly around the main ranger camp on the escarpment.
- The risk presented by domestic cats to wild cat (cross-breeding and disease) and sand cat populations (disease transmission) remains unknown but a point of concern.

Detections

| Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	1 (96)	4	27	0.01	0.04
Cold season (01/10/15 – 30/04/16)	3 (95)	5	18	0.03	0.03

24 hour activity pattern

Distribution

Hot season	Cold season
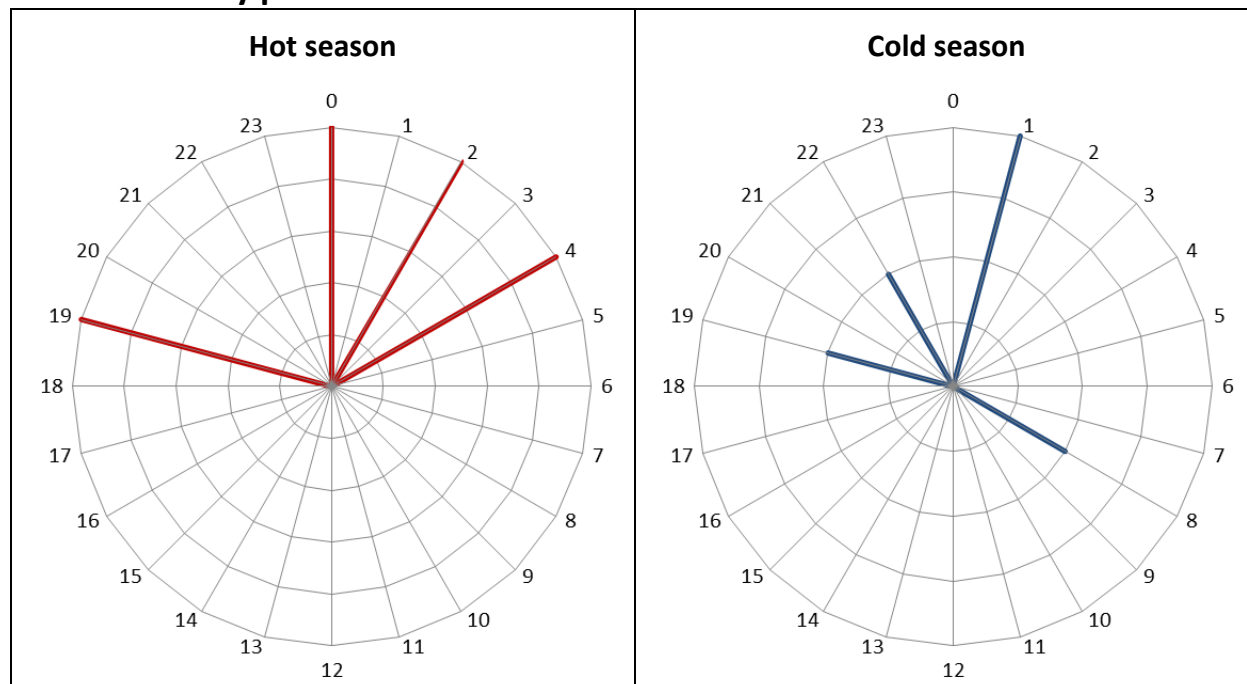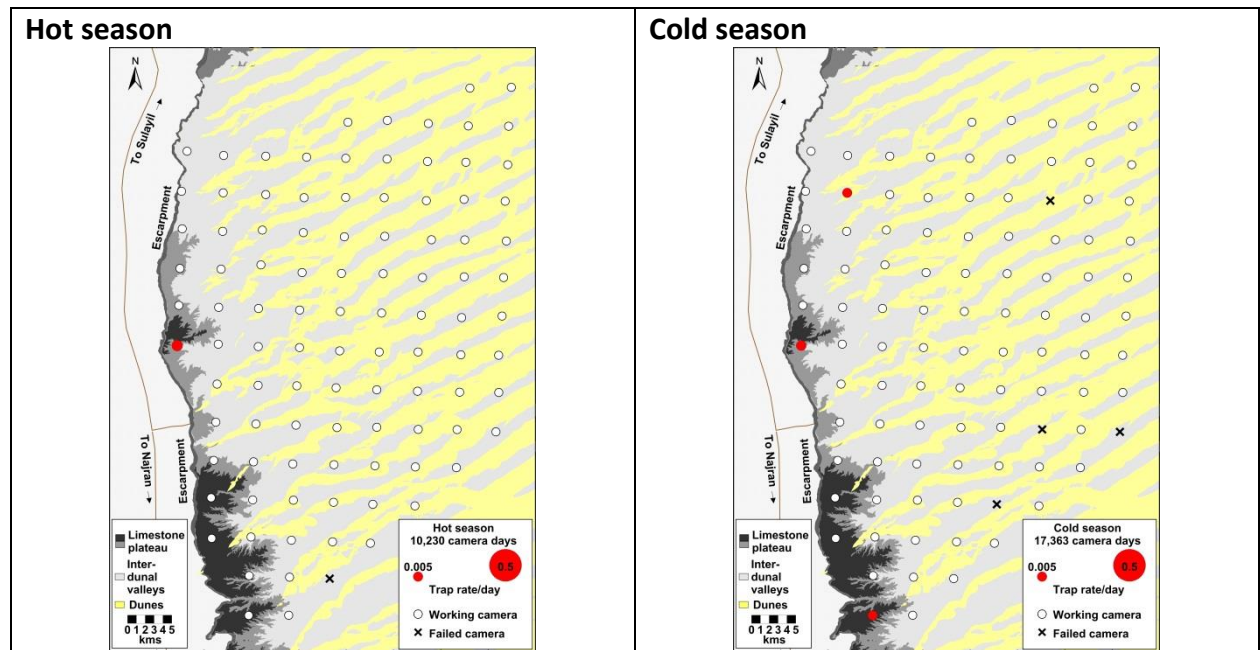
Core area use by distance from escarpment	Habitat use
NOT RELEVANT	NOT RELEVANT

