Siwa Gazelle Survey Project – 2024

A project commissioned by the Italian Agency for Development Cooperation on behalf of Nature Conservation Sector, EEAA.

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April -2024

Executive Summary:

The Nature Conservation Sector – Egyptian Environmental Affairs Agency is keen to establish the status of gazelle species in the Siwa Protected Area and its vicinity. A project was formulated and sponsored by the Italian Agency for Development Cooperation. The project commenced in April 2024 aiming at surveying a total area of 20,000 Km² encompassing Siwa Protected Area and a buffer of 20 Km around its borders. The study aimed at assessing 2 parameters mainly, Gazelle population size and Gazelle occupancy in the area. The study started in April 2024 and ended in early May 2024. The study involved Distance sampling of indirect marks of gazelle presence (dung piles) over 113 Km of line transects covering 20,000 Km² of range. Also, the study involved 196 days of camera-trapping over 14 sites distributed selectively in Siwa Protected Area. In addition, some interviews were done with some elderly of the local community to gather their local knowledge about the species.

Unfortunately, gazelle presence was very scant in the study with very few indirect detections (dung and tracks). None of the deployed camera traps was successful in capturing any gazelle presence. The study was able to establish that the status of the habitats around the Siwa Range is still in good condition and should be able to sustain a viable gazelle population while the current decline is probably attributed to human factors (poaching).

The study concluded that given the current decline in gazelle population in Siwa it is highly unlikely to recover naturally and an *ex-situ* measure should be in place such as population enforcement or even full reintroduction. These are also in line with the conservation measures proposed for the species in the Sahelo-Saharan Mega Fauna Initiative developed by the CMS.

ملخص تنفيذى

يحرص قطاع الحفاظ على الطبيعة – جهاز شئون البيئة المصري على التعرف على حالة أنواع الغزلان في محمية سيوة والمناطق المجاورة لها. وتمت صياغة المشروع ورعايته من قبل الوكالة الإيطالية للتعاون الإنمائي. بدأ المشروع في أبريل 2024 بهدف مسح مساحة إجمالية تبلغ 20 ألف كيلومتر مربع تشمل محمية سيوة ومساحة مجاورة تبلغ مسافة 20 كيلومترًا حول حدودها. هدفت الدراسة إلى تقييم عاملين أساسيين، حجم تعداد الغزال وإشغال الغزال في المنطقة. بدأت الدراسة في أبريل 2024 وانتهت في أوائل مايو 2024. وتضمنت الدراسة أخذ قياسات لعلامات تواجد الغزال على قطاعات خطية غير المباشرة لوجود الغزلان (أكوام الروث) على و تم المسح باستخدام مسافة 113 كيلومترًا من الخطوط المقطوعة التي تغطي نطاقًا يبلغ 20000 كيلومتر مربع. كما تضمنت الدراسة 196 يومًا من المسح بالكاميرا في 14 موقعًا موزعة بشكل انتقائي في منطقة سيوة المحمية. بالإضافة إلى ذلك، تم إجراء بعض المقابلات مع بعض كبار السن من المجتمع المحلي لجمع معلوماتهم المحلية عن هذا النوع.

لسوء الحظ، كان وجود الغزال ضئيلًا جدًا في الدراسة مع عدد قليل جدًا من الاكتشافات غير المباشرة (الروث والآثار). لم تنجح أي من مصائد الكاميرات المنتشرة في التقاط أي تواجد للغزال. تمكنت الدراسة من إثبات أن حالة الموائل المحيطة بسلسلة جبال سيوة لا تزال في حالة جيدة ويجب أن تكون قادرة على الحفاظ على أعداد غزال قابلة للحياة بينما من المحتمل أن يعزى الانخفاض الحالي إلى العوامل البشرية (الصيد غير المشروع).

وخلصت الدراسة إلى أنه نظرًا للانخفاض الحالي في أعداد الغزلان في سيوة، فمن غير المرجح أن تتعافى بشكل طبيعي، ويجب اتخاذ تدابير خارج الوضع الطبيعي مثل إنفاذ التعداد أو حتى إعادة الإنتاج بالكامل. وتتماشى هذه أيضًا مع تدابير الحفظ المقترحة للأنواع في مبادرة الحيوانات الكبرى في الساحل والصحراء التي طورتها CMS.

تم تطوير خطة مقترحة للحفاظ على أنواع الغزلان تتضمن سلسلة من الإجراءات التي من شأنها إن طبقت ان تساهم في إستعادة أنواع الغزلان التي من المفروض ان تكون جزءا من التنوع الحيوى المصرى

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1. Introduction:

Egyptian deserts are home to two gazelle species, namely Dorcas gazelle (*Gazella dorcas*) and Slender-horned gazelle (*Gazella leptoceros*). The latter is ENDANGERED (EN) and its range is restricted to a very limited area in the western desert and around few remaining oases, while Dorcas gazelle is in a slightly better situation where it is classified as VULNERABLE (VU) (IUCN, 2017). Its range spans areas in the Western Desert, Eastern Desert, Southern Egypt, and the littoral plains of Sinai (El Alqamy & Baha El Din, 2006). The Egyptian population of Slender-horned gazelle is very significant to the survival of the species globally as it is considered the only surviving population of that subspecies. On the other hand, the Egyptian population of the dorcas gazelle is also significant to the global population as it is estimated to comprise about 10% of the species' global population. The Redlist designates both species as of declining population trends across their global range. (Husam ElAlqamy, Alaa Soultan, Adnan Abdelhameed and Abdullah Nagy, 2011) showed that the southern Sinai population of dorcas gazelle showed a continuous decline of about 94% for the period of 1999 to 2011. Yet, there is no conservation action plan for the species as reported by the IUCN RedList assessment.

Unfortunately, except for some surveys done during the 2000s and earlier in South Sinai, there is no systematic monitoring for gazelle species through its Egyptian Range. Annual surveys for the dorcas gazelle have been conducted by Saint Katherine Protectorate since 1998, however, surveys were interrupted from 2003 to 2005 due to lack of human resources and logistic reasons. During 2006 surveys were resumed with good hope for further continuation. The survey was conducted during the summer of 2006 by the St. Katherine Protectorate (SKP) ranger team. Another separate survey was conducted in the Siwa Protected Area in 2009. Although the extent of the current study and the previous one done back in 2009 do not match, the 2009 data will be used as a baseline for comparison with outcomes of the current assessment for the lack of a better alternative.

This document represents reporting of the results of the Siwa Gazelle survey commissioned by the Italian Agency for Development Cooperation on behalf of Nature Conservation Sector, EEAA 2024. The survey was conducted in the Siwa Area encompassing both the eastern and western sectors of SPA and including a buffer area of 20 Km around it. The survey effort was done from March to April 2024. This effort aims to provide some insight and working knowledge about the current status of the gazelle population in this vicinity. Thus, there were 2 main investigation protocols applied to the study. First, Distance sampling was applied as the primary sampling protocol for population size investigation as devised by El Alqamy 2003. Second, the Occupancy of the species was also targeted using camera trap sampling coupled with the Daryl & Mackenzie occupancy estimation model.

