Project proposal

A study of the population densities, movement patterns and land uses of oryx, springbok and mountain zebra in and around the Greater Sossusvlei-Namib Landscape

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CONTENTS

1. Background

The Greater Sossusvlei-Namib Landscape (GSNL; Figure 1) promotes collaborative management between the owners and custodians of land, both private and public, for the purpose of improved ecosystem and biodiversity management and socio-economic development (Anon. 2013). This landscape forms part of the NAMIBIA Protected Landscape Conservation Areas initiative (NAM-PLACE; www.landscapesnamibia.org), designed to conserve Namibia's biodiversity and ecosystem values and provide sustainable benefit flows at local, national and global levels, through the establishment of Protected Landscape Conservation Areas.

The GSNL area is rich in arid adapted wildlife, with oryx, springbok and mountain zebra being the three most abundant ungulate species. Much of the land within and surrounding the GSNL is managed for wildlife, with the Namib-Naukluft Park, at 5 million ha, being a core component. The poor economic returns from farming (mainly small-stock) on the edge of the Namib have resulted in much of the private land in this important belt, which links the Namib to the escarpment, being converted to wildlife and tourism. A consequence of this is that many land owners have removed their internal stock fences and other farming infrastructure to create private nature reserves.

One of the most important adaptations of wildlife to arid zones is mobility – the ability of animals to move extensively in response to changing climatic and grazing conditions. These movement patterns and their underlying drivers have been little studied and are poorly understood. The future of Africa's wildlife depends on ecologically functional conservation areas (Fynn & Bonyongo 2010). Ungulate populations in many African wildlife conservation areas are in widespread decline, which can be attributed largely to a lack of ecosystem functionality of the land encompassed by these areas. Many do not include both the necessary wet- and dry-season resources between which ungulates traditionally migrated. Human populations and economic development have grown to levels where they interfere with or block such migrations. These restrictions to ungulate movements between areas of water and grazing resources make it difficult for the animals to utilise their traditional seasonal grazing areas. The potential effects of climate change may result in further range changes and other impacts.

During the period when small-stock farming was the main land-use on the edge of the Namib, up until the 1990s, there was considerable conflict along the border between the Namib-Naukluft Park and the farmlands. Farmers were struggling economically, particularly in dry periods, and many augmented their farming income by poaching, illegally funnelling animals from the Park onto their land and then organising large-scale biltong hunting. Farmer activities also included the extensive use of poisons to kill predators such as jackal and caracal, but this also virtually eliminated all scavengers, both mammalian and avian, including vultures. As a result, the Ministry of Environment and Tourism (MET) constructed a strong game-proof fence along the eastern border of the Namib-Naukluft Park. However, an unanticipated consequence of this fence was that, in dry periods, wildlife attempted to move eastwards towards the escarpment, was stopped by the fence and died. In times of average to good rainfall this was not perceived as a problem, but during below-average rainfall, wildlife populations – and particularly oryx – declined significantly.

With the change in land use from farming to wildlife and tourism, conflicts diminished along the Namib-Naukluft Park border and the Park found itself with friendly neighbours practicing compatible land uses. This created the opportunity for the MET to enter into a new phase of adopting collaborative approaches with neighbours to promote better land and natural resources management. One of the initiatives of the GSNL is to open up the Namib Desert through to the escarpment with the objective of creating a "Fence Free Namib". Neighbouring land owners have started to dismantle their border fencing on the basis of a Memorandum of Agreement between them.

This is opening up corridors for wildlife to start returning to their historic movement patterns and land uses in response to changing climate and resources.