Daily trap rate
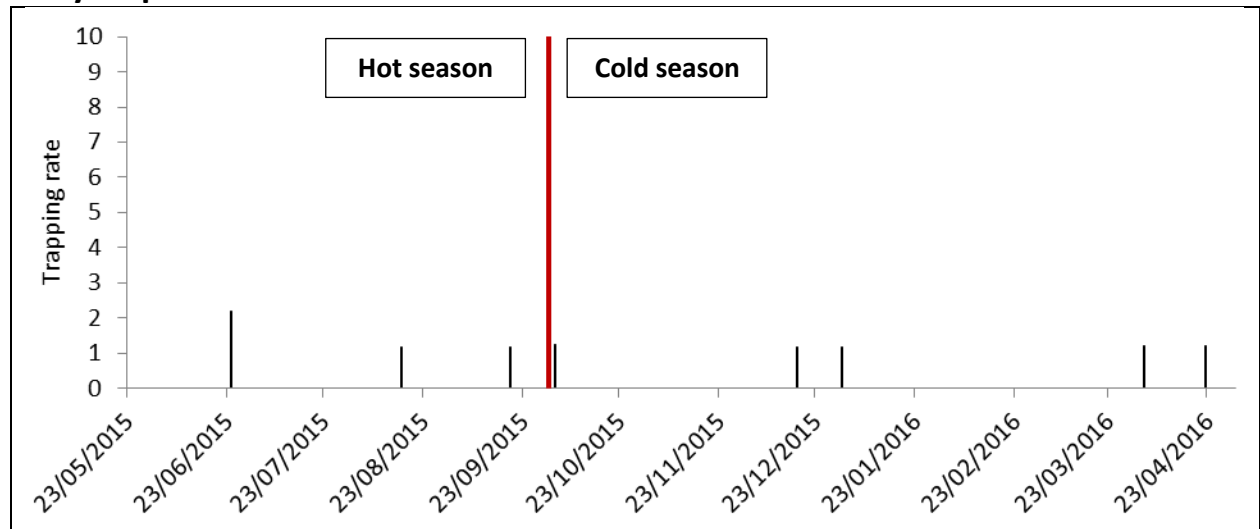
13) DROMEDARY (*Camelus dromedarius*)

Global conservation status: N/A

Specific notes
- Most frequently encountered in the cool season, with detections of camel inside the core area indicate that the strict no-use policy for this zone is not being adhered to.
- Primarily diurnal in activity.