2. Study Region:

The study involved the vicinity of the Siwa Protected Area (SPA) in its 2 sectors eastern and western sectors. On top of this, the study area also included a 20 km buffer around both sectors. This resulted in a total survey area of 20,536 Km². This area is usually known as a hot spot for *Gazella dorcas* and *Gazella leptoceros* based on both local knowledge and systematic science points of view. The topology of the study region was a quite variable mix composed of sand dunes, sand sheets, lithified sandstone escarpments (pic1), rocky gravel plains, sabkha depressions, Acacia grooves with distinct vegetation Pic(4), in addition to the scattered wetlands associated with permanent and seasonal massive water bodies and lakes (Pic2). The total annual rainfall for the area is about 100ml annually. The vegetation of the study region is distributed from the herb layer to the tree layer. The most dominant species in the area are listed in table (1) The extent of the surveyed area is shown in Map (1).

1Table (1) Dominant flora species in the study region

Latin Name	**Vernacular Name**
Alhagi graecorum	**(AQOUL)**
Calligonum polygonoides	**(ARTA)**
Juncus rigidus	**(DEES)**
Nitraria retusa	**(GHARQAD)**
Phoenix dactylifera	**(NAKHL)**
Phragmites australis	**(HAGNA)**
Tamarix nilotica	**(ATHL)**
Imperata cylindrica	**(HALFA)**
Acacia gerrardii	**(TALH)**

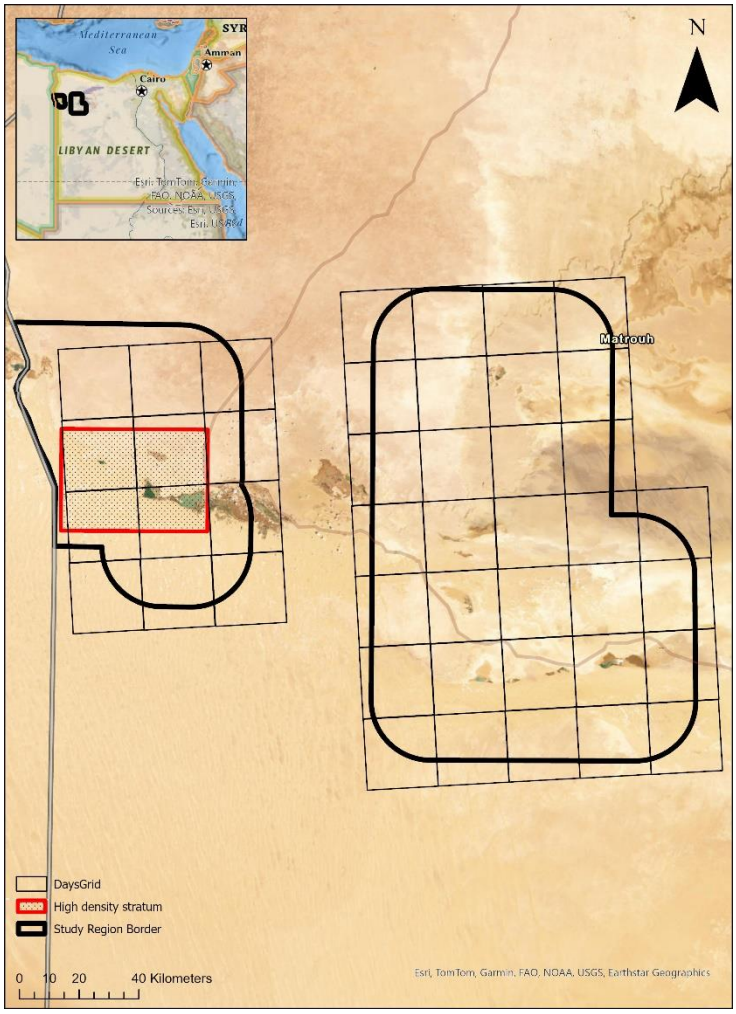
1Pic(1) lithified Sandstone escarpments and gravel Plains

2Pic(2)Wetland vegetation associated with permanent and seasonal water bodies

3Pic(3) Large permanent lakes in Sand dunes

4Pic(4) Acacia groove habitat with unique vegetation

The study region was stratified according to previously known gazelle density which is closely spatially associated with the lakes and oases in the study domain. Systematic Random line transects were laid over the area representing effort allocation according to the corresponding density in each stratum. The total effort was 113.68 Km of line transects distributed as 32 Km in the high-density stratum and 81.68 Km in the wider low-density stratum.

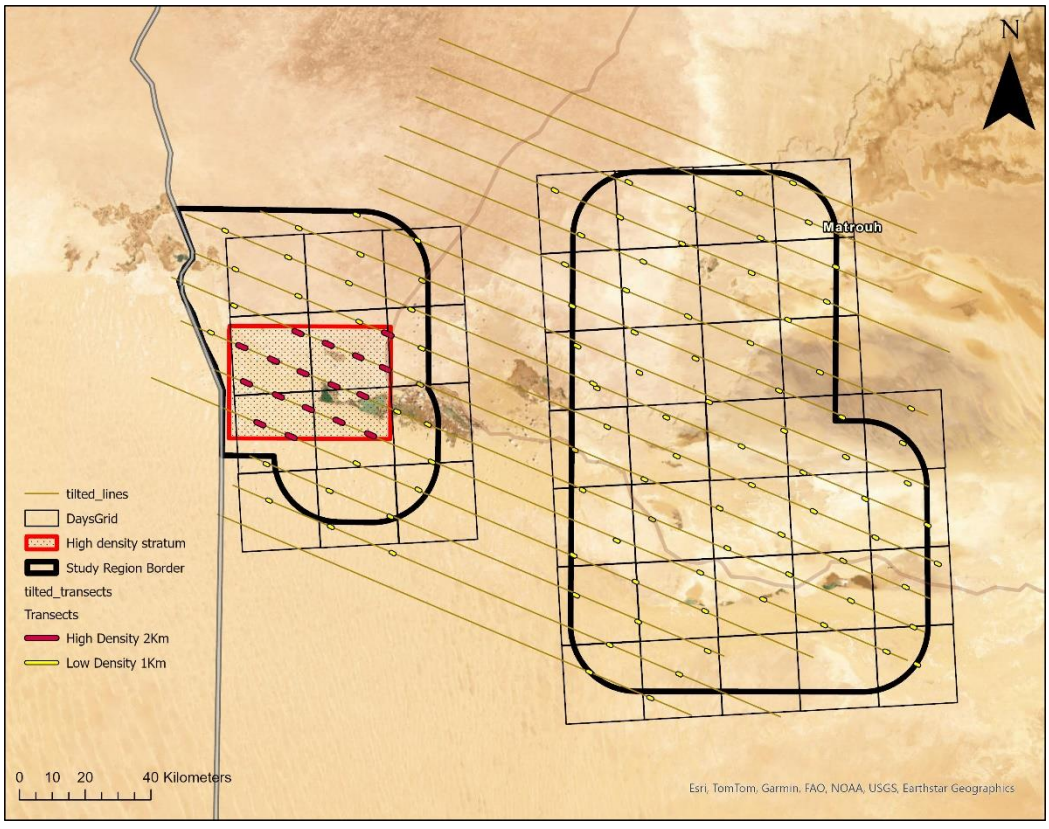


Map (1) Study Region of Siwa Protected Area and the vicinity of a buffer of 20 Km around