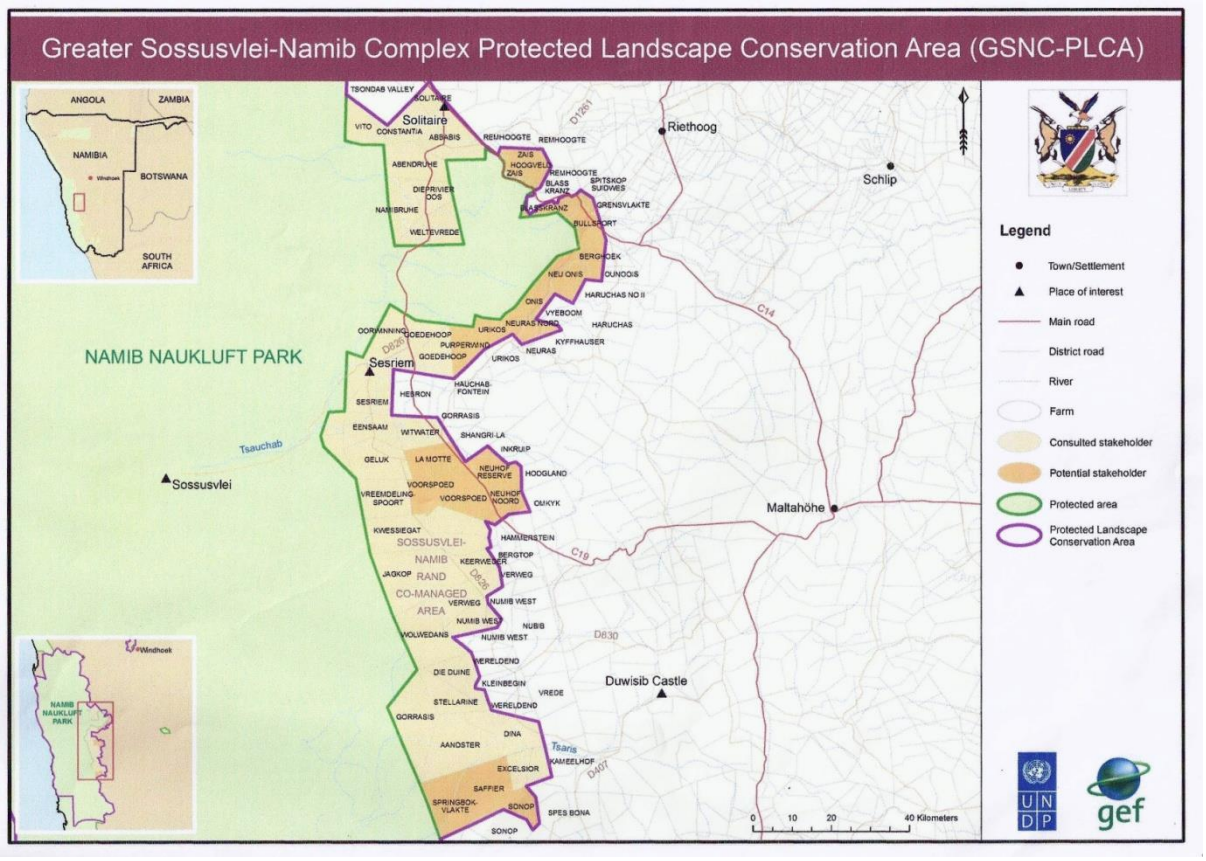

Figure 1. The core study area of the Greater Sossusvlei-Namib Landscape (GSNL), showing property boundaries and current borders of the GSNL.

2. Aim and objectives

The aim of the project is to study the population densities, movement patterns and land uses of oryx, springbok and mountain zebra in and around the Greater Sossusvlei-Namib Landscape (GSNL). The objectives are:

- To document the abundance, distribution and movement patterns of oryx, springbok and mountain zebra in the central Namib and Naukluft area with a particular focus in and around the GSNL,
- To interpret and understand these spatial distributions and movement patterns and the associated land uses by wildlife in response to rainfall and other climatic conditions, veld condition, water availability, other natural resource conditions and issues, wildlife densities, and land uses,
- To understand the impacts on movements and land uses by the selected species resulting from fence removal, breaching and the creation of corridors, and to identify remaining barriers and bottle-necks,
- To develop management guidelines for the three selected species in the GSNL based on an understanding of their movements and land uses, and incorporating wildlife population densities to be derived from landscape game counts and other monitoring sources.

