EXPEDITION REPORT

Expedition dates: 21 - 28 January 2017

Report published: December 2018

Ways of the desert: conserving Arabian oryx, Gordon's wildcat and other species of the Dubai Desert Conservation Reserve, United Arab Emirates.

محمية دبي الصحراوية
DUBAI DESERT CONSERVATION RESERVE

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Ways of the desert: Conserving Arabian oryx, Gordon's wildcat and other species of the Dubai Desert Conservation Reserve, United Arab Emirates.

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Abstract

The successful collaboration between Biosphere Expeditions and the Dubai Desert Conservation Reserve (DDCR), initiated in 2012, continues with citizen scientists collecting data for a week from 21 to 28 January 2017. Data gathered alerted the DDCR management to several conservation issues and also allowed for informed, fact-based management decisions to be made in a showcase of how the work of citizen scientists can aid the efforts of conservation professionals.

The 2017 expedition conducted quadrant surveys, circular observations, camera trapping for animals and a vegetation survey.

The expedition observed the following target species during a quadrant survey: 345 Arabian oryx (*Oryx leuoryx*), 360 mountain gazelle (*Gazella gazella*), 69 sand gazelle (*Gazella marica*), 2 red fox (*Vulpes vulpes arabica*), 5 Arabian hare (*Lepus capensis*) and 3 pharaoh eagle owls (*Bubo ascalaphus*).

In 2017, an emphasis on collecting good data from circular observations meant very few counts/observations at the feedspots and therefore a greatly reduced final count of Arabian oryx when compared to both the 2016 Biosphere Expeditions count and the DDCR count. This is also reflected in the predicted distribution of Arabian oryx across the DDCR, with fewer areas with a high concentration of animals, not reflecting the true distribution of the reserve's oryx herd. However, this methodology greatly improved the counts and predicted distribution of the Arabian gazelle, reflecting their natural behaviour of smaller family groups, which are more widely distributed and with very few congregations of large groups. The counts of sand gazelle were consistent with the previous year's count and can be considered an accurate estimate of the population within the DDCR. Their predicted distribution has contracted from that of 2016 with some areas predicted not to have any sand gazelle. However, the hotspots were consistently in the southwest of the DDCR and correlated to a concentration of individuals at the Tawi Ghadier irrigated area.

In 2017, Biosphere Expeditions for the first time collected data on the distribution of vegetation, in particular large shrubs and trees. Nearly 10,000 plants were counted during the circular observations. The dominant species was fire bush (*Leptadenia pyrotechnica*) (8,888), the congregated ghaf trees (*Procera cineria*) (823), date palms (*Phoenix dactylifera*) (140) and the more widely distributed Sodom's apple (*Calotropis procera*) (112). Predicted distribution of the two shrub species (*L..pyrotechnica & C. procera*) have provided the DDCR management with the most accurate picture to date of the distribution of these two indicator species for the reserve's habitat.

The 2017 survey of red fox dens showed a 59% reduction in the number of active dens, most of which were abandoned, and a 25% reduction in inactive dens, of which only two dens became active. There were, however, 44 new den sites (14 active, 21 inactive and nine abandoned) discovered in 2017 compared to only seven new sites found in 2016. Continued monitoring of all den locations is recommended on future expeditions. The Arabian red fox will need to be closely monitored due to the sudden reduction in active dens. If any recently deceased foxes are found in the DDCR, the opportunity to perform a post mortem should be undertaken to ascertain the cause of death, as disease could be a potential cause of the sudden decline.

The success of trapping for medium-sized mammals is expected to be limited over the short period of the expedition and as such is unlikely to reflect the true status of the target species, Gordon's wildcat (*Felis silvestris gordoni*) and sand fox (*Vulpes rueppellii*), within the DDCR. A study over a longer period, including the different seasons and a sustained trapping effort, would provide data that could help in assessing the population status of these species, but this is outside the scope of a short-term citizen science expedition. However, data collected from any capture, including size, weight and sex, add useful data to the growing database of these target species within the DDCR.

Of the 18 camera traps set, there were two traps that failed to produce any meaningful photographs. This resulted in a total of 76 trapping days that captured 4,064 images of which 3,312 were live images; 2,363 of these contained naturally occurring fauna and 713 contained humans or vehicles. This included seven photos of the nocturnal Arabian hare and over 270 records of the Arabian red fox. However, the rare and cryptic species within the DDCR, namely Gordon's wildcat and sand fox, were once again not recorded.

The DDCR management's major challenge is the increase of the ungulate population. Approval has been obtained from UAE authorities to translocate Arabian oryx from the reserve to other protected areas and zoological collections within the region and this will alleviate some of the pressure of a growing population on the environment.

The reintroduction of an apex predator to restore a natural ecological process putting top-down pressure on the ungulate population will continue to be explored to hopefully find a socially acceptable solution, as similar reintroductions elsewhere have also had numerous other benefits to the function of the ecosystem.

الملخص

مازال التعاون الناجح بين محمية دبي الصحراوية وبرنامج بعثات المحيط الحيوي مستمرا منذ بدء البرنامج في العام 2012م حيث استمرت الدراسة بتجميع البيانات الحقلية بواسطة متطوعين من غير ذوي الاختصاص لمدة أسبوع من 21 يناير 2017م وحتى 28 يناير 2017م. حيث أيدت البيانات التي تم تجميعها للعديد من الملاحظات والأنشطة من قبل إدارة محمية دبي الصحراوية وكذلك ساعدت المحمية في الحصول على العديد من المعلومات المفيدة واتخاذ قرارات صحيحة والتي تصب في صالح المحمية والتي بدورها ساهمت في تعزيز التعاون المثمر بين المتطوعين المهتمين بالحياة البرية والباحثين العاملين بالمحمية.

أجرت بعثة المحيط الحيوي لعام 2017م العديد من المسوحات العلمية منها ما هو باستخدام المربعات، أو عن طريق تسجيل المشاهدات بصورة دائرية، وكمائن الكاميرات لتسجيل الحيوانات، بالإضافة لمسح النباتات البرية الصحراوية.

تم تسجيل البيانات التالية من خلال دراسة مسوحات المربعات، حيث تم تسجيل 345 فرد من المها العربي(*Oryx leuoryx*) ، 360 غزال الأدمي(*Gazella gazella*) ، 69 فرد من غزال الريم(Gazella marica) ، اثنان من الثعالب الحمراء (*Vulpes arabica*)، خمسة أرانب برية(*Lepus capensis*) ، بالإضافة إلى عدد ثلاث من البوم الصحراوي (*Bubo ascalaphus*).

أنصب التركيز في عام 2017 على تجميع العديد من البيانات الهامة من خلال تسجيل الملاحظات بالطريقة الدائرية مما أدي إلى تسجيل عدد قليل جدا من المشاهدات والملاحظات لأعداد المها العربي في مواقع التغذية مقارنة بكل البعثات السابقة وبالأخص بعام 2016م مما أدي إلى تغير في التوزيع المتوقع لقطيع المها بالمحمية مع وجود أعداد أقل بالمناطق ذات التركيز العالي بالمحمية مما لا يعكس التوزيع الحقيقي لقطعان المها داخل محمية دبي الصحراوية. وبالرغم من ذلك، فإن هذه المنهجية قد حسنت بشكل كبير التعداد الحقيقي والتنبؤ المتوقع للغزال العربي مما يعكس أسلوب وسلوك الغزال الطبيعي للمجموعات العائلية الأصغر المنتشرة بصورة أكبر من المجموعات الكبيرة. في تلك السنة 2017م تم تسجيل نفس الأعداد لغزال الرمال مقارنة مع الأعداد المسجلة في 2016م مما يمكن اعتباره تقديرا دقيقاً لتوزيع غزال الرمال ضمن نطاق محمية دبي الصحراوية بتسجيل بعض النقاط الساخنة في الجنوب الغربي من المحمية.

في عام 2017 تم لأول مرة البدء في تجميع بيانات ومشاهدات توزيع النباتات بالمحمية مثال الأشجار والشجيرات الكبيرة حيث تم حصر أعداد ما يقرب من 10,000 فرد من النباتات من خلال تسجيل المشاهدات في المواقع التي اعتمدت الطريقة الدائرية. كانت الأنواع السائدة هي شجيرات المرخ (*Leptadenia pyrotechnica*) بأعداد تتراوح إلى (9,000شجيرة)، وأشجار الغاف (*Procera cineria*) (823 شجرة)، وأشجار النخيل (*Phoenix dactylifera*) (140 شجرة)، وشجيرة العشار (*Calotropis procera*) (112 شجرة) ولقد ساعدت البيانات التي تم تجميعها عن شجيرات المرخ وشجيرات العشار المحمية لتقدير ادق توزيع لتلك الشجيرات داخل نطاق المحمية والبيئات المناسبة لكلا النوعين.

أظهر المسح الذي أجري عام 2017م لأوكار الثعالب الحمراء انخفاضا في عدد الاوكار النشطة بنسبة 59% مقارنة بالأعوام السابقة حيث تم التخلي عن معظم تلك الأوكار النشطة، وانخفاض بنسبة 25% في الاوكار الغير نشطة والتي لم ينشط منها سوي وكرين أثنين فقط خلال 2017م. مع ذلك، في 2017 تم اكتشاف 44 وكر جديد (14 وكر نشط و21 وكر غير نشط وكذلك 9 أوكار مهجورة) مقارنة بسبعة مواقع جديدة تم اكتشافها والعثور عليها في العام 2016م. من خلال هذا التقرير تمت التوصية بمتابعة الرصد المستمر لجميع المواقع في الرحلات المستقبلية حتى يتم تفسير ظاهرة الانخفاض المفاجئ في الاوكار النشطة وكذلك يوصي بعمليات التشريح بعد الوفاة إذا تم العثور على أي ثعالب متوفاة حديثا للتأكد من السبب الفعلي للوفاة حيث قد يكون أحد الأمراض المنتشرة سببا للوفاة والتراجع المفاجئ في أعداد الاوكار النشطة.

من المتوقع أن يكون نجاح اصطياد الثدييات متوسطة الحجم محدوداً خلال فترة الرحلة القصيرة ومن غير المرجح أن يعكس هذا التسجيل الوضع الحقيقي للأنواع المستهدفة مثال القط جوردون البري (*Felis silvestris gordoni*) وكذلك الثعلب الرملي (*Vulpes rueppellii*) داخل محمية دبي الصحراوية، ولذلك يعتقد أن الدراسة على مدد زمنية أطول وكذلك تمثيل عينات من خلال الفصول الجغرافية المختلفة وبجهود اصطياد مستمرة سوف يوفر بيانات يمكن ان تساعد في تقييم حالة توزيع تلك الأنواع ولكن ذلك لا يمكن تحقيقه من خلال بعثات المحيط الحيوي قصيرة الأجل. ومع ذلك، فإن البيانات التي يتم تجميعها من خلال أي اصطياد بما في ذلك الحجم والوزن والجنس تضيف بيانات مفيدة إلي قاعدة البيانات المتنامية لهذه الأنواع المستهدفة داخل محمية دبي الصحراوية.