3. Methods:

3-a. Distance Sampling :

The study region was stratified according to gazelle density obtained from the previous study of gazelle in the Siwa area (Alaa Soultan and Adnan Abdelhameed, 2009).The high-density stratum was defined as a polygon around Shyata Lake as of 1680 Km² based on the area of most recorded gazelle activity recorded in 2009, while the rest of the study region was defined as the low-density stratum comprising 18856 Km² Map(1). Systematic Random line transects were laid over the area representing effort allocation according to the corresponding density in each stratum. It was reported that considerable clustering and variation occur in the distribution of dorcas gazelle throughout the study area. Also, there was a noticeable gradient of gazelle density with high values around major water bodies and lakes. Thus, there was a need for representative coverage for the whole area with appropriate effort allocation to the highly populated areas relative to the low-density ones. Systematic segmented sampling was used to identify the sample transects. It involves randomly superimposing a systematic set of segmented parallel lines onto the survey region. The lines were assigned different arrangements according to the sampled stratum. Accordingly, parallel lines were laid out across the study region spaced 10 km apart. Transects were placed over these parallel lines in an on-off fashion. Transects were spaced by 5Km along the parallel line and were of a length of 1Km in the low-density stratum and a corresponding transect length of 2 Km in the high-density stratum. Also, the direction of the transects was assigned as northwest to the southeast (130° bearing) that's to coincide with the streamlines and small channels caused by the major water flow direction in the landscape. See map (2) for detailed sampling Design.



5Map (2) Transect layout and sampling effort distribution across strata in the Study Region

A handheld GPS receiver was used to locate the start point of each transect. The exact location of the start and end points was recorded to the nearest 1 m. Transects were surveyed by a two-person team, an observer, and a recorder. The observer walked ahead of the recorder, pulling a 20 m rope

that acted as the reference point for the track line (Pic. 5). Transects were made at a constant bearing of 315° in the whole study region. Bearings were chosen to cross the water-made ditches, which gazelles prefer to walk along. At the beginning of each transect habitat and terrain type were ranked according to the category system summarized in Table (2.1). The occurrence and location of all recently deposited gazelle and camel dung piles within 10 m of the transect were recorded. The age of dung piles was estimated and assigned to one of six categories. Only relatively recent dung piles in categories 1, 2, and 3 were recorded as perpendicular distances to the rope. Older dung ranked as 4,5 and 6 was overlooked. The perpendicular distances greater than 1.0 m were measured with an ultrasonic distance measurer (RadioShack), shorter distances were measured with a metal measuring tape, and all were recorded to the nearest 1.0 mm. Gazelle tracks crossing the transect line from side to side of the rope were recorded as tally marks.

6 Pic(5) observer and recorder traversing line transect pulling 20m rope as a reference line

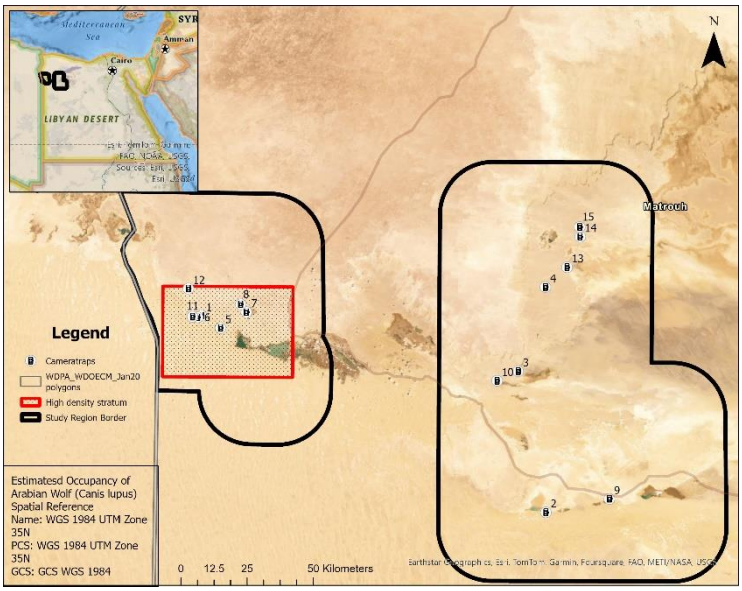
2.4.4 Comparing Camels and Gazelle spatial distribution.

The average number of gazelle tracks per km of transect was used to measure gazelle activity, called the Activity Index, in each area. The number of gazelle and camel dung piles encountered per km along each transect was called the Encounter Rate and was used to investigate the relative distribution of these two species using a Cremer von Misese-type test (Syrjala)

3-b. Occupancy estimation:

In addition to population size, this survey is also concerned with estimating the occupancy of gazelle species across the study region and this part of its Egyptian range. The Occupancy concept was developed by McKenzie et al 2000 (DARRYL I. MACKENZIE, JAMES D. NICHOLS, JAMES E. HINES, MELINDA G. KNUTSON,, 2003). Occupancy is a good parameter to monitor the range of a species especially when it is rare and shy and cannot be easily detected. However, due to imperfect detection, the species will not always be detected when present leading to false absences which, unaccounted for, could lead to misleading conclusions about the occurrence or distribution of the species. The Occupancy parameter is called Psi (ψ), it can be simply defined as the proportion of sites occupied by a species in relation to total sites investigated for its presence. Calculations were conducted using PRESENCE 2.0 software developed by Mackenzie et. al. (2006) Models under the same software package were used to evaluate the interaction between dorcas