3. Study area

The core area for the project is the Greater Sossusvlei-Namib Landscape (Figure 2). However, at the request of the Ministry of Environment and Tourism (MET), in the case of mountain zebra the study area will be extended northwards to include the Ganab/Gamsberg/Tsondab area, and southwards to

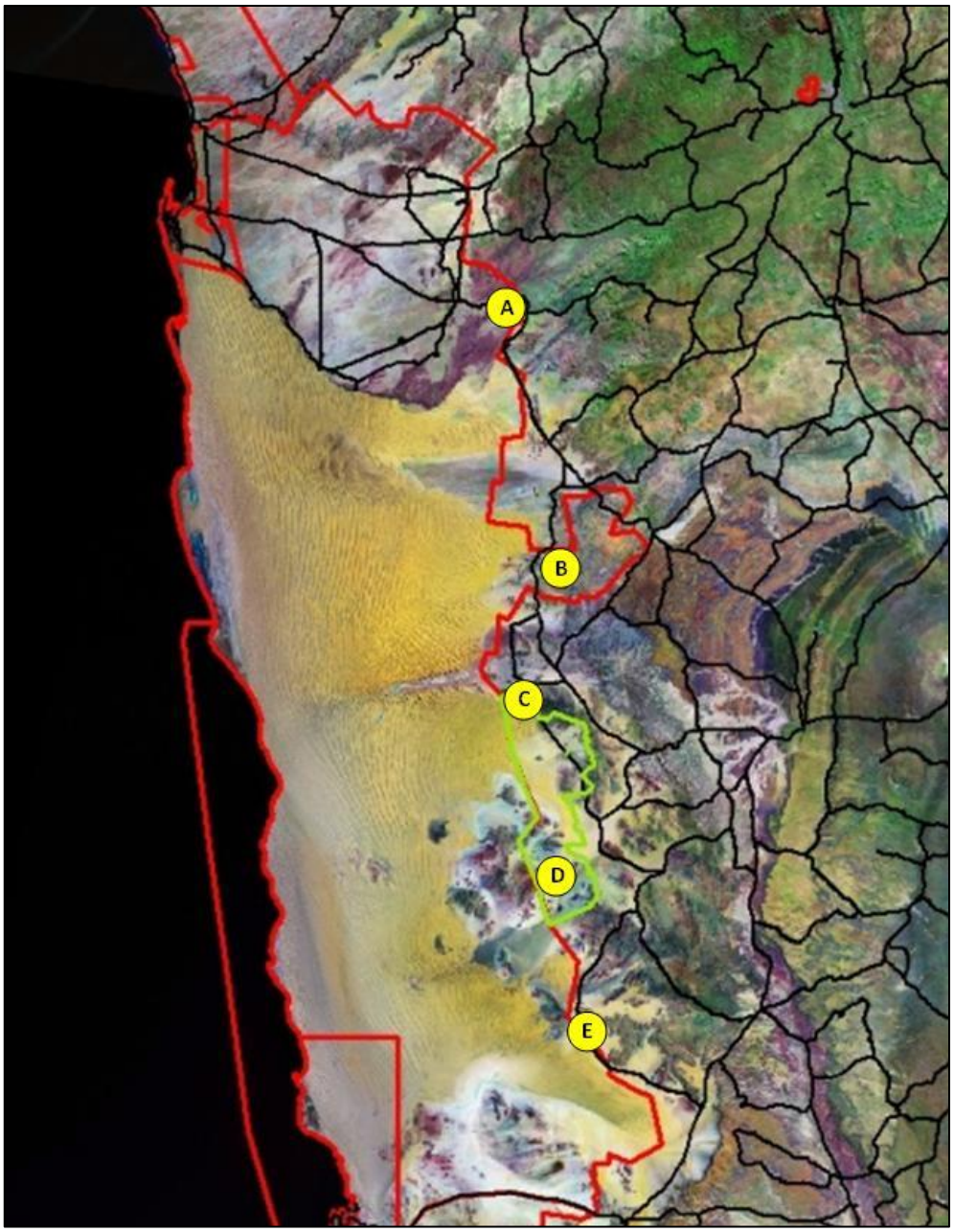

Figure 2. Suggested functional units/wildlife capture areas for the core Greater Sossusvlei-Namib Landscape study area (Unit B, C, D) and associated areas (Unit A, E) over a five-year time frame. Black lines indicate roads; red lines show national park boundaries; green lines show NamibRand Nature Reserve.