من بين 18 كاميرا مراقبة للحياة البرية، كان هناك عدد أثنين كاميرا فشلت في التقاط أي صور ذات معني. نتج عن ذلك ما مجموعه 76 يوما من المراقبة بالكاميرات حيث تم التقاط حوالي 4,064 صورة منها 3,312 صورة حية، وكان عدد 2,363 من تلك المشاهدات للحيوانات الموجودة بالطبيعة وعدد 713 صورة لبشر أو مركبات وشملت تلك المشاهدات بكاميرات المراقبة سبعة صور للأرنب العربي وأكثر من 270 صورة للثعلب الأحمر، وبالرغم من ذلك لم يتم تسجيل الأنواع النادرة داخل المحمية مثال القط جوردون البري، وثعلب الرمال.

يمثل التحدي الرئيسي لمحمية دبي الصحراوية زيادة أعداد المها العربي والغزلان، تم الحصول على موافقة السلطات الإماراتية لنقل أعداد من المها العربي من المحمية إلى مناطق محمية أخري خارج دولة الإمارات العربية المتحدة مما سوف يخفف بعض الضغوط التي تسببها الزيادة المضطردة للقطيع على بيئة المحمية.

Contents

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1. Expedition review

M. Hammer
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (scientific or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This expedition report deals with an expedition to the United Arab Emirates that ran from 21 – 28 January 2017 with the aim of assisting scientists of the Dubai Desert Conservation Reserve (DDCR) to gather scientific data on Arabian oryx, Gordon's wildcat, mountain and sand gazelle and Arabian red fox in order to gain a better understanding of their ecology so that informed management decisions can be made. Arabian oryx and Gordon's wildcat are on the IUCN Red List and the expedition's work will help to ensure the survival of the species in the wild. In gaining a better understanding of the Arabian oryx and Gordon's wildcat, through observations on their movements, habitat and food preferences and through their interaction with other species, this project is able to ascertain what the major threats are to their continued survival. Based on this, project scientists can then develop appropriate management plans that will provide a safe environment for the study species to thrive in.

1.2. Research area

The DDCR is an area of 225 km² that comprises 4.7% of Dubai's land area. Conservation in this area started in 1999 when the Al Maha Desert Resort was opened within a protected area of 27 km² (Al Maha Reserve). One of the first conservation actions of the reserve was a wildlife reintroduction programme for Arabian oryx and the two indigenous gazelle species (sand and mountain gazelle), as well as programmes for the protection of other key components of the ecosystem, in particular the vegetation (close to 6,000 indigenous trees were planted in 1999 to create a natural seed bank which has now led to germination of indigenous plants). In 2001, the resort management began a major environmental audit of the surrounding area. Following this audit a proposal was submitted to the Dubai government for the formation of a formal national park. The proposal was accepted and sanctioned almost immediately, and work began on protecting the area to be known as the Dubai Desert Conservation Reserve.

Figure 1.2a. Flag and location of United Arab Emirates and study site.

An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

Today the DDCR is a representative of the Dubai inland desert ecosystem and is characterised by a sandy desert environment consisting of sand dunes interspersed with gravel plains. There is one rocky outcrop in the north of the reserve, which provides nesting sites for the desert eagle owl and two groves of rare Ghaf trees (*Prosopis cineraria*). The Al Maha Reserve (27 km²) was the core area for the reintroduction of the Arabian oryx, mountain gazelle and sand gazelle. Currently the DDCR contains approximately 450 Arabian oryx from the 100 that were originally reintroduced in 1999. Both the Arabian oryx and the gazelle species have expanded into the DDCR naturally as the amount of human activity has decreased and been controlled. Mountain and sand gazelle can now be seen throughout the DDCR.

1.3. Dates

The expedition ran from 21 - 28 January 2017 and was composed of a team of international research assistants, guides, support personnel and an expedition leader (see below for team details).

1.4. Local conditions & support

Expedition base

The expedition field base was composed of a Bedu style tent camp (of a Bedu mess tent, a modern one and two-person dome tents for sleeping in). Each person had their own dome tent to sleep in (larger tents for couples) and there were campsite-style showers and toilets. All meals were provided by a catering company.

Weather

The UAE has a subtropical, arid climate with sunny blue skies most of the year. Over the eight days of the expedition the weather was overcast most mornings, clearing up to the usual cloudless sky later in the day. The mean low and high temperatures during the expedition were 12º and 26º C. On the first two days of the expedition there was fog cover in the morning, which lifted by 09:30.

Field communications

There was an (emergency) telephone close to base and mobile phones largely worked in and around camp, and around the study site. In the field, two-way radios and mobile phones were used for communication between research teams.

The expedition leader also posted an expedition diary on Biosphere Expeditions' social media sites.

Transport and vehicles

Team members made their own way to the Dubai assembly point in time. From there onwards and back to the assembly point all transport and vehicles were provided for the expedition team, for expedition support and emergency evacuations.

Medical

The expedition leader was a trained first aider, and the expedition carried a comprehensive medical kit. A network of first-rate private and government hospitals in Dubai provided further medical support. Safety and emergency procedures were in place. There were no medical incidences during the expedition and none of the medical support network or safety procedures were called upon.

1.5. Scientists

The expedition's field scientist was Stephen Bell. Born in South Africa, he graduated in Biology in 1996, with a bachelor's degree from the University of Witwatersrand, South Africa. Stephen has spent most of his career guiding throughout South Africa and Zambia in private game lodges. He was also a trails guide in the Greater Kruger National Park where he conducted 5-day walking safaris. Stephen fell in love with the fauna and flora of the Arabian desert while he spent six years guiding in the area at the Al Maha Desert Resort & Spa. Stephen joined the DDCR as a Conservation Officer in 2009 and works closely with on-going conservation projects on the reserve. Stephen has a passion for birding and is always keeping an ear out for the odd bird call. Stephen has always had a keen interest in wildlife; from a young age he was always found playing with all sorts of creepy crawlies. During his time off Stephen can be found with mates diving around the world.

However, Stephen Bell left the DDCR soon after the expedition and the report was written up by Greg Simkins, the DDCR's Conservation Manager. Greg Simkins is also South African by birth and has worked in the field of conservation and protected areas management since 2001. Greg began his career as a field guide in 1999. In 2001, he became a Reserve Officer in the area that later became the DDCR, and was heavily involved in the planning and implementation of eco-tourism activities within the protected area, which was created in 2003. In 2003, Greg took on his current role and was appointed Conservation Manager for the DDCR. He is now responsible for the overall management of the reserve and has been at the forefront of its development from conception in 2003 to its current international recognition. He also plays a major role in conducting key conservation research studies throughout the DDCR. Prior to coming to the Middle East, Greg studied at the University of Natal, Pietermaritzburg in Kwazulu-Natal, where he also did graduate work, including resource assessment and allocation for a farm, soil surveys and research at an ostrich export farm in the Eastern Cape.

1.6. Expedition leader

The expedition was led by Dr. Matthias Hammer, who founded Biosphere Expeditions in 1999. Born in Germany, he went to school there, before joining the Army and serving for several years with the German Parachute Regiment amongst other units. After active service he came to the UK and was educated at St Andrews, Oxford and Cambridge Universities. During his time at university he either organised or was involved in the running of several expeditions, some of which were conservation expeditions (for example to the Brazil Amazon and Madagascar), whilst others were mountaineering/climbing expeditions (for example to the Russian Caucasus, the Alps or the Rocky Mountains). With Biosphere Expeditions he has led teams all over the globe. He is a qualified wilderness medical officer, ski instructor, mountain leader, divemaster and survival skills instructor. Once a rower on the international circuit, he is now an amateur marathon runner and Ironman triathlete.

1.7. Expedition team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were (in alphabetical order and with countries of residence): Albert Arkush (USA), Jim Blomgren (USA), Martina de Marco (Belgium), Samar Elelemy* (UAE), Laura Holt (UK, press), Karin Leitz (Germany), Jörn Paraat-Zierrath (Germany), Kathie Priebe (USA), Sigrid Schramm (Germany), Jörg Schulze (Germany), Richard Tapper (UK, WTTC assessor) and Yvonne Vahlensieck (Switzerland). Also present were Biosphere Expeditions staff Amadeus DeKastle and Tessa Merrie.

*Local placement kindly sponsored by the Friends of Biosphere Expeditions.

1.8. Partners

The main partner on this expedition is the Dubai Conservation Board, a government-appointed organisation concerned with the conservation and protection of the Dubai inland desert. Other partners include the National Avian Research Centre.

1.9. Expedition Budget

Each team member paid towards expedition costs a contribution of £1,240 for the seven-day expedition. The contribution covered accommodation and meals, supervision and induction, all maps and special non-personal equipment, and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs, etc., as well as visas and other travel expenses to and from the assembly point (e.g. international flights). Details on how these contributions were spent are given below.

Income	£
Expedition contributions	15,661
Expenditure	
Staff includes local & international salaries, travel and expenses	2,862
Research includes equipment and other research expenses	1,164
Transport includes car hire, fuel, taxis and other local transport	2,354
Base includes food and camping fees	656
Team recruitment Arabia as estimated % of PR costs for Biosphere Expeditions	6,773
Income – Expenditure	**1,833**
Total percentage spent directly on project	**88%**

1.10. Acknowledgements

This study was conducted by Biosphere Expeditions, which runs wildlife conservation expeditions all over the globe. Without our expedition team members (listed above) who provided an expedition contribution and gave up their spare time to work as research assistants, none of this research would have been possible. The support team and staff (also mentioned above) were central to making it all work on the ground. Biosphere Expeditions would also like to thank the DDCR and its staff, and the Friends of Biosphere Expeditions for their sponsorship and/or in-kind support.

1.11. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Copies of this and other expedition reports can be accessed via www.biosphere-expeditions.org/reports. Enquires should be addressed to Biosphere Expeditions via www.biosphere-expeditions.org/offices.

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2. Desert species surveys

2.1. Introduction and background

The United Arab Emirates, and Dubai in particular, is well known for its rapid development over the past 40 years, as well as for the mega-construction projects such as the Palm Islands and the Burj Khalifa (the world's tallest building). Less well known is the diversity and beauty of the natural environment, from the dugongs and corals in the Arabian Sea, the flamingos in the khors (inlets) of the coastline, the rugged Hajar mountain range, to the serene splendour of the sandy dune inland desert. Also little known is that the largest piece of land given to any single project in Dubai was for the establishment of the DDCR at 225 km² or 4.7% of Dubai's total land area.

Previous work 2012 – 2016

Biosphere Expeditions and the DDCR first considered working together in 2011 and the first joint expedition was run in 2012 in what has become an annual survey expedition each January.

The aim in **2012** (Bell et al. 2013a) was to conduct the first systematic survey of Arabian oryx (*Oryx leucoryx*) and Gordon's wildcat (*Felis silvestris gordoni*) in the DDCR. This was achieved through three main survey activities: Gordon's wildcat live capture survey and camera trapping as well as Arabian oryx monitoring. In addition, the expedition team recorded any other species observation or encounters while in the field.

The live capture survey of 48 trap nights resulted in one capture of a feral hybrid cat. The camera traps recorded 316 pictures over 56 camera days at a capture rate of 2.46 per day. Fourteen oryx herds where surveyed, which gave a male:female sex ratio of 2:3 and an average condition score of 2.81. In conjunction with the camera trap and Arabian oryx monitoring data, the species encounters data provided a snapshot of species distribution and diversity, which served as a comparative baseline for future expeditions data.