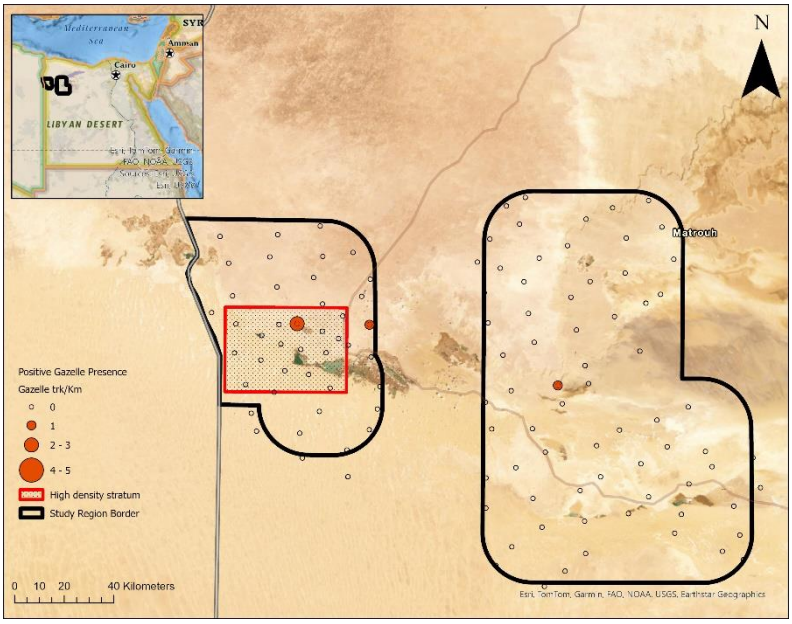
gazelles and free-ranging camels as the two species are believed to use the same resources and share the same habitat for their livelihood.



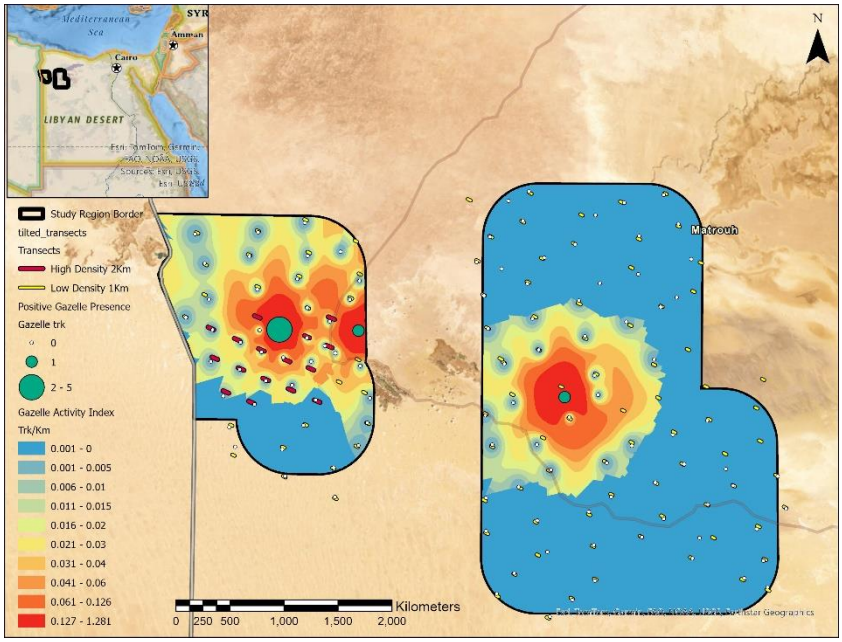
Map (3) sites for camera trapping with some emphasis on the high-density stratum

4. Results

4-a-1 Activity Index: Gazelle activity in the study region was very low. Only 5 gazelle tracks were observed along the whole surveyed distance of 113 Km of transects. Map (2) shows the localities of surveyed transects and those of positive gazelle activity. The observed value of the gazelle Activity Index in the Siwa study region is 0.072 trk/Km for 2024 resulting from a sample of 113 km of transects and detected 5 tracks only. In comparison the previous value recorded for the same area in 2006 was 0.551 Trk/Km resulting from only 13 km of transects. There has been a reduction of about 83% in observed gazelle activity since 2006 in Siwa Protected Area. The comparison indicates a deep decline in gazelle activity in the Siwa region. However, these simple numbers are quite alarming and point to a point where the population is pushed beyond natural recovery.



Map(4) showing locations of observed positive gazelle activity



Map(5) showing the expected spread of Gazelle activity based on observed values of Trk/Km index

4-a-2 Density estimate for Gazelle Dung:

Due to the extreme lack of detections recorded in the survey only one scenario was possible for the analysis. The inclusion of covariates was not possible for the same reason. The applied scenario is conventional detection modeling without the inclusion of environmental covariates and adopting the assumption that only distance from the transect line solely affects the observers' detection of gazelle dung. In this case, we would use Conventional distance sampling (CDS).

CDS was run with a selection between applicable to the hazard rate and the half-normal models as they might yield different shapes of detection function and thus a different point estimate of Density (D). Selection between the two rival models is done based on the lower Akaike Information Criterion (AIC) .

The two tested models are

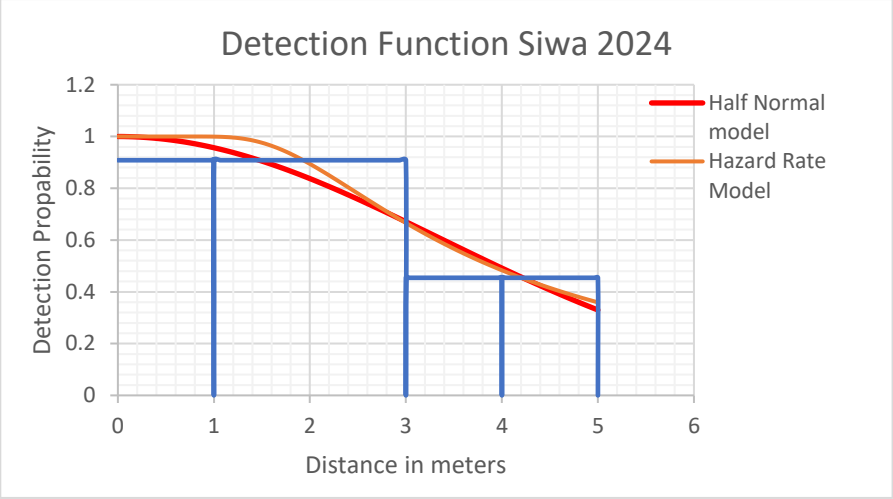
1- **Half-normal model** : $k(y) = e^{-\frac{y^2}{2xA(1)^2}}$

where Y is the recorded distance and k(y) is the detection function

2- **Hazard Rate Model**: $k(y) = 1 - e^{(-\frac{y}{A1^{-A2}})}$

A(1) & A(2) are parameters calculated by the model as $A(1) = 3.162$ & $A(2) = 1.765$

where Y is the recorded distance and k(y) is the detection. Running the AIC for selection, the half-normal Model returns a Minimum $AIC = 21.53053$ while the Hazard Rate model computes $AIC\ of\ 22.197193$. Thus, model 1 (Half normal) is selected for detection function over the Hazard Rate. Fig (1) shows the modeled 2 functions where half-normal detection function is selected for further analysis.