Detections

Survey	Number of sites detected (total sites)	Number of events	Number of images	Proportion of sites detected	Trap rate / 100 days
Hot season (23/05/15 – 30/09/15)	1 (96)	16	264	0.01	0.16
Cold season (01/10/15 – 30/04/16)	14 (95)	30	579	0.15	0.17

24 hour activity pattern

Distribution

Hot season

Cold season


Core area use by distance from escarpment

Habitat use
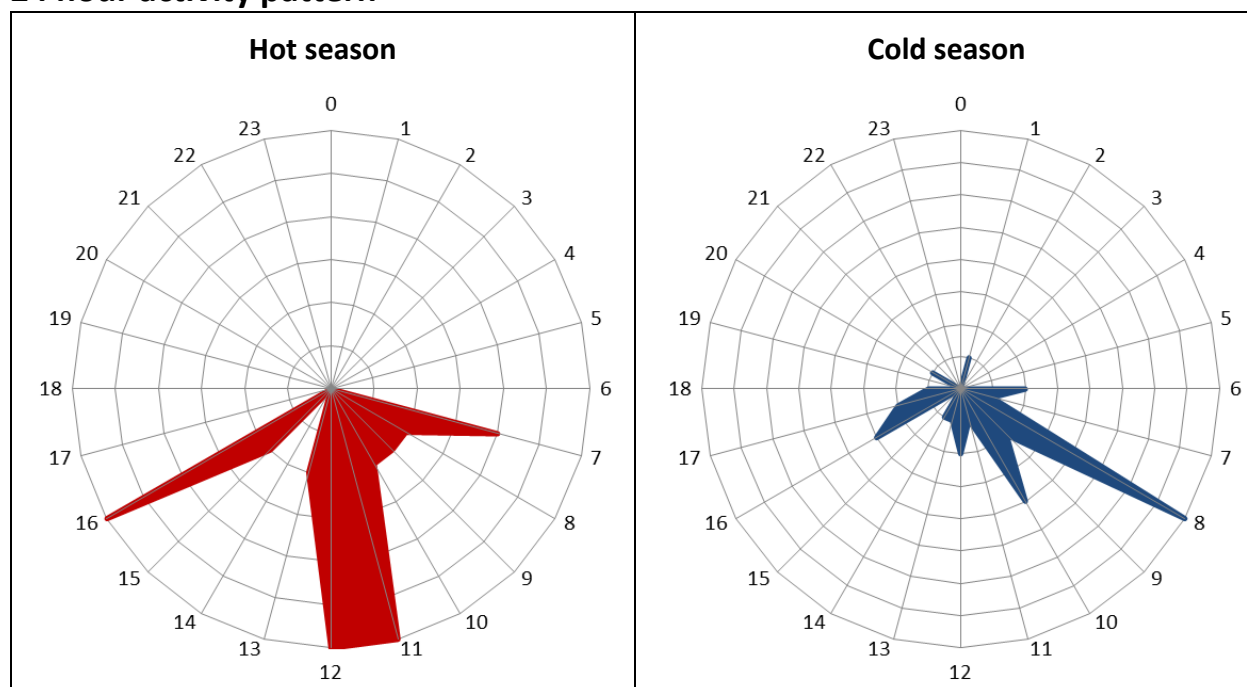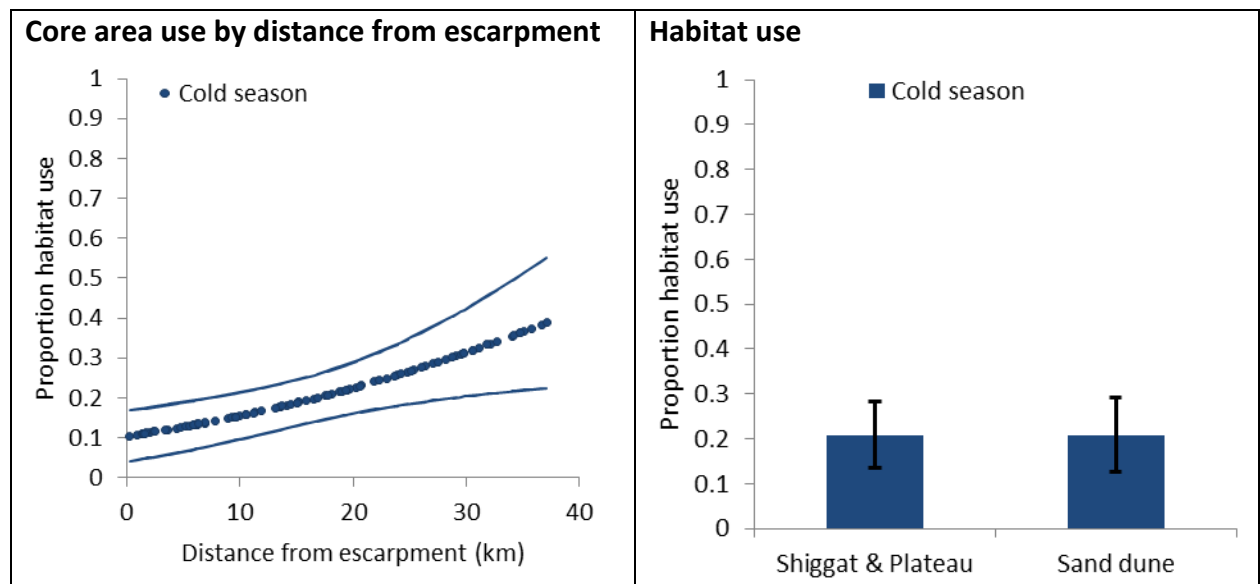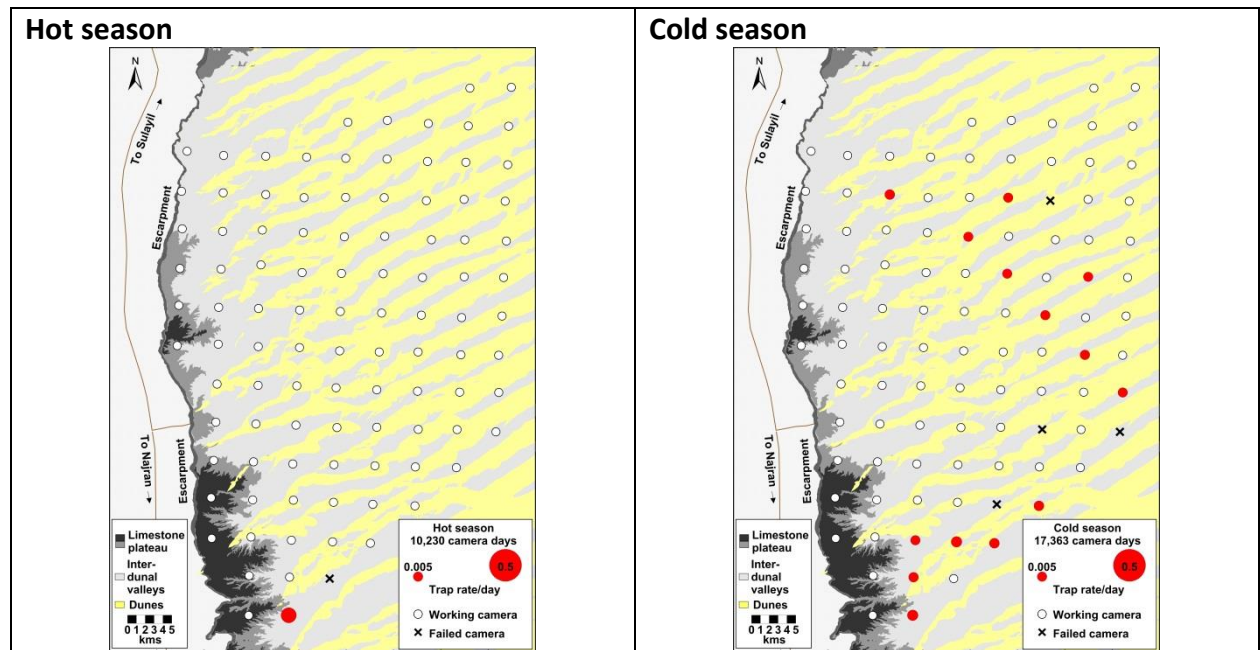
Daily trap rate
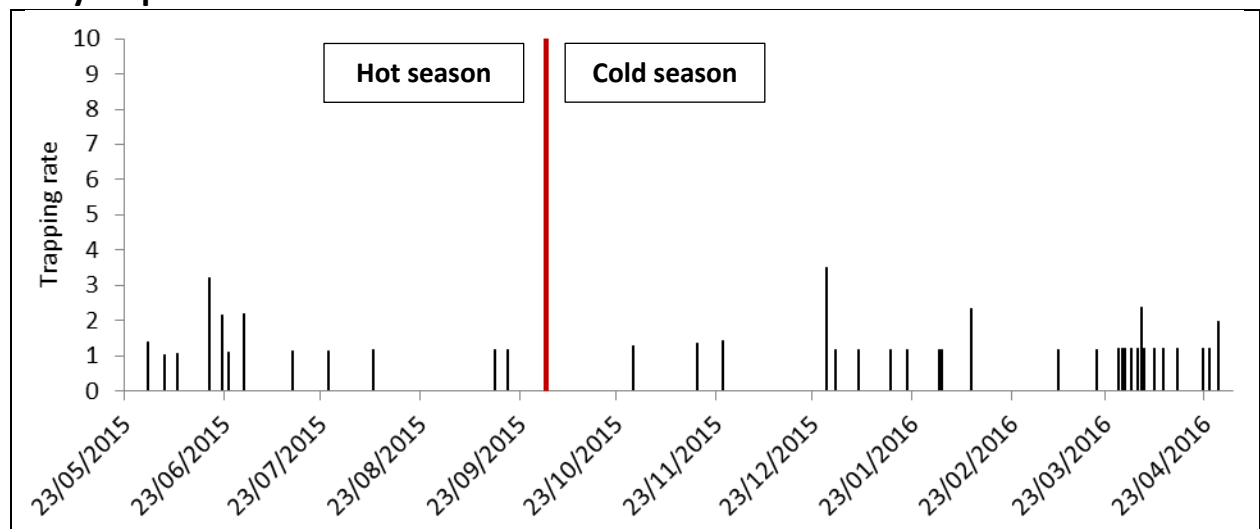
Annex I – Birds & Reptiles