In **2013** (Bell et al. 2013b), species studied included the Arabian oryx (classified by IUCN as vulnerable), other antelope species (sand and mountain gazelle, *Gazella marica* and *Gazella gazella*), Gordon's wildcat as well as some major bird and reptile species. A grid methodology was adopted and forty-two grids 2 x 2 km in size were surveyed within the 225 km^2 area of the DDCR. Sample methods included encounter surveys, camera and live trapping and body scoring (for oryx). It was found that mountain gazelle (87 encounters), sand gazelle (26 encounters), Arabian red fox (*Vulpes vulpes arabica)* (24 camera trap pictures) and Arabian oryx were common throughout most of the study area. Gordon's wildcat was not documented by camera or live traps, but only by tracks, which can be misidentified. Because of this result, the DDCR made plans to enhance the population through the reintroduction of genetically pure, captive bred, Gordon's wildcat.

The body condition scoring for oryx revealed malnutrition and supplementary feeding was increased by DDCR management. The expedition found that oryx distribution had largely shifted to the north of the reserve as a result of a sustained drought, but a few hardy and now largely independent herds persisted in the south. Sand gazelle populations shifted northwards within the reserve as a result of expanding populations needing to establish new, if less favourable territories. Nine lappet-faced vultures (*Torgos tracheliotos*), rare in the United Arab Emirates (UAE), were recorded, showing that the DDCR is likely to be the best habitat for this species in the UAE.

In **2014** (Bell & Hammer 2014), citizen scientists collected data on nine target species, namely the Arabian oryx, Gordon's wildcat, mountain gazelle, sand gazelle, Arabian red fox, sand fox (*Vulpes rueppellii*), MacQueen's bustard (*Chlamydotis macqueenii*), lappet-faced vulture and pharaoh eagle owl (*Bubo ascalaphus*). Data gathered alerted the DDCR management to several conservation issues and also allowed for informed, fact-based management decisions to be made, in a showcase of how the work of citizen scientist volunteers can aid the efforts of conservation professionals.

The expedition body-scored 278 Arabian oryx for herd health again, resulting in an average score of 2.9, which is just below the fit and healthy score of 3.0. After the feed increase based on the 2013 expedition results, this was a highly satisfactory management result.

A total of 206 mountain gazelles and 159 sand gazelles were counted during the expedition. Since the majority of these were likely to have been separate individuals, the numbers found for both species were considered to be alarmingly high. It was evident that under current conditions the reserve could not sustain the present oryx and gazelle populations without significant supplementary feeding. Furthermore, previous vegetation surveys showed that the DDCR vegetation was already showing clear signs of overgrazing. Therefore, the expedition concluded that a major management requirement was the establishment of a gazelle carrying capacity for the DDCR, as well as self-sustaining control measures. Such control measures may include the removal of antelopes from the reserve through translocation and the introduction of an apex predator such as the Arabian wolf or hyaena to apply top-down pressure to the antelope populations.

There were no live captures of Gordon's wildcats or feral cats during this expedition and no Gordon's wildcats were photographed by camera traps. However, there was a possible presence observed during the expedition in terms of tracks. The expedition concluded that it is difficult to assess whether the DDCR's Gordon's wildcat population is stable, increasing or declining, and more trapping is needed to assess this. Major threats to the Gordon's wildcat in the DDCR were likely to be the availability of food, as well as hybridisation with feral cats.

A rare sand fox was caught by the expedition for the first time in the history of the DDCR, As a result of this capture, it was concluded that further expeditions should start targeting this species in an attempt to obtain more information about it.

Population modelling using the IDW (Inverse Distance Weighted Interpolation) and diversity indices methods showed distributions in accordance with feed points and habitat preferences. Oryx populations were found to be concentrated around the feed points, as were gazelles. Mountain gazelle distribution was found to follow their preferred stony/rocky habitat distribution.

The MacQueen's bustard population was found to be small and very confined to specific areas of the DDCR. A small increase in numbers was noticed. The lappet-faced vulture was seen fairly regularly as there is a good food source on the DDCR for them. The goal for both species is to have them breed in the reserve in future. Pharaoh eagle owl was a concern and numbers appeared to be on the decline, probably due to the scarcity of rain over the past few years, which affected the vegetation and thereby rodents, which are the owl's primary food source.

In **2015** (Bell & Hammer 2015), citizen scientists continued to collected data on the nine target species of 2014 (see above).

258 oryx were counted in the reserve, most of them likely to be separate individuals. Oryx distribution in the reserve followed artificial feeding points. However, there were found to be too many oryx in the reserve and it was recommended that their numbers be reduced, amongst other things in order to discontinue artificial feeding, which is not in line with the DDCR's goal of non-interference in the reserve. The expedition report argued that this reduction in numbers could be achieved through natural processes by introducing a top predator (most likely the Arabian wolf) into the reserve as soon as fence upgrades were completed.

At 218 individuals counted, the mountain gazelle was at healthy population levels. Its distribution followed habitat preference of vegetated dunes and areas of high vegetation and water around the Al Maha resort.

The sand gazelle population was found to have grown, successfully expanding in the reserve and showing new distribution hotspots that mirrored its preferred vegetated sand dune habitats. Only 37 gazelles were counted by the expedition, but this was a reflection of expedition participants being busy with many other tasks.

Gordon's wildcats and sand foxes continued to be rare and elusive, with no live or camera captures in 2015. This is in contrast to red fox, which was abundant, dominating camera captures alongside oryx.

Pharaoh eagle owls were found again to be in decline, probably due to low rodent prey availability because of a prolonged drought, and due to the abundance of red fox, which prey on the owl's ground nests. This was found to be a concern, which needs to be addressed by management.

The MacQueen's bustard population was found to be small again with low nesting incidences and success, despite favourable conditions. The reasons for this may be another area for future expeditions to investigate.

The lappet-faced vulture was found to have gone from rare to abundant and the DDCR is now the best place in Dubai to observe vultures. However, no nesting was observed, despite favourable conditions. This conundrum was suggested to be another area for future expedition investigation.

A limited pilot rodent trapping effort in one habitat, yielding 13 individuals of one species (Cheesman's gerbil *Gerbillus cheesmani*), suggested that the rodent population had not suffered greatly from the drought conditions and abundance of red foxes. This finding was in contrast to the pharaoh eagle owl decline, which suggested a decline in the rodent population. It was argued that rodent trapping efforts should be expanded during future expeditions to capture more species in a larger variety of habitats in order to corroborate or disprove the owl decline hypothesis.

In **2016** (Simkins et al. 2016), the expedition observed 498 Arabian oryx, 181 mountain gazelle, 71 sand gazelle, 38 lappet-faced vultures, 8 MacQueen's bustards, 2 red fox, 1 Arabian hare (*Lepus capensis*) and 1 pharaoh eagle owl. An improved survey methodology of circular observations within each quadrant significantly improved data quality, thereby improving predicted species distributions.

Live trapping was carried out for small- (rodents) and medium- (wildcat and fox) sized mammals over a trapping effort of 72 and 83 trapping nights respectively. Trapping success was very low, with only three Cheesman's gerbils captured.

The red fox den survey revisited 161 den sites and identified seven new dens. In the five-year period between surveys, the number of active dens has not decreased significantly, although only 34% of den statuses remained the same as in 2011. Twenty-five inactive dens became active and 24 active dens became inactive. Only 18% of active dens were abandoned, whereas 47% of inactive dens were abandoned.

Camera traps (unbaited in 2016) captured 12 Arabian oryx, 4 Arabian Gazelle and 1 Arabian hare.

The expedition survey results since 2012 showed an increase of all the reserve's ungulate species and the management of the DDCR is well aware that in order to achieve the stated aim of herd self-sustainability, the size of the ungulate populations will have to match the carrying capacity for ungulates of the DDCR as provided by the natural vegetation. A long-term study to determine the carrying capacity of the reserve is ongoing. In 2016, DDCR management suspected that the population levels exceeded carrying capacity, especially during extended dry periods. Control measures considered consisted of a combination of an apex predator reintroduction, species relocation and utilisation.

Background on species under investigation

Arabian oryx (*Oryx leucoryx*) is one of four oryx species, all of which are adapted to arid and semi-arid environments. Locally known by its Arabic name of Al Maha, the Arabian oryx was first described in 1777. Endemic to the Arabian Peninsula, the Arabian oryx's historical range was across Oman, Saudi Arabia, Jordan, United Arab Emirates, Yemen, Kuwait and Iraq, but the advent of firearms saw their rapid decline due to hunting all across Arabia. Since 1986 the Arabian oryx has been classified as "Endangered" on the IUCN Red List, but was already "very rare and believed to be rapidly decreasing in numbers" in 1965. The Arabian oryx is the largest of the antelopes in the region and it is very well adapted to the extremely arid environment. It is culturally significant in Arabia, revered for its beauty, and is common in poetry and as a woman's name, Maha. Reintroduced into the DDCR in 1999, the population has steadily grown from the original 100 individuals to nearly 500 today.

Figure 2.1a. Arabian oryx (photo courtesy of S. Bell).

The Arabian oryx is a medium-sized antelope with a distinct shoulder bump, long straight horns, and a tufted tail; it is a bovid, and the smallest member of the oryx genus, native to desert and steppe areas of the Arabian Peninsula. The Arabian oryx was extinct in the wild by the early 1970s, but was saved in zoos and private preserves and reintroduced into the wild starting in 1980. Arabian oryx prefer to range in gravel desert or hard sand, where their speed and endurance will protect them from most predators, as well as most hunters on foot. In the DDCR they are found in the hard sand areas of the flats between the softer dunes and ridges. The diet of the Arabian oryx consists mainly of grasses, but they will eat a large variety of vegetation, including trees, buds, herbs, fruit, tubers and roots. Herds of Arabian oryx are known to follow infrequent rains to eat the new plants that grow afterwards (Talbot 1960).

The **Gordon's wildcat (*Felis silvestris gordoni*)** is the same size as a domestic cat. The background colour of its coat ranges from reddish and sandy yellow to tawny brown and grey, and is typically marked with faint tabby stripes and spots. Its preferred habitat is the vegetated dunes, gravel plains and mountains, in which it hunts a carnivorous diet at night. It is thinly distributed throughout the Nubian, Saharan and Arabian deserts, where it is generally restricted to mountains and dry watercourses. The biggest threat to the survival of the Gordon's wildcat as a species is the interbreeding with feral or domestic cats, which could lead to its extinction as a distinct species. Very little is known about the Gordon's wildcat population within the DDCR. The last population estimate was done in 2004. The expedition has enabled DDCR scientists to update information on population size and distribution as well as conduct a DNA study of the species; information that is important for informed management decisions to be made and threats to be averted.

Figure 2.1b. Gordon's wildcat (photo courtesy of P. Roosenschoon).

The **Arabian or mountain gazelle (*Gazella gazella*)** has a delicate body of 10 to 14 kg and can reach speeds of 65 km/h if it needs to escape danger. The mountain gazelle has a pure white belly with a dark to black stripe on its flanks that changes to dark beige or brown on the back, the neck and the head. The facial markings consist of various shades of brown with two white stripes extending from the eyes towards the nostrils. Females can give birth to a single fawn during any month, but with natural peaks in spring and autumn. Most grazing activity takes place at dawn and dusk. It rests during the hottest hours of the day under any shelter available, which may be a cave for those that inhabit the mountains. Usually moving in small groups of four to six animals, the species is highly territorial, with the dominant male continuously marking its territory with a wax-like substance, which it produces in glands below the eyes. The substance is deposited by the gazelle rubbing its head against a bush, a branch or a stone. The group also maintains several places within its territory, which it establishes as "toilets". The animals usually only defecate and urinate at these sites. As with oryx and sand gazelle, mountain gazelles do not need to drink water, but will readily do so if water is available (Grubb 2005).

Figure 2.1c. Arabian gazelle (photo courtesy of G. Simkins).

The **sand gazelle's (*Gazella leptoceros*)** elegantly curved horns of both males and females are considerably longer than those of other gazelles occurring in the area. The animals are very light in colour, the head completely white in older animals, with back and flanks light beige. The belly is white and there is no darker stripe between the white underside and the beige flanks and back of the gazelle. Contrasting with the overall pale body are the black eyes, nostril and mouth. Their colouring is obviously an adaptation to the habitat they favour, which are the open sands. They are absent from the mountains. The sand gazelle is the only antelope in this area that regularly gives birth to twins, and this usually in spring and autumn. The young spend their first days in shallow scrapes, or under a small bush, until they are strong enough to move with the adults (UAEInteract 2012).

Figure 2.1d. Sand gazelle (photo courtesy of G. Simkins).

The **Arabian red fox (*Vulpes vulpes arabica*)** is widespread in the region. Highly adaptable, it inhabits virtually every environment and lives in the cities along the coast, the desert and the mountains. However, it does not seem to penetrate areas such as the Liwa with soft sand and high dunes. An omnivorous animal, it will eat almost anything, from dead fish on the beach, to dates, carrion and of course small mammals and birds, which it actively hunts during the night. The cubs, numbering up to six per litter, are raised in a burrow that the vixen excavates herself and often uses year after year. Cubs are born in early spring, fully furred but blind; their eyes open after about 10 days. At the age of four weeks they start taking solid food and this is also the time when they begin exploring the surroundings of their burrow. Soon after this they follow the vixen on short hunting trips. As it lacks the long dense fur of the European fox, the Arabian fox appears to have a thin body and long legs, but proportionally they are the same, with the exception of the ears. These are larger and have thousands of tiny blood vessels that help the Arabian fox to maintain its body temperature. Reddish to sandy-brown, its colour has adapted to the environment in which it is living (Harrison and Bates 1991, Hellyer 1993).

Figure 2.1e. Arabian red fox (photo courtesy of J. Babbington).

The **sand fox (*Vulpes rueppellii*)**, also know as Ruppell's, Rueppell's or Rüppel's fox, is a species of fox living in North Africa and the Middle East, from Morocco to Afghanistan and the southwestern parts of Pakistan. It has an average life expectancy of up to six or seven years in the wild, but can live longer in captivity. Sand foxes are about 40-52 cm long and have an average weight of 1.7 kg. It is a very small canine, and is considerably smaller than the red fox. It is sandy in colour and has black patches on the muzzle, as well as a white-tipped tail. The sand fox relies on scent glands for many activities. It uses them to mark territories as well as to spray at unwanted predators, similar to the behaviour of the skunk. The female sand fox uses her scent glands to mark the cubbing den. Another use for the scent glands is to greet each other. Sand foxes can bark, in a way similar to a dog. During the mating season, they travel in monogamous groups, or a male and a female, but after the breeding season, the fox reportedly moves in family groups of 3-15 individuals. One animal occupies about 50-69 km^2 of territory, with the male's territory larger than that of the female. The sand fox is nocturnal and gregarious. Animals change dens often, and will abandon a den if there is a dangerous disturbance in the area. Most dens are dug under rocks or under trees.

The sand fox was pushed to living in the desert biome due to competition with its larger cousin, the red fox. It is known as being an extremely good survivor. It is preyed upon only by the steppe eagle and the eagle owl. A solitary forager and omnivore, it will eat almost anything that crosses its path. It is mostly an insectivore, but its diet also consists of tubers and roots, as well as small mammals, reptiles, eggs, and arachnids. The female sand fox has a gestation period of around 51–53 days. She has 2-3 offspring, and each is born blind. They are weaned at 6–8 weeks of age. They are born underground as protection from predators.

Figure 2.1f. Sand fox (photo courtesy of R. Ingram).

The **MacQueen's bustard (*Chlamydotis macqueenii*)** is a large bird in the bustard family. It breeds in southwestern Asia, in deserts and other very arid sandy areas. It is brown above and white below, with a black stripe down the sides of its neck. In flight, the long wings show large areas of black and brown on the flight feathers. Sexes are similar, but the female is smaller and greyer above. The MacQueen's bustard has recently been split as a separate species from the Houbara bustard (*Chlamydotis undulata*) of the Canary Islands and North Africa. These two species are the only members of the *Chlamydotis* genus (Ali 1993). The dividing line between the two species is the Sinai Peninsula. The MacQueen's has a greater tendency to wander than the more sedentary Houbara bustard. Both species have been hunted to near-extinction. Conservation efforts by the late Sheikh Zayed bin Sultan Al Nahyan in the UAE have given some hope for the future of the MacQueen's bustard.

Figure 2.1g. MacQueen's bustard (photo courtesy of S. Bell).

The **lappet-faced vulture (*Torgos tracheliotos*)** is a mostly African Old World vulture belonging to the bird order Accipitriformes, which also includes eagles, kites, buzzards and hawks. It is usually found in undisturbed open country, at elevations from sea level to 4,500 m (Ferguson-Lees & Christie 2001), with a scattering of trees and it apparently prefers areas with minimal grass cover. While foraging, it can wander into denser habitats and even into human habituated areas, especially if drawn to road kills. The species is fairly rare in the UAE, but good sightings have been made in the DDCR and it is the best place in the UAE to find the species. It is hoped that it will start to nest in the DDCR in the near future.

Figure 2.1h. Lappet-faced vulture (photo courtesy of G. Simkins).

The **pharaoh eagle owl (*Bubo ascalaphus*)** or desert eagle owl was heard every evening around the camp. These owls can be found in rocky deserts and semi-deserts, gorges, cliffs, and rocky mountain slopes. During the day they are mostly seen sleeping under fire bushes (*Leptadenia pyrotechnica*) and will take flight if disturbed.

Figure 2.1i. Pharaoh eagle owl (photo courtesy of G. Simkins).

2.2. Methods

Expedition participants assisted DDCR scientists in four important surveys: live trapping (targeting Gordon's wildcat), fox den survey, camera trapping and ungulate monitoring (Arabian oryx, Arabian gazelle, sand gazelle). In addition to these surveys, the participants were tasked with recording any other species while in the field.

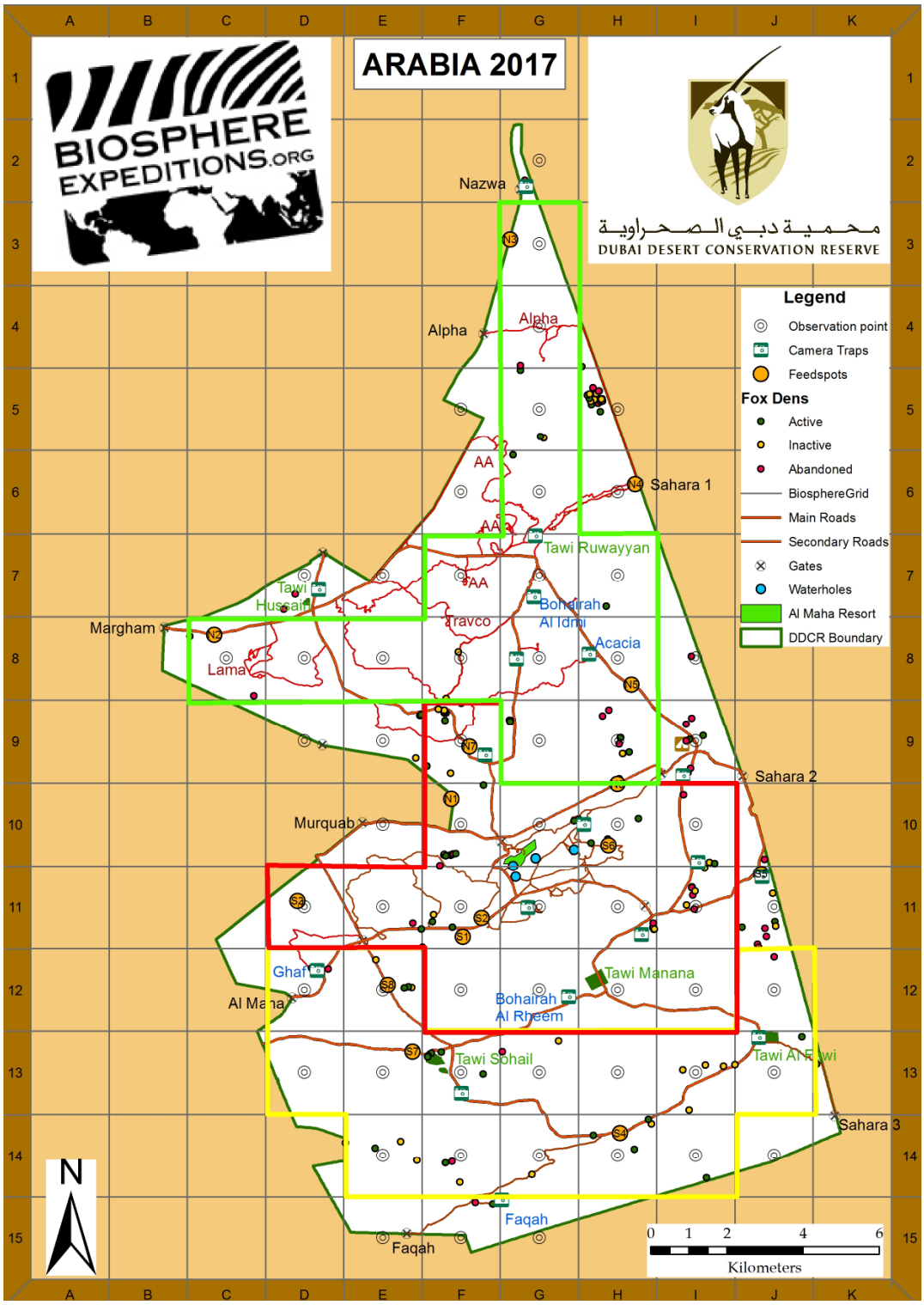


Figure 2.2a. The DDCR and its survey zones (North = green, Central = red, South = yellow). The perimeter zone comprises all other zones within the DDCR.

After a training period that lasted one and a half days, participants were split into four groups to conduct the various surveys, in four separate zones of the DDCR, namely a North Zone, Central Zone, South Zone and Perimeter Zone (see Figure 2.2a). Each zone comprised fifteen 2 x 2 km quadrants, the perimeter zone comprised of 17 partial quadrants. These 62 quadrants together represented approximately 214 km² of the 225 km² of the DDCR (or 95%). The area included all key habitats of vegetated dunes, sand dunes and gravel plains.

Every day each group of expedition participants was tasked to survey four quadrants or approximately 16 km². A total of 62 quadrants (214 km²) were surveyed in this way during the expedition. During surveys any target species encounters were recorded in the relevant datasheets.

Target species quadrant survey

A more structured approach to the target species survey was implemented by this expedition, based on the experiences from previous expeditions. It involved the selection of one observation point within 300 m of the centre of the quadrant, which provided a good vantage point. From this vantage point a 360º circular observation of the surrounding area was carried out by four participants with binoculars for 30 minutes.

Target species as described above and encountered during these surveys were recorded in the datasheets as follows: species name, position of researcher when the species was first seen, distance and bearing from researcher to target species, time of day when the species was observed, ecological information such as number of animals, sexes etc., additional comments. In addition, for the first time on this project, trees and large shrubs were counted as well.

During analysis, IDW (Inverse Distance Weighted Interpolation) was used to predict the value (abundance and distribution of species sampled at each cell) of cells at locations that lack sampled points (ESRI 2012). Inverse distance weighted methods determine cell values using a linear-weighted combination set of sampling points and are based on the assumption that the interpolating surface should be influenced mostly by the nearby points and less by the more distant points. The interpolating surface is a weighted average of the scatter points, and the weight assigned to each scatter point diminishes as the distance from the interpolation point to the scatter point increases. Abundance counts over the study area were used as input and predictions were applied to all the species recorded using ESRI® Arc Map 10.0 spatial analyst extensions.

Live traps for medium-sized animals

Four Tomahawk live traps were used during the expedition for the purpose of capturing Gordon's wildcat. At the beginning of the expedition, each survey group was given a live trap to place within their allocated zones (North, South, Central and Perimeter zones). Each group marked the position of the live trap in the GPS. The live traps were baited with tinned sardines and left out in the field for five nights, resulting in a total of 20 trap nights. The bait was placed right at the back of the trap (using an extendable reacher/grabber), forcing the animal to step onto a pressure plate to trigger the trap. The pressure plate was covered with sand to give the trap a more natural feel and to ensure that the target species was at ease when entering the trap.

Each morning groups set out into their zones to check each of their live traps. This involved checking the surroundings of the traps for a possible presence/absence record from tracks around the trap, to see if the trap had been disturbed or investigated by a Gordon's wildcat or a feral cat. Where necessary, traps were rebaited.

Arabian red fox den survey

The Arabian red fox is the largest predator within the DDCR, so it is important to monitor its population. The red fox is both a nocturnal and cryptic species, so direct counts are unreliable. A better method of monitoring the population is through a count of their dens. This was initially done by DDCR staff in 2011 and then repeated in 2016 with the help of Biosphere Expeditions, when all dens were classified as either active, inactive or abandoned based on signs of fox activity such as tracks, fresh digging, prey remains and fresh scat.

During the 2017 expedition all dens sites were revisited and once again classified based on signs of fox activity, with an additional classification of abandoned when the den had filled in with sand. In addition, any new dens found were recorded and classified.

Camera trapping

As many species in the desert environment are both nocturnal and elusive, it is difficult to gather reliable information on their populations. A camera trap triggers when an animal passes in front of an infrared and/or motion detector. This has the advantage of detecting with equal efficiency both nocturnal and diurnal activities with minimal environmental disturbance.

Eighteen camera traps (three Reconyx RC60, five Reconyx Hyperfire and ten Bushnell Trophy Cam HD) were used during the expedition, four cameras in four zones, plus two extras. Predetermined quadrants in each of the zones were chosen for the survey groups to set their camera traps in, close to water sources. As in 2016, the traps were not baited (as this tended to attract red foxes, probably keeping Gordon's wildcats away as a result) and left out in the field for five days, resulting in potentially 90 trap nights.

2.3. Results

Species encounters

Table 2.3a Species encountered during the expedition. Encounter method S = sighting, L = live trap, C= camera trap.

Common name	*Latin name*
Birds	
Egyptian goose S C	*Alopochen aegyptiaca*
Northern pintail S	*Anas acuta*
Pallid harrier S	*Circus macrourus*
Shikra S	*Accipiter badius*
Long-legged buzzard S	*Buteo rufinus*
Bonelli's eagle S	*Aquila fasciatus*
Common kestrel S	*Falco tinnunculus*
MacQueen's bustard S	*Chlamydotis macqueenii*
Cream-coloured courser S	*Cursorius cursor*
Red-wattled lapwing S C	*Vanellus indicus*
Feral pigeon S C	*Columba livia*
Eurasian collared dove S C	*Streptopelia decaocto*
Laughing dove S C	*Spilopelia senegalensis*
Pharaoh eagle owl S	*Bubo ascalaphus*
Short-eared owl S	*Asio flammeus*
Eurasian hoopoe S	*Upupa epops*
Southern grey shrike S	*Lanius meridionalis*
Arabian babbler S	*Turdoides squamiceps*
Brown-necked raven S C	*Corvus ruficollis*
Crested lark S C	*Galerida cristata*
White-eared bulbul S	*Pycnonotus leucotis*
Greater hoopoe lark S	*Alaemon alaudipes*
Black-crowned sparrow-lark S C	*Eremopterix nigriceps*
Barn swallow S	*Hirundo rustica*
Asian desert warbler S	*Sylvia nana*
Common redstart S	*Phoenicurus phoenicurus*
Isabelline wheatear S	*Oenanthe isabellina*
Desert wheatear CS	*Oenanthe deserti*
Pied wheatear S	*Oenanthe pleschanka*
House sparrow S C	*Passer domesticus*
Mammals	
Arabian oryx S C	*Oryx leucoryx*
Arabian hare S C	*Lepus capensis*
Arabian red fox S C	*Vulpes vulpes arabica*
Arabian gazelle S C	*Gazella gazella cora*
Sand gazelle S C	*Gazella subgutturosa marica*
Cheesmans gerbil S	*Gerbillus cheesmani*

Table 2.3a (continued) Species encountered during the expedition. Encounter method S = sighting, L = live trap, C= camera trap.

Common name	*Latin name*
Reptiles	
Arabian toad-headed agama S	*Phrynocephalus arabicus*
White spotted lizard S	*Acanthodactylus schmidti*
Sandfish S	*Scincus scincus*
Least semaphore gecko S	*Pristurus minimus*
Arthropods	
Wolf spider S	*Lycosidae Spp.*
Dimorphic cockroach S	*Blatta lateralis*
Sulphurous jewel beetle S	*Julodis Euphratica castelnau*
Arabian darkling beetle S	*Pimelia arabica*
Urchin beetle S	*Prionotheca cornata*
Desert runner (ant) S	*Cataglyphis niger*
Butterflies	
Desert white S	*Pontia glauconome*
Blue-spotted Arab S	*Colotis phisadia*
Indian (small) cupid S	*Chilades parrhasius*
Painted lady S	*Vanessa cardui*
Plain tiger S	*Danaus chrysippus*

Of the target species, the 2017 expedition observed 345 Arabian oryx, 360 mountain gazelle, 69 sand gazelle, 2 red fox, 5 Arabian hare and 3 pharaoh eagle owls.

Ungulate survey

Over the years, the ungulate counts conducted by Biosphere Expeditions have shown an inconsistency when compared to the established methodology of weekly counts by DDCR staff, which focus mainly on wildlife support infrastructure such as feed spots, waterholes and irrigated areas. This may be a result of the differing emphases year to year of the expeditions, which can result in skewed data (see Figure 2.3a). For example, when the expedition task was primarily body condition scoring, citizen scientists spent a lot of time with the oryx herds resulting in a much higher count than simple observations.

Arabian oryx

In 2017, an emphasis on collecting good data from all the circular observations meant that results differed from previous years, which had more emphasis on aspects of the oryx herd such as condition scoring to estimate herd health. This resulted in very few counts/observations at the feed spots in 2017 and therefore a greatly reduced final count of Arabian oryx when compared to both the 2016 Biosphere Expeditions count, as well as the DDCR weekly count. This is also reflected in the predicted distribution of Arabian oryx across the DDCR, with fewer areas with a high concentration of animals not reflecting the true distribution of the reserve's oryx herd (see Figure 2.3b).

Arabian gazelle

The focus on collecting good data from both circular and random observations greatly improved the counts of Arabian gazelle when compared to the results from 2016, and was consistent with the DDCR weekly counts. As the natural behaviour of Arabian gazelle is smaller family groups, which are more widely distributed and with very few congregations of large groups, the revised survey methodology is well suited to obtaining an accurate estimate of their population and distribution. This is reflected in their predicted distribution, with consistent distribution of one to three individuals across the DDCR, as well as a number of groups of four to six individuals distributed throughout the reserve. The hotspots of greater than seven animals observed could be due to bachelor herds that are generally larger in number than family groups (see Figure 2.3c).

Sand gazelle

The counts of sand gazelle are consistent with both the previous year's count and the regular DDCR counts, and can be considered an accurate estimate of the population within the DDCR. Predicted distribution has contracted from that of 2016 with some areas predicted not to have any sand gazelle. However, the hotspots are consistently in the southwest of the DDCR and correlate to a concentration of individuals at Tawi Ghadier irrigated area (see Figure 2.3d).

Large shrub survey

Data on the distribution of vegetation, in particular large shrubs and trees, were collected for the first time. Nearly 10,000 plants were counted during the circular observations. The dominant species was fire bush (*Leptadenia pyrotechnica*) (8,888), followed by the congregated ghaf trees (*Procera cineraria*) (823), date palms (*Phoenix dactylifera*) (140) and the more widely distributed Sodom's apple (*Calotropis procera*) (112). Predicted distribution of the two shrub species – fire bush and Sodom's apple - have provided the DDCR management with the most accurate picture to date of the distribution of these two indicator species for the reserve's habitat (see Figure 2.3e).

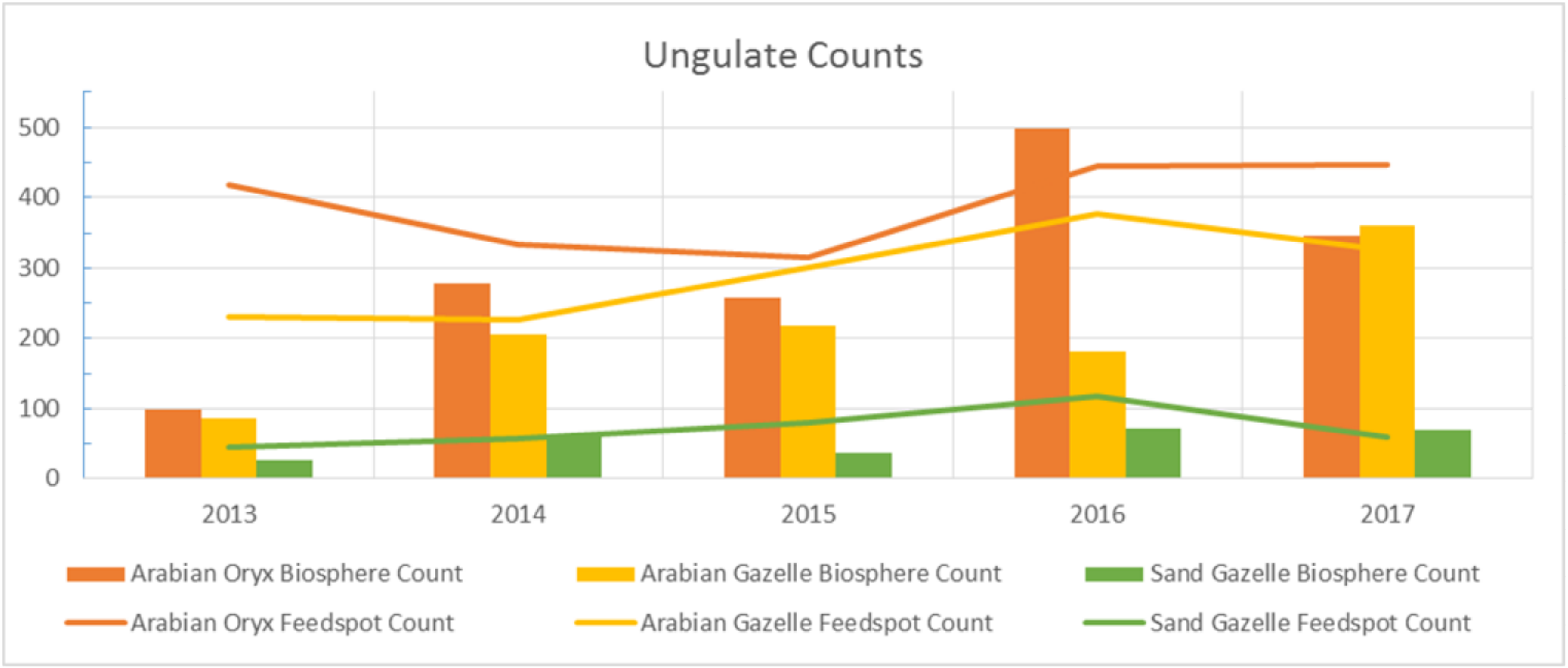


Figure 2.3a. Comparative chart of ungulate numbers recorded by the expedition (intensive survey of one week duration, once a year) And DDCR feedspot counts (during the same week as the expedition).

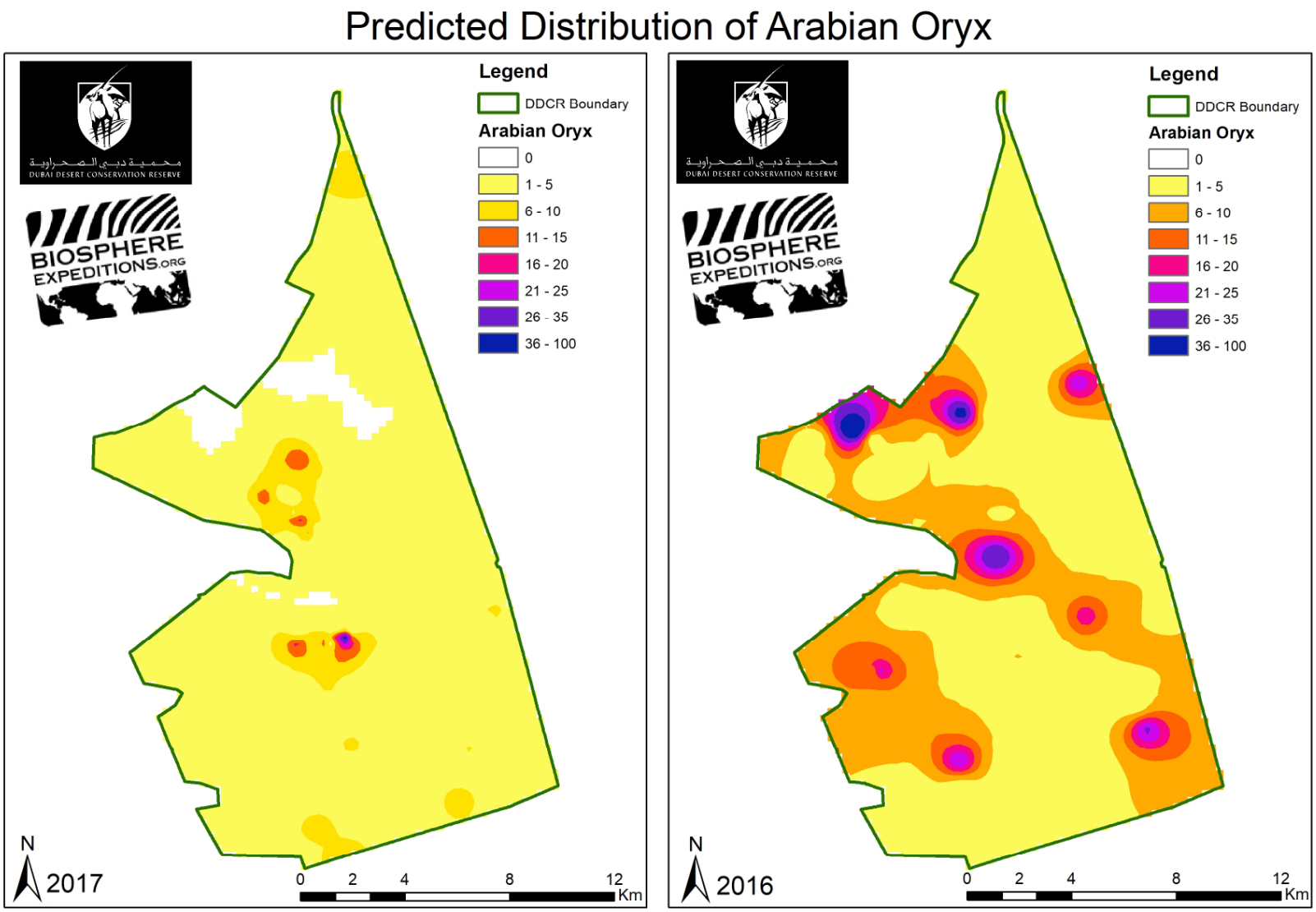


Figure 2.3b. Arabian oryx distribution 2017 vs. 2016. Predicted distribution calculations are based on observation data.

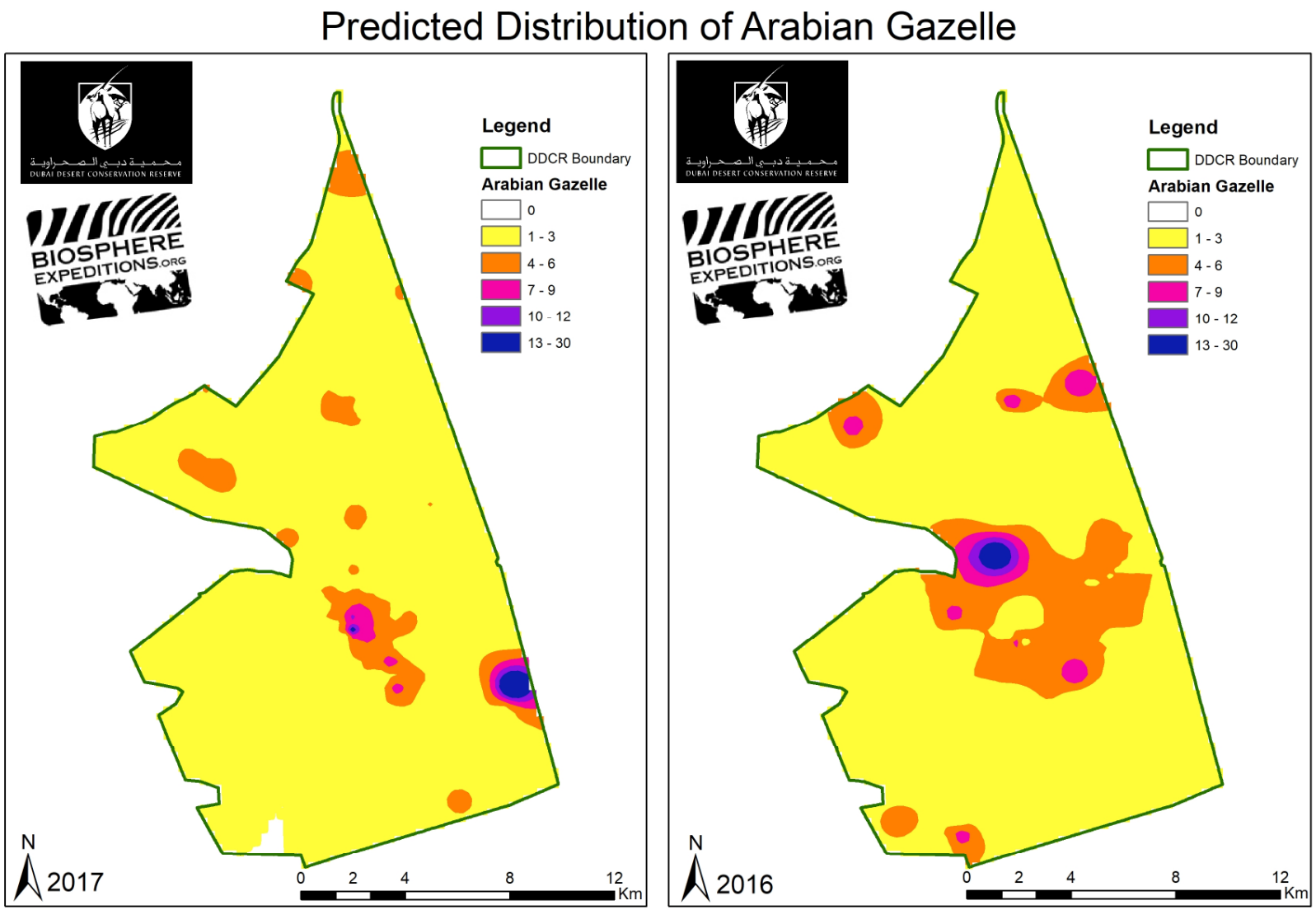


Figure 2.3c. Arabian gazelle distribution 2017 vs. 2016. Predicted distribution is based on observation data.

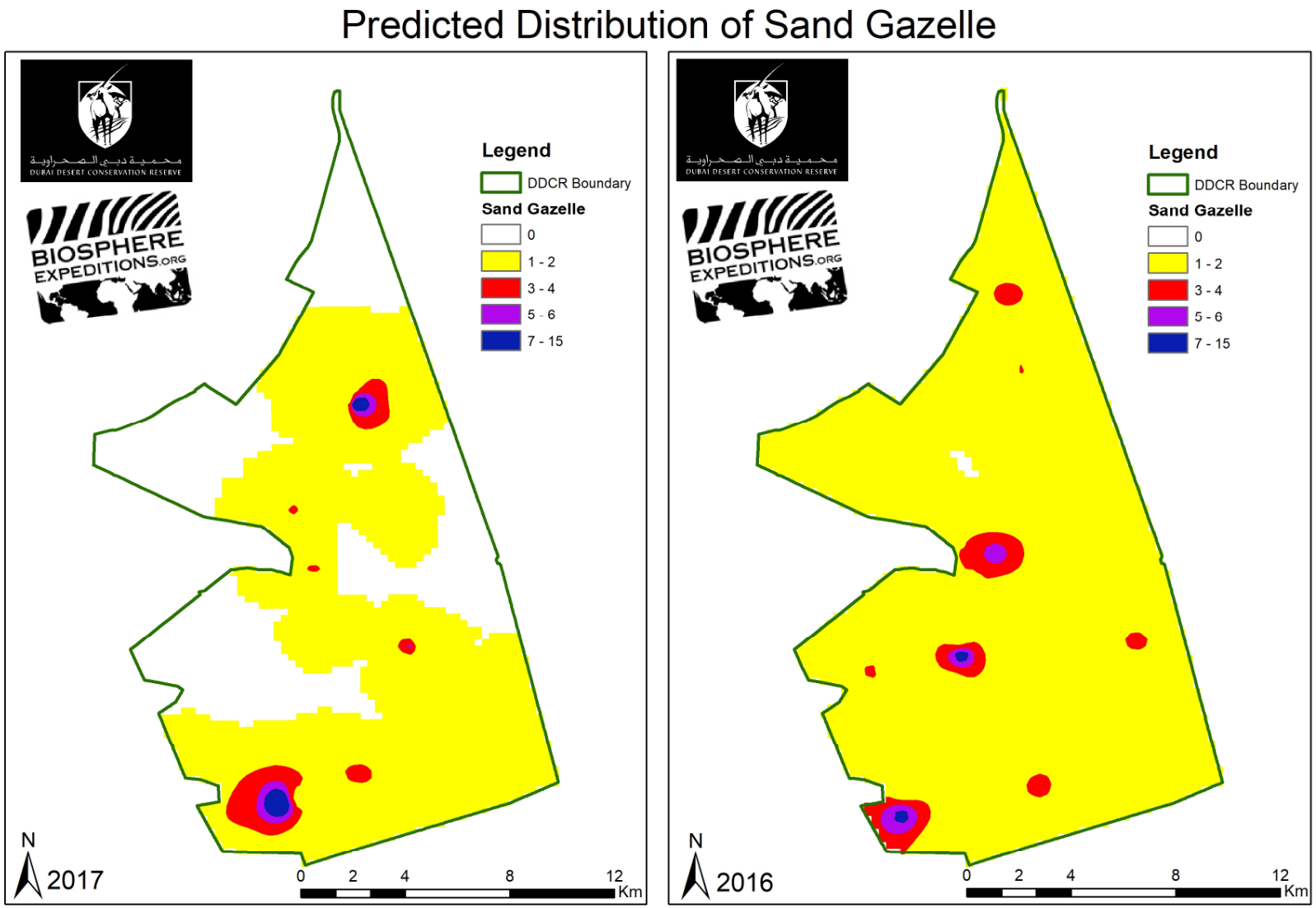
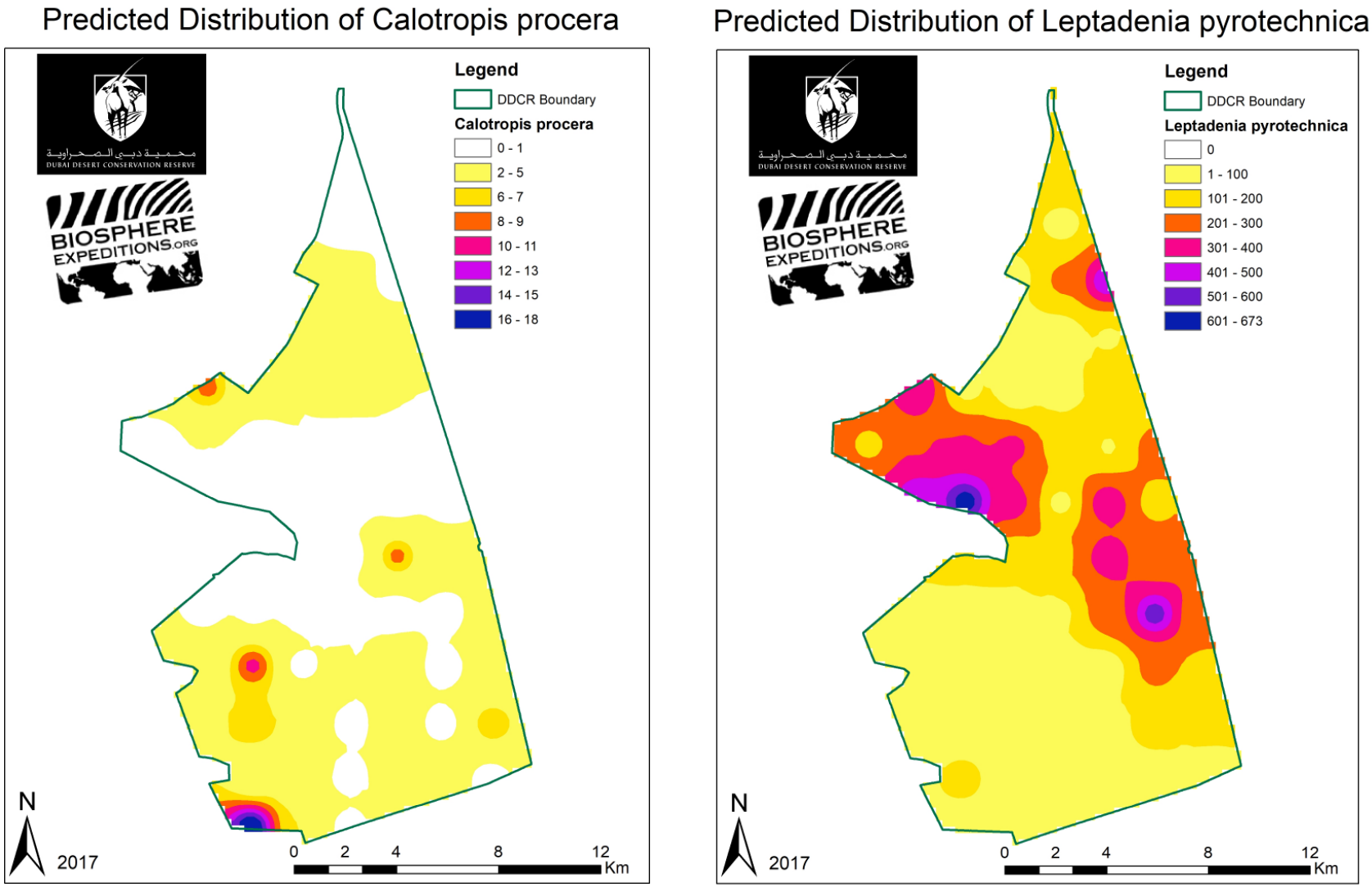


Figure 2.3d. Sand gazelle distribution 2017 vs. 2016. Predicted distribution calculations are based on observation data.



2.3e. Distribution of two key plant species, Sodom's apple (left) and fire bush (right). Predicted distribution calculations are based on observation data.

Live traps for medium-sized animals

No Gordon's wildcats or sand foxes were caught in the traps. There was a presence in the form of fox tracks at the trap in Quadrant E12 and cat tracks at the trap in Quadrant H8.

Arabian red fox den survey

Compared with 2016, the 2017 survey shows a 59% reduction in the number of active dens, most of which were abandoned, and a 25% reduction of inactive dens, of which only two dens became active (see Table 2.3b). There were, however, 44 new den sites (14 active, 21 inactive and nine abandoned) discovered in 2017 compared to only seven new sites found in 2016.

Table 2.3b. Results of the Arabian red fox den surveys in 2011, 2016 and 2017.

Status	2011	2016	2017
Active	66	59	24
Inactive	95	52	39
Abandoned	0	57	138
TOTAL	161	168	201
Status changes			
Unchanged		56	65
New active		4	14
Inactive to active		25	2
Abandoned to active		0	0
New inactive		3	21
Active to inactive		24	3
Abandoned to inactive		0	5
New abandoned		0	9
Active to abandoned		12	44
Inactive to abandoned		44	38

The density estimates of Arabian red fox dens in the DDCR (Figure 2.3f) were calculated using ArcGIS software tools based on Kernel density estimates. High den densities were, as expected, within relatively well-vegetated areas, dominated by large shrubs, in particular *Leptadenia pyrotechnica,* which meet the habitat requirements of providing a stable soil substrate supported by the shrub's root system. However, there was a shift in the highest den densities to the southern sector of the reserve, which is dominated by *Haloxylon salicornicum,* which has a similar effect on the soil structure. Less human disturbance in the south of the reserve may be the main contributing factor to this shift.

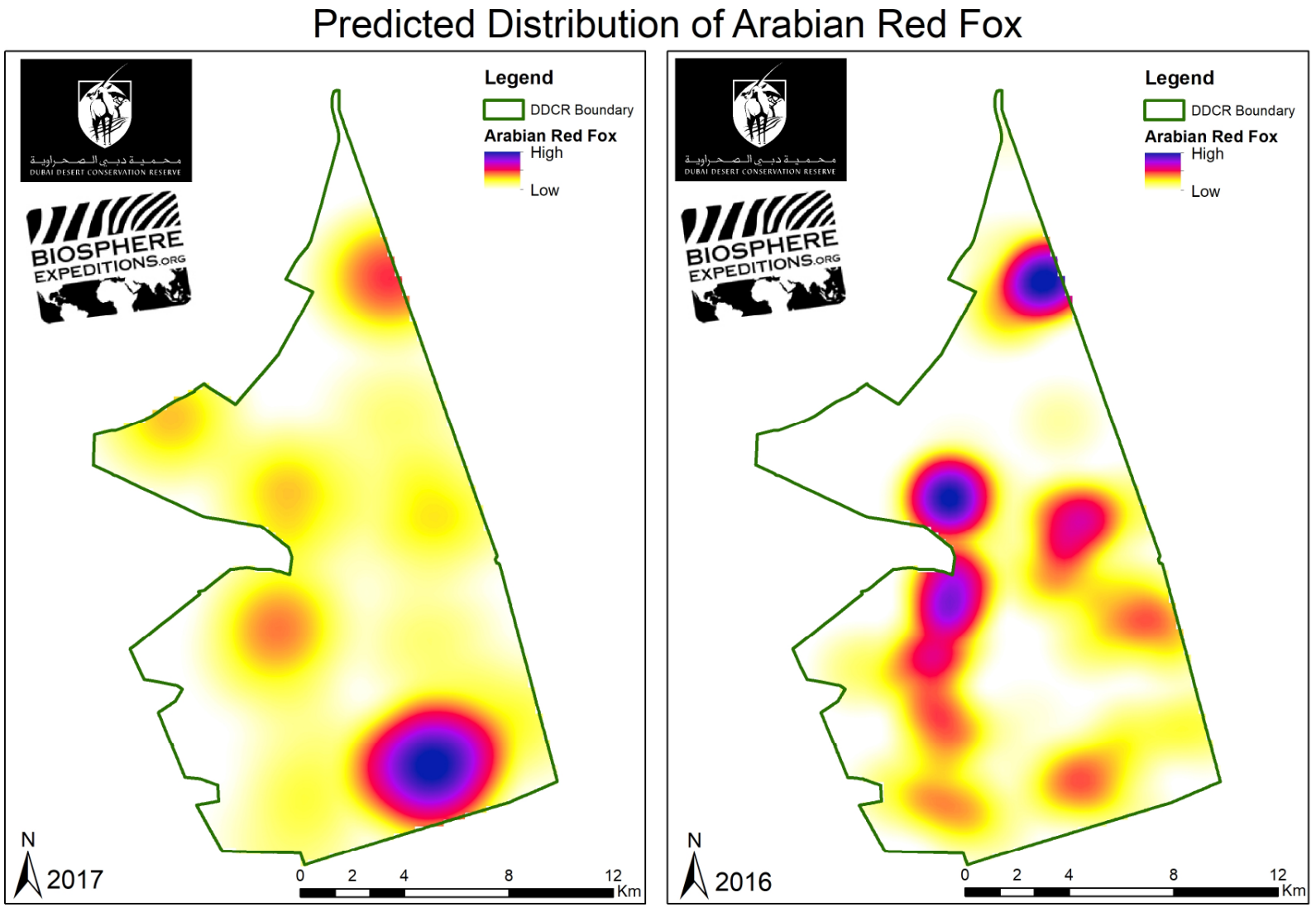


Figure 2.3f. Arabian red fox den distribution in 2017 (left) and 2016.