7Fig (1) Half normal detection Function for Siwa 2024 Survey

Proceeding further with the analysis DISTANCE density and abundance of Gazelle dung in Siwa study region are calculated. reports the findings as shown in Table (1)

Table 2 Point estimates of dung density and abundance in the Siwa study region 2024

	Point Estimate	%Coeff. Of Variation	df	95% Confidence Interval	
D (dung/Km²)	9.6690	71.84	68.07	2.6690	35.028
N (dung counted)	0.19858E+06	71.84	68.07	54814	0.71938E+06

There was no local knowledge for differentiating between gazelle dung of dorcas or Slender-horned gazelle. The detected dung gazelle was relatively old Pic(6) and there was no chance of making the differentiation in the field. Thus, this estimate is considered a pooled estimate for the 2 species on the assumption that these are still occurring together.

Pic(6) Very few detection of old gazelle dung didn't allow for differentiation between gazelle species

Table(3) Other results from Distance Sampling (explanation can be found in Annex I , glossary of Terms)

	Estimate	CV%	LL (95%)	UL (95%)
m	2.0			
LnL	-9.7448			
f(0)	0.26794	35.05	0.12306	0.61549
p	0.74642	35.05	0.32494	1.0000
ESW	3.6335	35.05	1.6247	8.1260

4-a-3 difference between camel and Gazelle distributions:

Kriging was used to interpolate values of camel and gazelle dropping encounter rates between transects to obtain an estimated distribution for the entire Study Region . Kriging uses the auto-correlation between values to estimate encounter rates in unsurveyed areas, no information about environmental factors underlying the distribution is involved in the model. Kriging is a method to interpolate point data, while the estimated dropping encounter rates are associated with transect lines, thus the geometrical center of the line was used for kriging. Figure 3.12 shows that gazelles and camels appear to be using the study area differently.

The Cramer von Mises statistic, W_n^2 can be used to measure the level of agreement between the distribution of gazelle droppings (Gn(x)) and camel droppings (FX(x))

$$W_n^2 = n\int_0^1 [G_n(u) - u]^2 d_u$$

This statistic is used to test the null hypothesis that droppings of the two species are distributed in a similar way over the Study region [Ho: Gn(x) = FX(x)]. The encounter rates with camel and gazelle droppings were used to describe these distributions. The ordered individual encounter rates of transects are used to calculate the statistic G :

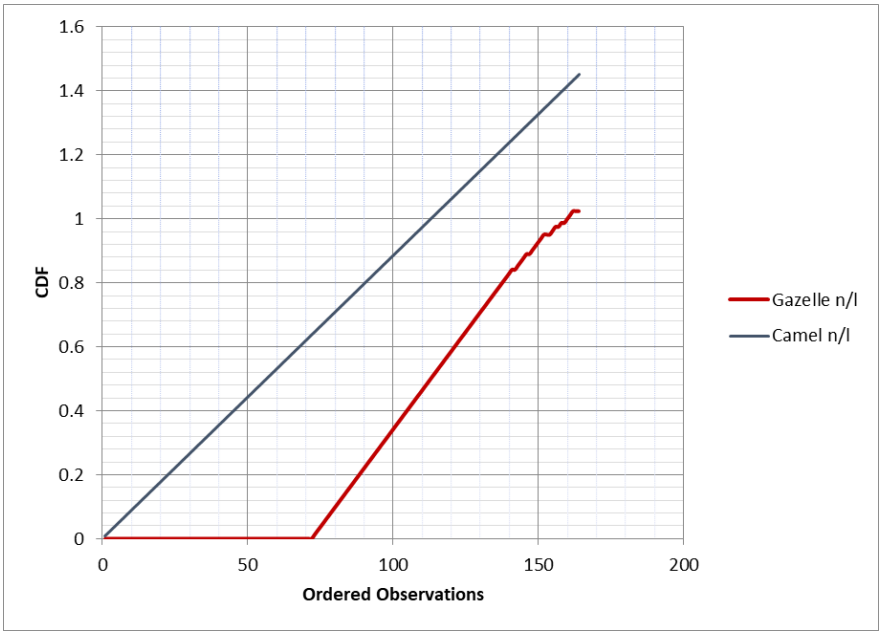
$$\Gamma = \left(\frac{n_1 \times n_2}{(n_1 + n_2)^2}\right) \times \sum_{i=1}^{n} (S_{1i} - S_{2i})^2$$

where :

S_1 is the first event (gazelle dung encounter rate) & n_1 number of transects used to assess event 1
S_1 is the second event (camel dung encounter rate) & n_2 number of transects used to assess event 2

The two cumulative distribution functions are shown in Fig. 3.11. The null hypothesis is rejected if G > W0.05=0.12794 (for n>40, α=0.05) . The calculated value of G for Siwa study region is -12.4363 thus the null hypothesis is accepted.

Accordingly it is concluded that the spatial distribution of gazelle droppings is not significantly different from that of camels'Cremer-Von Mises distribution was used to estimate distribution function densities of camel dung and gazelle dung as 2 independent properties as shown graphically in Fig(2). This calculation suggests that camels are posing as a proofed competition for Gazelles over the limited resources of food.



Fig(2) graphical representation of Cumulative Density Function of Encounter Rates of Camel dung and Gazelle dung encounter rates showing similar spatial distribution.

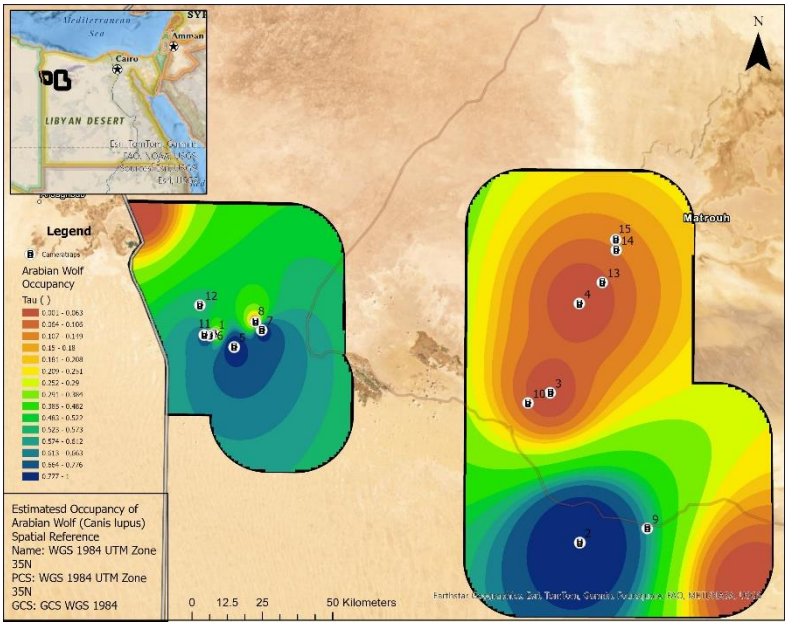
3-b Gazelle species Occupancy: A total of 196 camera-trap days were sampled during this study. This is 14 camera trap sites over 14 days each. Unfortunately, none of the camera traps used in the study was successful in recording any presence of either of the expected gazelle species. Capture history of all showing negative records of dorcas gazelle Fig(3). It is strongly suggested that the sampling period was a limited factor. A camera-trapping of not less than 500 camera days is suggested as a minimum for desert rare species to achieve any success in occupancy estimation. However, this is a strong indication of the dire status of the gazelle species in this part of its Egyptian range. This requirement was deeply hindered by the short duration of the project and the complications imposed by security measures and Border Guards' requirements. These 2 factors limited the field team movement and ability to implement survey design. It is concluded by this occupancy survey that Gazelle occupancy in Siwa Protected Area in very close to Zero.