Additional species detected in the Uruq Bani Ma'arid camera trap array are listed below.

Birds

Scientific name	Common name	Hot Season	Cold Season
Aquila chrysaetos	Golden eagle	N	Y
Buteo rufinus	Long-legged buzzard	N	Y
Circus macrourus	Pallid harrier	N	Y
Torgos tracheliotos	Lappet-faced vulture	N	Y
Streptopelia roseogrisea	African collared dove	Y	Y
Streptopelia turtur	European turtle dove	Y	N
Oena capensis	Namaqua dove	N	Y
Coturnix coturnix	Common quail	N	Y
Bubo ascalaphus	Pharaoh eagle-owl	N	Y
Caprimulgus aegyptius	Egyptian nightjar	N	Y
Upupa epops	Hoopoe	Y	N
Alaemon alaudipes	Greater hoopoe-lark	Y	Y
Calandrella brachydactyla	Short-toed lark	Y	N
Ammomanes deserti	Desert lark	Y	N
Ammomanes cinctura	Bar-tailed desert lark	Y	N
Eremopterix nigriceps	Black-crowned sparrow-lark	Y	N
Corvus ruficollis	Brown-necked Raven	Y	Y
Lanius excubitor	Great grey shrike	N	N
Lanius collurio	Red-backed shrike	N	Y
Oenanthe deserti	Desert wheatear	N	Y
Oenanthe isabellina	Isabelline wheatear	Y	N
Oenanthe hispanica	Black-eared wheatear	Y	N
Oenanthe pleschanka	Pied wheatear	N	N
Phoenicurus sp.	Redstart sp.	N	Y
Sylvia nana	Asian desert warbler	Y	N
Phylloscopus sp.	Chiffchaff sp.	N	Y
Hippolais languida	Upcher's Warbler	Y	N

Reptiles

Scientific name	Common name	Hot Season	Cold Season
Uromastyx aegyptia	Egyptian spiny-tailed lizard	Y	Y
Scincus mitranus	Eastern Skink	Y	Y
Varanus griseus	Grey monitor	Y	Y
Cerastes cerastes	Horned desert viper	Y	N