Unit A – Ganab-Gamsberg
Unit B – Tsondab-Naukluft
Unit C – Sossusvlei-Sesriem
Unit D – NamibRand-Nubib
Unit E – Koichab (longer term)

include the Koichab area. The reasons for this are that the highest concentrations of zebras are found in this area and as a result there are pressing management issues regarding this species, particularly related to the high population numbers. In addition, this study forms part of a national assessment on the status of the mountain zebra in Namibia.
Key "functional units" have been identified provisionally that will form focal areas for the capture of target animals (Figure 2):

Unit A: Ganab-Gamsberg
Unit B: Tsondab-Naukluft
Unit C: Sossusvlei-Sesriem
Unit D: NamibRand
Unit E: Koichab (longer term)

Functional units are defined as aggregations of land holdings which provides a practical scale at which to monitor and manage, and where free movement of wildlife is currently possible or potentially so.

4. Project duration

The project duration will be for an initial period of five years.

5. Methods

*A logframe summary is included in Appendix 1; note that each action and each output has a unique number that corresponds with the logframe and the budget)

Acronyms
GSNL – Greater Sossusvlei-Namib Landscape
MET – Ministry of Environment and Tourism
MZ – mountain zebra
NRNR – NamibRand Nature Reserve
PC – Project Coordinator

5.1 Stakeholder consultation

Background
Proposed actions are based on consultations with key people in MET, NamPlace, GSNL and other partners including educational/research institutions (see Table 1) to ensure that all objectives and ideas are taken into account and combined into a comprehensive but practical proposal.

Actions
1) Initial and ongoing consultations with major stakeholders/funders and researchers (Table 1; this proposal).
2) Follow-up consultations with other relevant partners once capture areas have been finalised and the project is in progress (Table 1; GSNL).

Outputs to track progress:
1. Stakeholders consulted and inputs incorporated into project plan on a dynamic basis

Table 1: Stakeholder consultation			
Stakeholder	**Representative(s)**	**This proposal**	**Follow-up consultations**
NAM-PLACE Steering Committee	Teofilus Nghitila (chairperson) Michael Sibalatani 5x Landscape chairpersons	x x	x x x
NAM-PLACE / Greater Sossusvlei-Namib Landscape (GSNL)	Nils Odendaal (chairperson)	x	x
	Michael Sibalatani (secretariat)	x	x
	Jonas Heita (secretariat)	x	x
NamibRand Nature Reserve	Nils Odendaal	x	x
	NamibRand Board & staff	x	x
Gondwana	Dr Chris Brown	x	x
Ministry of Environment & Tourism (MET)	Kenneth Uiseb	x	x
	Colgar Sikopo		x
	Manie le Roux	x	x
	Chief control warden	x	x
	Vitalis Mushongo	x	x
	Riaan Solomons	x	x
	Werner Kilian	x	
	Pierre du Preez	x	
	Wilferd Versfeld	x	
Other key GSNL participants	Geluk		x
	Voorspoed/la Motte		x
	Weltevrede		x
	Ababis		x
Educational/research institutions			
University of Newcastle (UK)	Dr Morris Gosling	x	
Gobabeb/DRFN	Dr Mary Seely		x
	Gillian Maggs-Kölling		x
Polytechnic of Namibia	Barbara Curtis		x
	Morgan Hauptfleisch		x
	Ibo Zimmermann	x	
University of Namibia (UNAM)	Dr Mfune		x
University of Nebraska-Lincoln (USA)	Prof. Larkin Powell		x
Other partners	Sylvia Thompson	x	
	David Peddie	x	
	Dr John Mendelsohn/ Alice Jarvis/ Tony Robertson	x	x

5.2 Objective 1:

To document the abundance, distribution and movement patterns of oryx, springbok and mountain zebra in the central Namib and Naukluft area with a particular focus in and around the GSNL; and also mountain zebra in the Ganab/Gamsberg area in the north and the Koichab area in the south

5.2.1 Capture and fitting of GPS collars (oryx, springbok and mountain zebra)

Background

A practical sampling scheme is envisaged that will make use of a range of techniques including ground surveys, aerial surveys, GPS satellite tracking and camera trapping. GPS tracking can help provide uniquely detailed information about connectivity between different parts of the GSNL area and movements in areas where fences have been removed or corridors established. If it is not possible to sample the entire area then substantial subsets of the area should be selected that demonstrate the principles of ecosystem function (especially the main movement patterns in relation to the food supply). However, different techniques may be needed in different parts of the study area for different species.