Camera trap sit name	day1	day2	day3	day4	day5	day6	day7	day8	day9	day10	day11	day12	day13	day14
sheyata1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
El-Bahrain	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garet Ghanam	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hatyat 5 (Gara area)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
om el ghozlan	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sheyata 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
El-Gerba 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
El-Gerba 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nawamisa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tabaghbagh	0	0	0	0	0	0	0	0	0	0	0	0	0	0
El- Magharba	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Om -Asha	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Talh abubaker	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Om Hariga	0	0	0	0	0	0	0	0	0	0	0	0	0	0

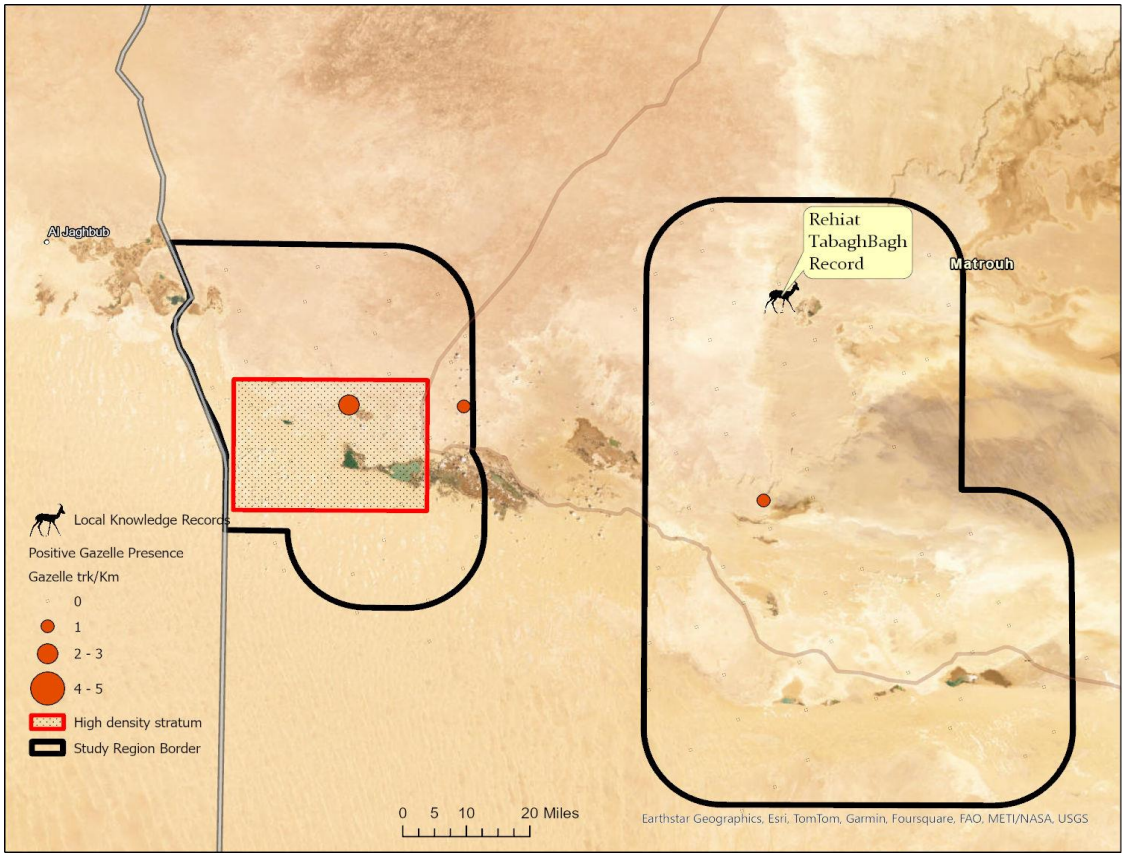
Fig(3) Capture history from all camera trap sites showing negative results for Dorcas Gazelle

Alternatively, other species were recorded in this camera trap survey. A wolf-like species is abundantly recorded on camera traps. The species is probably either Arabian Wolf *Canis Lupus* or a Jackal *Canis aureus*. It is hard to tell morphologically and in such hard desert conditions where the body condition is poor in most cases. Red Fox *Vulpes vulpes* and Cap hare *Lepus capensis* are also recorded. Occupancy is calculated for the three species as shown in Table (4).