Lappet-faced vulture

Golden eagle

Common quail

Long-legged buzzard

Greater hoopoe lark

Sand partridge

Horned viper

Desert monitor
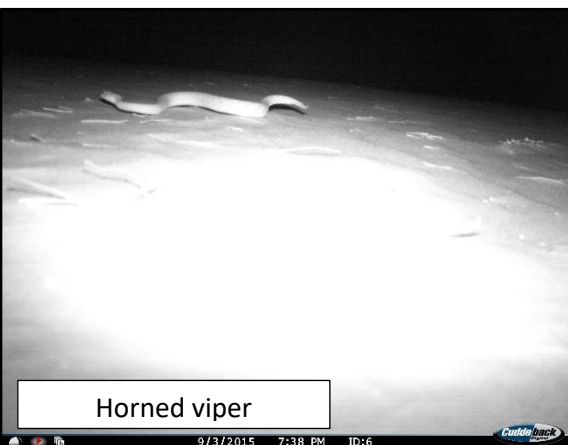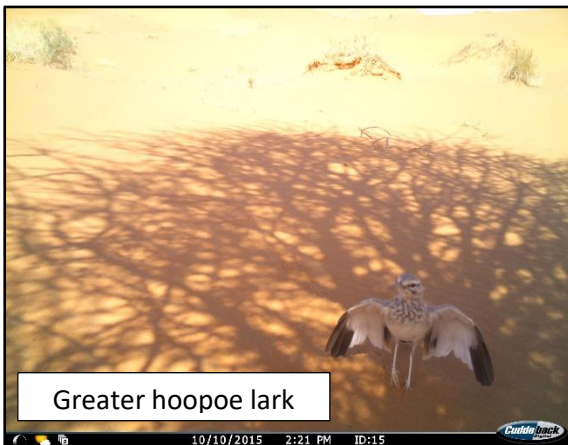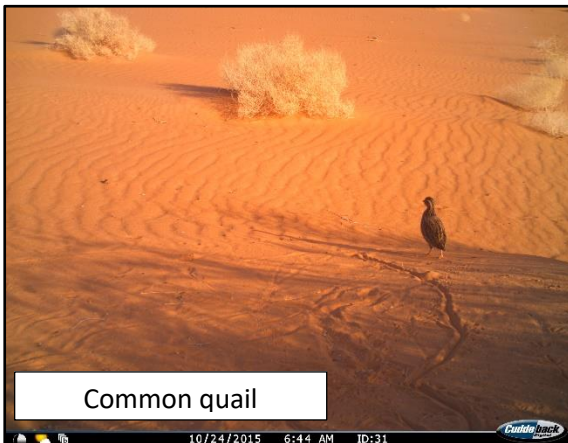
Annex II – CAMERA TRAP LOCATION COORDINATES