For the capture and darting of target animals, the MET will supply helicopter flying time, veterinary services, drugs and any other capture support services required. According to MET experience and recommendations, only GPS collars (battery-powered) from African Wildlife Tracking (AWT) are recommended. Smaller collars may apply for springbok.

According to MET policy not to leave animals collared indefinitely, all collars will need to be removed before the two-year lifespan of the collars expires. This will require additional helicopter flying time and veterinary services. Alternatively, collars with a remote release mechanism should be investigated (see No. 6) above).

Actions

3) Identify provisional functional units within the GSNL, and target capture sites (as indicated in Figure 2; GSNL/MET).
4) Determine target animals for fitting GPS collars in target areas per unit (species, number, sex; see Table 2 for suggested matrix; GSNL/MET).
5) Determine optimal tracking frequencies, e.g. 4 hours for MZ (Muntifering & Harris 2011); 7 hours for oryx (Lehmann *et al*. undated); combination of day-night and seasonal frequencies (GSNL/MET).
6) Investigate remote-release collars (GSNL/MET).
7) Purchase 54 (27 year 1; 27 replacements year 2) collars from African Wildlife Tracking (GSNL/ MET).
8) Register download service (with AWT; GSNL/MET).
9) Test collars (GSNL/MET).
10) Set potential capture dates (ideally before first summer rains) (GSNL/MET).
11) Book helicopter time and vet time (MET/GSNL).
12) Within Year 1 capture and fit GPS collars; captured MZ should be photographed on both sides of the body so that they can be checked against existing ID registers (MET/GSNL).
13) Monitor collared animals post-capture (GSNL/ MET,).
14) After two years, locate collared animals and remove collars (GSNL/MET)
15) Evaluate results from collared animals and replace key collars as required (GSNL/ MET).

Table 2: Capture and fitting of GPS collars				
Functional unit	**Species**	**No. males**	**No. females**	**Total**
A. Ganab-Gamsberg	Mountain zebra	2	2	**4**
B. Tsondab-Naukluft	Oryx	0	3	**3**
	Springbok	0	3	**3**
	Mountain zebra	2	1	**3**
C. Sossusvlei-Sesriem	Oryx	0	3	**3**
	Springbok	0	3	**3**
D. NamibRand-Nubib	Oryx	0	3	**3**
	Springbok	0	3	**3**
	Mountain zebra	1	1	**2**
TOTAL		**5**	**22**	**27**

Outputs to track progress:

2. *Project plan in place and finalised*
3. *GPS trackers (satellite) acquired and download service registered (AWT)*
4. *Target animals captured, fitted with GPS trackers and monitored*
5. *Collars removed after two years and re-fitted/refurbished as required*

5.2.2 Camera traps (mountain zebra)

Background

Numbers of cameras depend on the distribution of water holes and the time of use; spacing can be greater over longer periods because MZ move more over longer periods (M. Gosling pers. comm; see Table 4 for suggested numbers of cameras per functional unit). When establishing networks of camera traps to estimate populations of areas, spacing is crucial: one camera per 5-10 km^2 is recommended, based on experience in Gondwana Canyon Park and NamibRand. If the number of cameras needs to be limited according to budget, investigate (a) a contribution from stakeholders towards purchasing extra cameras, and (b) a strategic sampling rotation, depending on person-power available to monitor/manage the cameras and analyse the data; i.e. move the cameras about, focussing on particular areas for a few months, then moving on.

The cost will be strongly affected by the type of camera. Dr Gosling will be testing alternatives (see Table 5). Although used in the past, Buck Eye cameras are not considered suitable as they are expensive and need to be serviced in the US.

One aim of the GSNL scheme is to document patterns of movement following the removal of barriers and the implementation of corridors etc. Monitoring individuals using camera traps at water holes and by using conventional photography in the field allows such documentation (M Gosling).

All photographs should be retained in a digital archive so that results, including identities established by different researchers, can potentially be audited. The quality of camera data should be ensured by ongoing monitoring of results. A system for uploading photographs to the GSNL website will be explored, from both camera traps and conventional field photography.

Actions

16) Identify and map optimum localities and types/numbers of camera traps (GSNL/MET/M Gosling; see Table 4 for suggested matrix).
17) