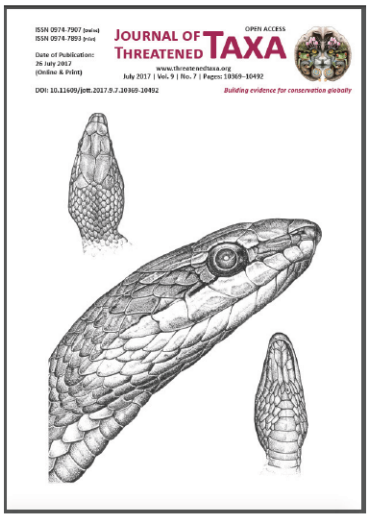

Journal of Threatened Taxa

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

Communication

The status of Arabian Gazelles *Gazella arabica* (Mammalia: Cetartiodactyla: Bovidae) in Al Wusta Wildlife Reserve and Ras Ash Shajar Nature Reserve, Oman

Mansoor H. Al Jahdhami, Sultan Al Bulushi, Haitham Al Rawahi, Waheed Al Fazari, Ahmed Al Amri, AbdulRahman Al Owaisi, Salim Al Rubaiey, Zahran Al Abdulasalam, Metab Al Ghafri, Shaeilendra Yadav, Sami Al Rahbi & Steven Ross

26 July 2017 | Vol. 9| No. 7 | Pp. 10369–10373
10.11609/jott.3398.9.7.10369–10373

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2017 | 9(7): 10369–10373

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ISSN 0974-7907 (Online)
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OPEN ACCESS

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Abstract: We conducted distance sampling surveys of the Arabian Gazelle (*Gazella arabica*) in two protected areas, Al Wusta Wildife Reserve (WWR) and Ras Ash Shajar Nature Reserve (RSNR), regarded as important for gazelle conservation in northern and central Oman. The survey in WWR estimated a gazelle density of 0.161 gazelles/km^2 in the surveyed area, and in RSNR an estimated density of 25.8 gazelles/km^2. The density of Arabian Gazelle in RSNR is the highest recorded for a wild population. Using gazelle sighting frequency in non-surveyed parts of each reserve, we estimate Arabian Gazelle populations of 498 and 505 in WWR and RSNR, respectively. Our surveys demonstrated the potential for a high density of gazelles in well protected and productive habitats, but also that the Arabian Gazelle are in decline in WWR, most likely as a result of poaching and competition with domestic livestock.

Keywords: Arabian Gazelles, distance sampling, *Gazella arabica*, Oman, zoogeography.

DOI: http://doi.org/10.11609/jott.3398.9.7.10369-10373 | **ZooBank:** urn:lsid:zoobank.org:pub:0FC378AC-BF42-4149-BD7C-2243EB7D1FAE

Editor: David Mallon, Manchester Metropolitan University, Derbyshire, UK. **Date of publication:** 26 July 2017 (online & print)

Manuscript details: Ms # 3398 | Received 05 March 2017 | Final received 06 May 2017 | Finally accepted 07 July 2017

Citation: Al Jahdhami, M.H., S. Al Bulushi, H. Al Rawahi, W. Al Fazari, A. Al Amri, A.R. Al Owaisi, S. Al Rubaiey, Z. Al Abdulasalam, M. Al Ghafri, S. Yadav, S. Al Rahbi & S. Ross (2017). The status of Arabian Gazelles *Gazella arabica* (Mammalia: Cetartiodactyla: Bovidae) in Al Wusta Wildlife Reserve and Ras Ash Shajar Nature Reserve, Oman. *Journal of Threatened Taxa* 9(7): 10369–10373; http://doi.org/10.11609/jott.3398.9.7.10369-10373

Funding: Office for Conservation of the Environment, Diwan of Royal Court, Sultanate of Oman.

Competing interests: The authors declare no competing interests.

Author Details: see end of this article.

Author Contribution: MHAJ - project leader, field surveys, survey design, data analysis and writing up manuscript; SAB - field survey at AlWusta Wildlife Reserve and data entry; HAR - field survey at Ras AlShajar Nature Reserve; WAF - field survey at AlWusta Wildlife Reserve; AAA - field survey at Ras AlShajar Nature Reserve; AAO - field survey at AlWusta Wildlife Reserve; SAR - field survey at AlWusta Wildlife Reserve; ZAA - field survey at AlWusta Wildlife Reserve; MAG - field survey at AlWusta Wildlife Reserve; SY - field survey at AlWusta Wildlife Reserve; SAR - field survey at AlWusta Wildlife Reserve; SR - manuscript reviewing, editing and made the map.

Acknowledgments: We would like to thank the Director General of OCE, Mr Yassir Al Salami for his continuous support. We would like to thank all people who participated in the surveys in one way or another. The support of Mr Haitham Al Amri and the WWR staff was also much appreciated. The support of Masoud Al Gadhani and Yusuf Al Ghadani at Ras Ash Shajar Nature reserve was much appreciated. Comments by two anonymous reviewers also improved the manuscript.