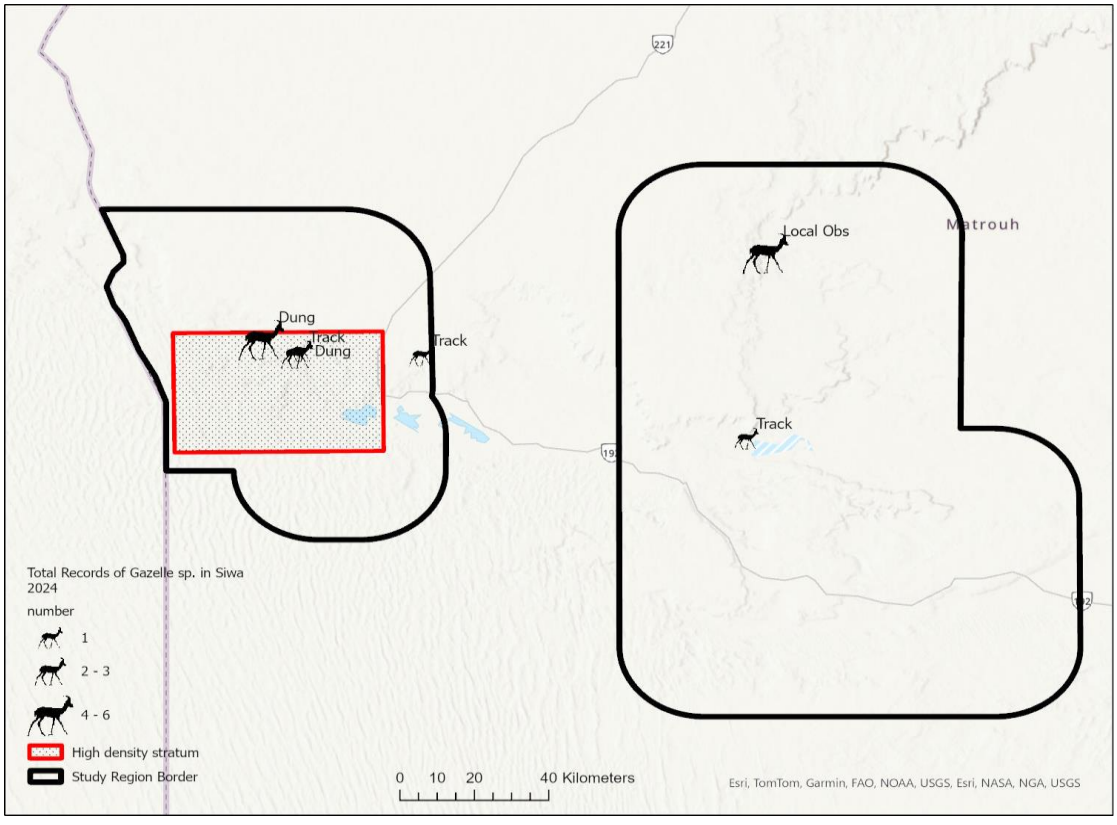
The team while fixing camera traps in the survey study region to collect occupancy records.



An anecdotal record was mentioned by one of the local Bedouins From Gara Village. He mentioned that he have seen a group of 5 to six adult dorcas gazelle climbing an escarpment in (Rehiat Tabghbagh) six months ago (around October 2023). He verified his story with a video clip on his mobile showing the gazelles scaling the escarpment. This record is the only verifiable proof (in addition to the detected dung and tracks) of any of the gazelle species is still surviving in Siwa Vicinity. The location of the record is shown in map (6). Map (7) shows the total records of Gazelle species recorded in the whole survey of all types (track, dung, and local knowledge observation)



Map (6) anecdotal observation reported by local community of a group of 6 Gazelles climbing an escarpment on October 2024



Examples of wild species recorded on Camera Traps in Siwa study

Capehare (*Lepus capensis*)

Arabian Wolf (*Canis sp.*)

Red Fox (*Vulpes vulpes*)

Other Miscellaneous species

5. Discussion and Conclusion:

A comprehensive and representative land survey of the Siwa Protected Area and its vicinity shows that this part of the Egyptian Gazelle Range has deteriorated severely. The occupancy survey for 196 camera days couldn't establish any gazelle presence but the sample size is deemed inadequate. In addition, 133 Km of transects managed only to detect 8 dung piles and 5 gazelle tracks. Comparing these numbers to a finding of 69 dung piles over only 19 km of transects in 2009 survey to the current one shows a real decline of the population and makes it a real candidate for being locally extinct. and The Gazelle populations in this part of the range have gone into severe decline compared to the available baseline data emerging from localized surveys conducted in 2009 (The current results show that the previously reported, relatively abundant population of Gazelle species is probably exterminated. This is a surprising outcome knowing that this is a designated Protected Area designated for species conservation. Given that the area covered in 2009 was only 30Km² compared to the current area covered of 20,000 Km² speaks more to the extent of the severity of the situation in the Siwa Protected Area and its surroundings.

Local extinction of the two gazelle species *Gazella dorcas* and *Gazella leptoceros* is immanent if left for natural recovery. Suspected threats include poaching and illegal hunting, given the sharp decline from the results of the 2009 survey. For the Sake of conserving these two threatened species, NCS should address the threats and the conservation actions mentioned in the status report submitted in the earlier course of this project. The study was able to establish that the status of the habitats around Siwa Range is still in good condition and should be able to sustain a viable gazelle population. Thus, the current observed decline is probably attributed to human factors (poaching). The conservation action on this species is strongly tilted to the *ex-situ* conservation side of things where the only effective action would be population enforcement or even full re-introduction. However, this is not valid unless the threats are addressed first. Continuous assessment with a systematic repeated survey is also strongly recommended.

On the other hand, other wild species were recorded in the survey on Camera traps and line transects. It was noticeable the high encounter of the cape hare and the wolfs. This is worthy of notice since the frequency of encounters with wolves in broad daylight in the desert was higher than ever encountered in any wild landscape elsewhere in Egypt. This needs a dedicated study to be quantified and reported.

Between 2013 and 2021 species conservation strategies have been developed for many sahelo-Saharan antelopes with a marked absence of any Egyptian input on the official side. Over the past 3 decades, the NCS has wasted many chances for engaging in the conservation of the species even upon recommendations of its staff and studies. It is noteworthy that SMC developed a conservation action plan – as Part of the Sahelo-Saharan Mega Fauna Initiative (SSMFA)- for several Sahelo-Saharan species including the Dorcas Gazelle and Slender-horn Gazelle. The current status of *G. leptoceros* & *G. dorcas* cannot be verified in the light of the current study. The TOR of the study arbitrarily delineated the study area of interest and was not based on data; thus the results are inconclusive. An action is advised to conduct pilot Positive-Negative surveys for the species all over its Egyptian range based on an initial stage of collecting local Knowledge, and accordingly delineate the potential areas for more through survey to establish status.

6. Recommendations and Proposed Action Plan:

It is hard to draw recommendations on the National level based on a localized assessment as the one in hands. However, as required by NCS and in the light of the current findings and previous work, some actions are recommended hereby. The recommended conservation action for the *G. leptoceros* was to conduct field surveys. Additionally, under the objective of Policy Framework Strengthening, it was proposed to develop a national action plan. We see this objective as unrealistic and not possible with the current status of the lack of contemporary data about the species and its range. The latest confirmed record of the species was by ELALQAMY 2006. NCS has no information about the species since the early eighties thus it is not possible to come up with any feasible *in situ* plan for the species. Only reintroduction would be the obvious action for *Gazella leptoceros* in Egypt. However, following a theoretical framework and inconsistency with the actions proposed by the IUCN- Antelope Specialist Group ((IUCN SSC ASG and RZSS, 2020) for the species, the following action options can be proposed:

6.1 SlenderHorned Gazelle (*Gazella leptoceros*)

6.1.1 Determining current status in the wild

6.1aCurrent status of *Gazella leptoceros* in Egypt

The slender-horn gazelle in Egypt is lacking contemporary information to define its status. The latest documented record of its population size and known range dates back to 2006 (Elalqamy & BahaEldin 2006). The species was known to occur in the western desert oases of Egypt. The current survey shows that it cannot be found anymore in Siwa Protected Area and its vicinity. Its presence in the rest of the oases cannot be ruled out without further investigation. The area spreading from Uweinat Mountain to Qattara depression should be subjected to systematic detailed surveys for both occupancy and population densities of Gazella leptoceros.

6.1.2 Strengthening protection of known sites

Ensuring effective protection of surviving populations and potential sites that would support *Gazella leptoceros* population, is critical to the species' survival and allow recovery.

- Increase protection inside Protected Areas (PAs) where the species is known to occur.
- Anti-poaching and patrolling activities should be closely coordinated with the military and border guards due to the sensitivity of these localities.
- Provide PA management with adequate staff and vehicles to patrol effectively.
- Identify key localities outside PAs
- Work with government agencies to recommend new PAs
- Establish ‘safe zones’ in key areas outside the PA network through targeted patrolling
- Liaise with tourism operators on monitoring and control of disturbance due to touristic activity.
- Establish communities of citizen monitors to monitor poachers
- Engage local communities in conservation projects through incentives such as sustainable tourism

6.1.3 Enhancing ex-situ populations.

Ex-situ population is not known to exist in any collection in Egypt. However, it is essential to establish a nucleus ex-situ captive population of *Gazella leptoceros* and organize to establish a captive beeding facility in Egypt. This potential breeding population should be carefully selected in a way to match or be closest to the genetic breed that is found in Egypt. Thus, genetic assessment should be planned to establish this baseline. Museum samples are recommended since field samples are very hard to obtain and verify as *Gazella lepotoceros*.

6.1.4. Strengthening awareness of slender horned gazelle conservation

While activities on the ground are principally carried out at national level, bilateral measures are needed for transboundary populations. Regional cooperation is also important. In North Africa the IUCN Centre for Mediterranean Cooperation can play a key coordinating role, and at range-wide level the CMS Concerted Action for Sahelo-Saharan Antelopes.

It is essential to raise awareness on the local regional importance of slender-horned gazelle and its current plight at all levels: governments, local administration, local communities, hunting associations, tourism operators, zoos, the public and international donor organizations.

6.1.5. Reintroduction and reinforcement of populations

The potential for these options is limited at the present time because the captive population is small and has low genetic diversity. Since Egypt has no captive population, it is necessary to build relations with the two existing breeding centers in North Africa and the metapopulation in North America and help increase the numbers in captivity. The species usually gives birth to twins so under experienced management in adequately sized facilities, it should be possible in future to produce stock for return to the wild. Any future release site must contain an adequate area of suitable habitat and be under strict protection before any operation takes place. The eastern form (G. l. leptoceros) is not found in captivity so any operations to restore populations in Egypt or eastern Libya would rely on animals from the western part of the range. Habitat modeling studies should be conducted to identify candidate sites for reintroduction.

On a parallel front, PAs should manage the habitat in a way that ensures the availability of a suitable range adequate to support the reintroduced population.

6.2 Dorcas Gazelle (*Gazella dorcas*)

On the other hand, for *Gazella dorcas*, summarizing, those proposed conservation actions and adding to them it is deduced that the only viable action now is assessing the status of the species in its Egyptian range and build the knowledge body required for further planning. In addition to species and population status assessments, it is crucial to assess the habitat status for establishing a viable gazelle reintroduction in parallel to the proposed gazelle survey efforts.

To conclude a conservation action plan for the Gazelle species in Egypt is proposed with the following activities in the following order:

6.2.1 Determining current status (*Gazella dorcas*) in the wild

1. Build the required knowledge body to enable any planning as the status of Gazelle species in Egyptian Range is totally lacking, by:
    a. Field survey in known Gazelle areas on four actions: 1) local knowledge gathering; 2) pilot positive negative surveys; 3) distance sampling surveys and 4) genetic assessment.
    b. Assess the habitat status for gazelle species requirements systematically with high priority inside potential current Protected Areas.
2. Using the collected Data and body of Knowledge and involving species experts conduct a series of brainstorming sessions, workshops, etc.. to develop the National Conservation Action Plan as a framework for reviving the species in its Egyptian Range.

6.2.2 Strengthening protection of known sites

3. Enhance the protection efforts in current Protected areas spanning the known gazelle range and enable active coordination with military and border guards for real rangers' presence in Protected Areas.

6.2.3 Enhancing ex-situ populations.

4. Investigate and work towards the objective of building an *ex Situ* conservation plan aiming at captive breeding followed by reintroduction of Gazelle species into identified areas resulting from Activities 1 & 2.
5. Initiate communication with captive breeding institutions and captive population holders to start building an Egyptian nucleus for the gazelle founder population intended for breeding and reintroduction.
6. Implement the Action plan through a national strategy to implement actions, monitor, and report back to a governing body.

The NCS should be the custodian of the previously mentioned activities and engage in a self-assessment process to achieve maximum performance on the objective of building the populations of gazelle species into its Egyptian Range.

Acknowlegement.

The authors would like all the staff who worked on this project and whose efforts are indispensable and without which this work wouldn't be possible. We would like to thank them for their sincere field efforts where they traversed the desert fasting on days of Ramadan and accomplished all assigned tasks. Namely, they are:

Siwa Protected area staff
*Ibrahim Omar Mohamed Baghy (manager)
*Ali Ahmed Mohamed Elmarakby.(ranger)
*Ashraf Ahmed bn Idris.
*Youssif Mohamed Ahmed.
*Mahmoud Omar Mohamed Baghy.
*Abdelnasr Bakrin Mohamed Bakrin. (driver)
*Mohamed Ali Soliman Ambiwa. (driver)
*Hamd Idris Masod Abo Zahra. (driver)
*Elsanosy Mohamed Elsanosy. (driver)

Safe Soar staff
*Moaz Gamal Abdelghafar.
*Aya Asser Ayad.
*Shahd Elgohary Helal Elgohary.

Annex I

Distance Sampling Glossary of terms

Data items:

n - number of observed objects (single or clusters of animals)
L - total length of transect line(s)
k - number of samples
K - point transect effort, typically K=k
T - length of time searched in cue counting
ER - encounter rate (n/L or n/K or n/T)
W - width of line transect or radius of point transect
x(i) - distance to i-th observation
r-p - probability for regression test
chi-p- probability for chi-square goodness-of-fit test

Parameters or functions of parameters:

m - number of parameters in the model
A(I) - i-th parameter in the estimated probability density function(pdf)
f(0) - 1/u = value of pdf at zero for line transects
u - W*p = ESW, effective detection area for line transects
p - probability of observing an object in defined area
ESW - for line transects, effective strip width = W*p
D - estimate of density of animals
N - estimate of number of animals in specified area

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