Camera Trap Station Label	Latitude DD.dddd	Longitude DD.dddd	Distance from escarpment km		Camera Trap Station Label	Latitude DD.dddd	Longitude DD.dddd	Distance from escarpment km
UBM_A03	19.41036	45.13194	1.31		UBM_E09	19.15994	45.28929	18.08
UBM_A04	19.36787	45.12600	0.26		UBM_E10	19.11796	45.29028	18.76
UBM_A05	19.32818	45.12674	0.97		UBM_E11	19.07865	45.28716	19.44
UBM_A06	19.28633	45.12438	2.04		UBM_E12	19.03881	45.28658	19.06
UBM_A07	19.24722	45.12320	1.34		UBM_E13	18.99698	45.28562	17.73
UBM_A08	19.20466	45.12156	1.51		UBM_E14	18.95814	45.28266	16.16
UBM_B03	19.40586	45.17053	2.39		UBM_F02	19.44283	45.34335	20.3
UBM_B04	19.36631	45.17011	1.75		UBM_F03	19.40182	45.34290	19.75
UBM_B05	19.32559	45.16949	1.52		UBM_F04	19.36111	45.34013	19.34
UBM_B06	19.28559	45.16787	1.61		UBM_F05	19.32027	45.34084	16.85
UBM_B07	19.24509	45.16494	4.45		UBM_F06	19.28066	45.33921	20.78
UBM_B08	19.20623	45.16479	4.79		UBM_F07	19.23912	45.33728	21.91
UBM_B09	19.16387	45.16362	5.27		UBM_F08	19.19796	45.33506	22.33
UBM_B10	19.12366	45.16228	6.29		UBM_F09	19.15791	45.33224	22.99
UBM_B11	19.08312	45.16008	5.57		UBM_F10	19.11819	45.33242	23.9
UBM_B12	19.04365	45.15733	5.93		UBM_F11	19.07744	45.33038	23.67
UBM_B13	19.00071	45.15792	3.65		UBM_F12	19.03674	45.32814	21.86
UBM_C03	19.40498	45.21512	6.86		UBM_F13	18.99551	45.32560	20.64
UBM_C04	19.36447	45.21510	6.2		UBM_G02	19.43962	45.38682	24.82
UBM_C05	19.32692	45.21152	6.04		UBM_G03	19.39944	45.38586	24.25
UBM_C06	19.28502	45.20884	5.86		UBM_G04	19.35797	45.38474	23.25
UBM_C07	19.24393	45.20736	3.43		UBM_G05	19.31667	45.39006	25.36
UBM_C08	19.20367	45.20704	2.48		UBM_G06	19.27672	45.38069	26.34
UBM_C09	19.16249	45.20695	8.99		UBM_G07	19.23688	45.37951	27.04
UBM_C10	19.12170	45.20465	9.34		UBM_G08	19.19789	45.37595	27.51
UBM_C11	19.08162	45.20206	9.62		UBM_G09	19.15633	45.37533	28.26
UBM_C12	19.04137	45.20122	10.56		UBM_G10	19.11603	45.37613	27.81
UBM_C13	19.00219	45.19942	9.99		UBM_G11	19.07632	45.37308	26.01
UBM_C14	18.96133	45.19748	9.67		UBM_G12	19.03510	45.37268	25.14
UBM_C15	18.91916	45.19704	7.77		UBM_H01	19.47705	45.43077	29.15
UBM_D03	19.40404	45.25823	11.35		UBM_H02	19.43714	45.42911	28.82
UBM_D04	19.36114	45.25555	10.58		UBM_H03	19.39865	45.42655	29.52
UBM_D05	19.32415	45.25475	10.58		UBM_H04	19.35933	45.42456	29.8
UBM_D06	19.28193	45.25340	9.65		UBM_H05	19.31644	45.42527	30.53
UBM_D07	19.24224	45.25089	6.96		UBM_H06	19.27748	45.42464	31.18
UBM_D08	19.20250	45.25064	6.38		UBM_H07	19.23425	45.42194	32.12
UBM_D09	19.16219	45.24788	13.46		UBM_H08	19.19484	45.42130	32.78
UBM_D10	19.12040	45.24698	13.56		UBM_H09	19.15531	45.41983	31.86
UBM_D11	19.07943	45.24357	14.15		UBM_H10	19.11588	45.41724	30.6
UBM_D12	19.04106	45.24424	15.23		UBM_H11	19.07558	45.41638	29.82
UBM_D13	18.99870	45.24220	14.53		UBM_I01	19.47792	45.47441	34.72
UBM_D14	18.95956	45.24017	13.74		UBM_I02	19.43677	45.47164	34.07
UBM_D15	18.91932	45.23928	11.92		UBM_I03	19.39602	45.47069	34.25
UBM_E02	19.44099	45.30187	15.9		UBM_I04	19.35739	45.46809	35.07
UBM_E03	19.40272	45.29958	15.2		UBM_I05	19.31527	45.46929	35.79
UBM_E04	19.36144	45.29947	15.07		UBM_I06	19.27667	45.46643	36.68
UBM_E05	19.31981	45.29814	13.15		UBM_I07	19.23590	45.46476	37.12
UBM_E06	19.28103	45.29513	11.22		UBM_I08	19.19440	45.46117	36.21
UBM_E07	19.24079	45.29383	16.56		UBM_I09	19.15509	45.46122	34.72
UBM_E08	19.19910	45.29318	17.55		UBM_I10	19.11346	45.45818	34.18

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