مكتب حفظ البيئة
Office for Conservation of the Environment

INTRODUCTION

Arabian Gazelles (Mammalia: Cetartiodactyla: Bovidae, *Gazella arabica* (Lichtenstein 1827)) are widely distributed across the Arabian Peninsula (Harrison & Bates 1991). Previously known as the Mountain Gazelle *Gazella gazella*, the species was recently split into two genetically distinct lineages (*G. arabica* and *G. gazella*; Lerp et al. 2013). Arabian Gazelle populations have been in decline for many years. Anthropogenic threats such as poaching, road kills, habitat destruction and fragmentation are resulting in the species becoming increasingly rare (Insall 2001; Strauss et al. 2009; Al Hikmani et al. 2015). Although Oman has also seen a large decline in Arabian Gazelle numbers over the last 50 years, the Sultanate remains one of the strongholds for Arabian Gazelle conservation in the region. Conservation efforts have played a role in maintaining or even increasing populations of gazelle in some Omani protected areas, while in others, despite being protected, populations have decreased. For instance, Al Wusta Wildlife Reserve (WWR), previously known as the Arabian Oryx Sanctuary, was reported to hold the largest population of Arabian Gazelles in Arabia with an estimate of 10,000 gazelles (Insall 2001). More recently a survey in the area estimated a density of 0.224 gazelles/km^2, corresponding to an approximate population of 2,700 gazelles (Strauss et al. 2009). Since then, the reserve has been reduced in size and fenced, but no further surveys were conducted. New population data are required to quantify trends in population size and distribution, particularly in core populations, which are under threat.

Arabian Gazelle inhabits desert and semi-desert habitats, and in Oman usually coincide with the distribution of *Vachellia tortilis* (= *Acacia tortilis; 'simr'* in Arabic) trees, from which they browse leaves and seed-pods. They can be found in both plains and rugged mountains but tend to avoid rocky areas (Mendelssohn et al. 1995). Males are territorial and either found overseeing a group of two or more females and young, or in bachelor herds.

Due to Arabian Gazelle's preference for flat, open woodland areas, their population can be quantified using Distance sampling techniques (Buckland et al. 2005). We employed distance sampling to survey two key Arabian Gazelle populations of Oman, Al Wusta Wildlife Reserve and Ras Ash Shajar Nature Reserve. We aimed to find population density and estimate population sizes for each reserve area, to understand population status, and provide a benchmark from which future surveys could monitor population trends.

MATERIALS AND METHODS

Our surveys were conducted in Al Wusta Wildlife Reserve (WWR) and Ras Ash Shajar Nature Reserve (RSNR; Fig 1). RSNR is a coastal reserve in northern Oman, dominated by mountainous topography, but with a smaller area in the east consisting of flat plains and foothills covered by *Vachellia tortilis* woodland. The reserve was established in 1982 with a total area of 93km^2. The dominant wild animal species in the reserve is the Arabian Gazelle but it also holds a small population of Arabian Tahr *Arabitragus jayakari* in the mountainous part of the reserve. The WWR lies in the central desert of Oman and covers 2,824km^2 (Fig. 1). Although the area is surrounded by a 2-m high fence for the purposes of protection, temporary human camps and livestock are currently present inside the reserve. Most of the reserve is flat or an undulating plateau but the eastern boundary consists of a 100m high escarpment, followed by the Huqf depression and a series of hills between the escarpment and the coastline. *Vachellia tortilis*

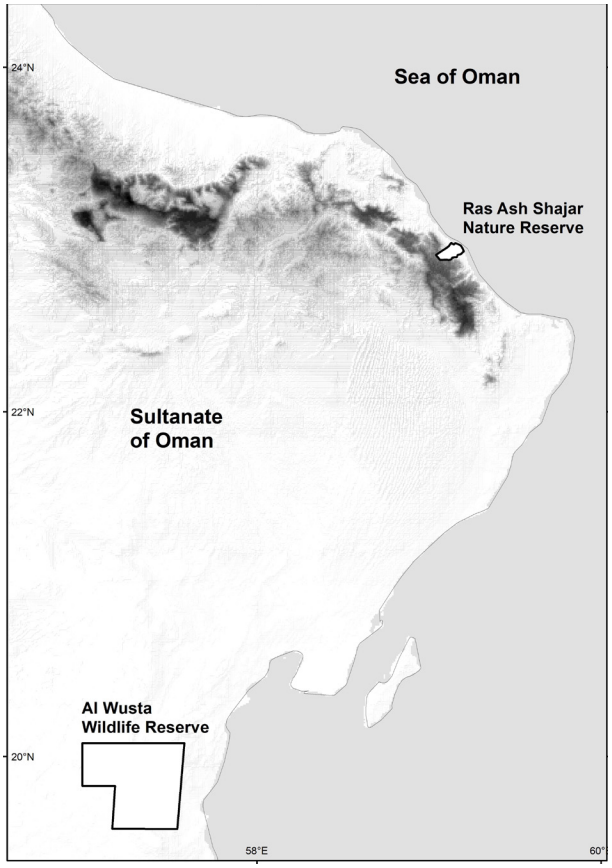

Figure 1. The location of two nature reserves, Ras Ash Shajar Nature Reserve (RSNR) and Al Wusta Wildlife Reserve (WWR), where Arabian Gazelle surveys were conducted.

Image 1. Arabian Gazelles *Gazella Arabica*

is the dominant tree above the escarpment, while *Prosopis cineraria* and *Vachellia ehrenbergiana* are more common below the escarpment and in coastal hills. Ungulates of WWR include Arabian Oryx *Oryx leucoryx* and Arabian Gazelle (Image 1) which have traditionally been most common on the plateau, while Nubian Ibex *Capra nubiana* and feral donkeys *Equus asinus* are mostly found on the escarpment and in the eastern hills (Massolo et al. 2008).

We used distance sampling (line transects) to estimate the gazelle population in the flat areas of each reserve. The transects were designed using the software Distance 6.0, based on a systematic random sampling design. The surveys were conducted on February 2015 in WWR and in December 2014 in RSNR. The transects consisted of 30 lines with 2-km spacing in WWR and nine lines with 1-km spacing in RSNR. The surveyed areas were 1,708km^2 and 15km^2 in WWR and RSNR respectively, where the total area of each reserve is 2,824km^2 (WWR) and 93km^2 (RSNR). For mountainous areas of both reserves we estimated the gazelle population based on relative sighting frequency. In WWR we estimated gazelle density based on relative sighting frequency during fieldwork activities in the area. While in RSNR we estimated gazelle density based on distance sampling surveys done in similar mountain habitat in As Saleel Natural Park, approximately 50km south of the reserve area (S. Ross, unpublished data).

During surveys, a minimum of three observers sat on top of a 4WD vehicle (open pickup deck) to make observations. Drivers maintained a steady speed during the surveys, which were conducted between sunrise to 13:00 and 16:00 to before sunset. All gazelle groups seen (one or more individuals) were recorded and the distance to the centre of the group from the place of sighting was measured using a rangefinder, and the azimuth to the group was measured using a handheld compass. The number of individuals, GPS location and time of gazelle sighting were recorded, and counts of temporary human encampments and livestock were also made. We used the sighting angle and distance to the gazelles to compute perpendicular distance from the transect line using an excel macro. Data were analysed using the software Distance 6.0 following the guidelines of Buckland (2004) and Buckland et al. (2005).

RESULTS

Al Wusta Wildlife Reserve

The total survey length was 922km within a survey area covering the entire Plateau (1,708km^2). A total of 39 gazelles were directly sighted during the survey. The population density was estimated as 0.161±0.027 gazelles per km^2. The abundance estimate for the surveyed area was 275±17 gazelles (95% CI = 196–384) (Table 1). Mean group size was 2.17±0.23 gazelles and maximum group size observed was five gazelles. In the unsurveyed Huqf area (1,116km^2) of WWR we estimated gazelle density based on relative sighting frequency to be approximately 0.2 gazelles per km^2, giving a gazelle abundance of 223 gazelles. Using the estimates for the Huqf and the plateau we estimate that WWR currently contains approximately 498 Arabian Gazelles. During the survey, a total of 17 temporary livestock camps of local people were found inside the reserve, and sighted livestock included 311 camels, 473 sheep and 304 goats.

Ras Ash Shajar Nature Reserve

The total survey length was 23.5km within an area of 15.6km^2, 309 gazelles were directly sighted. The population density was estimated as 25.8 ± 6.3 gazelles/km^2. The abundance estimate for the surveyed area was 403±98.7 gazelles (95% CI 248–654). The mean group size was 5.63±0.79 gazelles, with a maximum group size of 24 gazelles. Given the similarity of gazelle sighting frequency in the mountains of RSNR and similar habitat in As Saleel Natural Park we estimate that the mountainous areas of the reserve have a gazelle density of 1.5 gazelle/km^2 and a total of 117 gazelles. The estimated population within RSNR is therefore approximately 505 Arabian Gazelles.

Table 1. Population parameters for gazelle surveys carried out in Al Wusta Wildlife Reserve and Ras Ash Shajar Nature Reserve.