Camera trapping

Of the 18 traps set, there were two traps that failed to produce any meaningful photos. This resulted in a total of 76 trapping days that captured 4,064 images, of which 3,312 were live images and 2,363 of these contained naturally occurring fauna and 713 contained humans or vehicles (see Figure 2.3g, Table 2.3c).

Arabian oryx was the most abundant species recorded with 3,607 counted in all the photos, followed by Arabian gazelle with 1,165. High numbers (893) of feral pigeons were recorded, all from one site (BE17). Arabian red fox was the next most abundant species with 272 counted across 13 of the 16 camera trap sites, making them, along with Arabian oryx, the most widely distributed species recorded. Of the target species, the Arabian hare was recorded seven times across two sites. No Gordon's wildcat or sand fox were recorded.

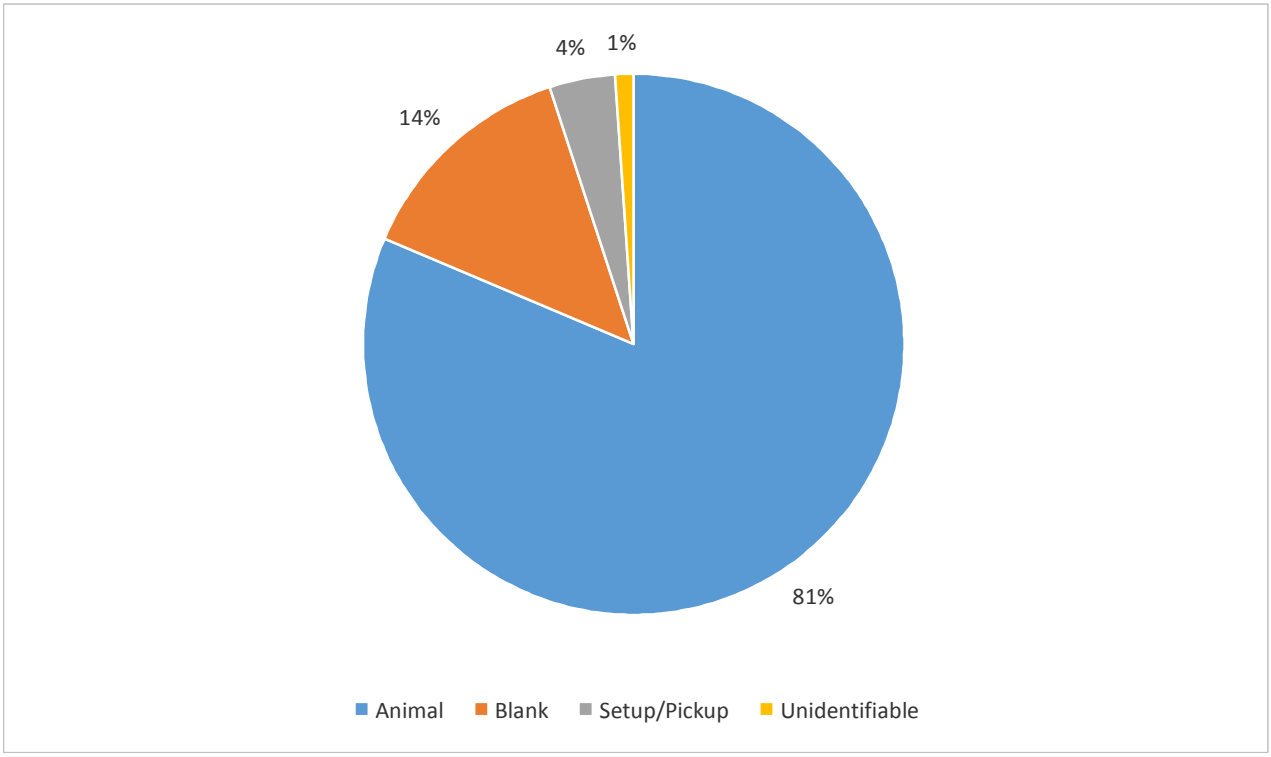


Figure 2.3g. Results of camera trapping 2017.

Table 2.3c. Results of camera trapping 2017.

Trap name	Latitude	Longitude	*Arabian oryx*	*Arabian gazelle*	*Sand gazelle*	*Red fox*	*Arabian hare*	*Brown-necked raven*	*Egyptian goose*	*Red-wattled lapwing*	*Crested lark*	*Eurasian collared dove*	*Laughing Dove*	*Sparrow-lark*	*Black-crowned*	*Feral pigeon*	*House sparrow*	**Total**
DDCR1	24.870435	55.677649	519	0	0	9	0	0	0	0	0	0	0	0	0	0	0	528
DDCR3	24.883820	55.665069	0	37	0	0	0	0	9	0	0	3	0	0	0	0	3	52
DDCR4	24.871238	55.661002	0	0	0	16	0	0	0	0	1	2	0	0	0	0	0	19
DDCR5	24.898310	55.664974	0	9	3	2	0	0	0	0	0	36	6	0	0	0	6	62
DDCR6	24.788745	55.671468	49	29	3	1	0	0	0	0	0	0	0	0	0	0	0	82
DDCR7	24.779626	55.717780	22	6	0	151	0	0	0	0	0	15	0	0	0	0	0	194
DDCR8	24.766412	55.647462	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78
BE11	24.980838	55.662628	15	40	0	12	0	0	0	0	0	0	0	0	0	0	0	67
BE13	24.741205	55.657025	18	0	2	3	4	0	0	0	0	0	0	0	0	0	0	27
BE14	24.804034	55.689942	65	48	0	27	0	0	0	0	0	0	0	0	0	0	0	140
BE15	24.810481	55.663280	174	3	0	6	0	0	0	0	0	0	0	0	0	0	0	183
BE16	24.819276	55.717691	2454	0	0	7	0	68	0	0	0	3	0	0	0	0	0	2532
BE17	24.893147	55.615748	26	881	6	11	0	0	0	24	0	0	0	0	893	0	0	1841
BE18	24.846395	55.653008	87	16	0	0	0	0	0	0	0	0	0	2	0	0	0	105
BE19	24.820712	55.703234	47	0	0	15	0	0	0	0	0	0	0	0	0	0	0	62
BE20	24.841635	55.699843	53	96	0	12	3	0	0	0	0	0	0	0	0	0	0	164
		Total	**3607**	**1165**	**14**	**272**	**7**	**68**	**9**	**24**	**1**	**59**	**6**	**2**	**893**	**9**	**6136**

2.4. Discussion and Conclusion

DDCR ungulates (Arabian oryx, Arabian gazelle, sand gazelle)

The relatively high numbers of ungulates within the DDCR continue to be a challenge for the DDCR as we need to balance the welfare of the individual animals with the health of the desert ecosystem. The supply of supplementary feed for the oryx herd address both these aspects, with additional food available for individuals while at the same time limiting the impact of overgrazing on the ecosystem. However, high levels of nutrition do result in good breeding and therefore exponential population growth, which is not sustainable in the long run. Management will continue to assess different options to reduce the number of ungulates on the reserve. These include translocation of animals to other reserves within the natural home range of the species and introduction of predators to reduce population growth.

Live traps for medium-sized animals

The limited success of the trapping for medium-sized mammals is expected over the short period of the expedition and as such is unlikely to reflect the true status of the target species, Gordon's wildcat and sand fox, within the DDCR. A study over a longer period, including the different seasons and a sustained trapping effort, would provide data that could help in assessing the population status of these species. However, even without such a sustained trapping effort, the data collected from any capture, including size, weight and sex, add to the growing database of these target species within the DDCR.

Red fox den survey

The results of the red fox den survey have shown a significant difference from the previous surveys in 2011 and 2016, with a marked reduction in the number of active dens. This was surprising, as observations of rodent dens and tracks would suggest a good prey base. The high number of new den sites could be an indication of expansion in range and suitable habitat even though the overall number of active dens has reduced. However, the increased survey effort in 2017 could also have resulted in the discovery of new den sites. The continued monitoring of the red fox dens now becomes even more important in light of these results, as a continued decline could be indicative of a threat to the population within the reserve that may require a management intervention.

Camera trapping

Increases in the number of camera traps, as well as improvements in their setup and placement, resulted in a vastly improved return of pictures, the majority of which were natural fauna. This included seven photos of the nocturnal Arabian hare and over 270 records of the Arabian red fox. However, the rare and cryptic species within the DDCR, namely Gordon's wildcat and sand fox, were once again not recorded. Continued camera trap surveys are therefore still needed to monitor their presence in the DDCR.

Having said this, populations of both these species are and have always been very small in the DDCR and are a cause for concern in terms of viability. Long-term capture-mark-recapture studies are probably the only way to establish true population sizes. However, this type of study is not possible with short-term citizen science expeditions.

As such, camera traps only help to give an indication, as animals are not individually identifiable from pictures, but they do provide important information about presence and distribution, and are a good way to utilise citizen science support.

Management considerations

The DDCR management has received approval to translocate Arabian oryx from the reserve to other protected areas and zoological collections within the region and this will alleviate some of the pressure of a growing population on the environment.

The reintroduction of an apex predator to restore a natural ecological process by putting top-down pressure on the ungulate population, will continue to be explored to hopefully find a socially acceptable solution, as similar reintroductions elsewhere have also had numerous other benefits to the function of the ecosystem (see Berger 2002, Weis et al 2007).

The Arabian red fox will need to be closely monitored due to the sudden reduction in active dens. If any recently deceased foxes are found in the DDCR, the opportunity to perform a post mortem should be taken to ascertain the cause of death, as disease could be a potential cause of the sudden decline.

Recommended activities and actions for the 2018 expedition

The kind of citizen science projects run by Biosphere Expeditions are ideally suited to the DDCR's research needs, which require a large area to be surveyed in a short period of time. Therefore:

- We will continue the quadrant survey with the circular observations in 2018, as this provides the DDCR management with valuable data collected on the size and distribution of many species across the entire reserve.

- In addition, feed spot counts will be included to improve the quality of the Arabian oryx counts.

- Due to the drastic reduction of active dens, the red fox den survey will be of particular importance in 2018 as continued declines in the number of active dens would be significant (and worrying) for the reserve's population of red fox. All dens, including abandoned dens, will be surveyed.

- Camera trapping will be continued as we survey the DDCR for the presence and distribution of Gordon's wildcat and sand fox.

- Finally, we will attempt to do some live trapping of Gordon's wildcat as well as sand fox in the reserve, with an emphasis on the collection of morphological data of individuals within the DDCR.

2.5. Literature cited

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Appendix 1: Expedition diary & reports

A multimedia expedition diary is available on http://biosphereexpeditions.wordpress.com/category/expedition-blogs/arabia-2017/

All expedition reports, including this and previous expedition reports, are available on www.biosphere-expeditions.org/reports.