	Al Wusta Wildlife Reserve	Ras Ash Shajar Nature Reserve
Area of reserve (km²)	2824	93
Survey area (km²)	1708	15.62
Survey effort (km)	922	23.5
Gazelle sightings	39	309
Group size	2.17 ± 0.23	5.63 ± 0.79
Density / km²	0.161 ± 0.027	25.8 ± 6.3
Population size	275 (95% CI 196-384)	403 (95% CI 248-654)
Estimate for full reserve area	498	505

Table 2. Comparison of Arabian Gazelle population density in Al Wusta Wildlife Reserve from 2001, 2009 and the current survey of 2015.

	Survey		
	Insall (2001)	(Strauss et al. 2009)	Current study (2015)
Population estimate	10,000	2,787	498
Area (km²)	27,000	12,420	2,824
Estimated density (by distance sampling)	No survey	0.224	0.161
Density estimate for WWR*	0.370	0.224	0.176

*based on the population estimate divided by the area.

DISCUSSION

Our surveys have provided the first assessment of Arabian Gazelle in Ras Ash Shajar Nature Reserve, and a follow-up survey for assessment of the current status of Arabian Gazelles in Al Wusta Wildlife Reserve. Considering the decline of Arabian Gazelle across its range, our surveys indicate that the reserves still make a substantial contribution towards Arabian Gazelle conservation in the region. However, the implementation of further protected area management measures could improve the status of gazelles, particularly in WWR.

Gazelle density differed substantially between the two reserve areas, and can be attributed to natural and anthropogenic differences between the sites. The position of RSNR in a productive northern coastal biome resulted in higher tree and undergrowth density, which positively influenced gazelle carrying capacity. Indeed, our surveys estimated the highest Arabian Gazelle densities recorded in the region, although densities of closely related mountain gazelle of 30 to 40 gazelles/km² have been recorded in Israel (Mendelssohn et al. 1995; Geffen et al. 1999). As gazelles of RSNR are situated in a small area observable from an adjacent ranger station and under 24-hour ranger surveillance, the protection received by the population was exceptional. In addition, the reserve has strong local community support in anti-poaching activities in the area. Both management actions have undoubtedly influenced the success of the reserve and positively influenced the gazelle population.

In contrast WWR is situated in a desert biome with low primary productivity, low tree density and patchy forage availability. Under such conditions, gazelle are unlikely to reach the densities found in RSNR. Nevertheless, the densities recorded in WWR are much lower than those previously documented (Table 2), indicating a gradual decline of the gazelle population. As there has been negligible human development in the area, poaching and overgrazing by domestic livestock appear to be the main factors involved in the population decline. Poaching was highlighted as the main threat to the gazelle in WWR in the study by Strauss et al. (2009), and has been an ongoing issue for Arabian Gazelle since the 1970s across Oman (Insall 2001). The extremely large size of WWR, and damage to the reserve fence caused by people, has resulted in numerous access points into the protected area, making adequate ranger surveillance and control of poaching in the reserve very difficult.

Although grazing pressure has not been highlighted in WWR up until now, the area has historically been used for livestock grazing (Price 1989) and stocking rates have increased over time, putting pressure on limited vegetation resources. Although talks between WWR and local people regarding grazing rights are ongoing, our study suggests that until resolved this remains a barrier to the conservation and recovery of Arabian Gazelles inside WWR.

Although we were unable to survey the Huqf area below the escarpment, we estimate that gazelle density is higher in this area based on more frequent sightings and observations of sign in the area. This is an interesting development, as historically the Huqf has been known as marginal gazelle habitat with much lower density in comparison to the flat plateau. However, the Huqf appears to have become a refuge habitat for the gazelle population that is under threat. Gazelle populations may be more successful in the Huqf due to the difficulty of motorized travel there, its isolation, the higher availability of cover habitats against poachers, and lower pressure from livestock grazing.

CONSERVATION IMPLICATIONS

The decline of Arabian Gazelle in WWR is striking, particularly as this protected area is a flagship for conservation in the region. Urgent remedial action is required to reverse the decline of gazelle in WWR and improve the status of this iconic species in Oman. Understanding and removing threats that are preventing gazelle recovery within protected areas is an important first step. The negative impacts of poaching and unsustainable livestock grazing have been highlighted as ongoing problems, which require resolution. Considering the benefits of ranger protection and community engagement demonstrated in RSNR, RSNR may provide a model of how conservation may be achieved. Fundamentally WWR needs to (1) Increase the mobility and expertise of rangers to deter poaching inside the reserve area, (2) engage with local people to find solutions to reduce livestock incursions inside the reserve, and (3) engage and educate the wider community about the potential benefits of wildlife conservation. How to achieve these actions over the vast area of WWR is a challenge that needs to be overcome.

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Journal of Threatened Taxa

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

July 2017 | Vol. 9 | No. 7 | Pages: 10369–10492
Date of Publication: 26 July 2017 (Online & Print)
DOI: 10.11609/jott.2017.9.7.10369-10492
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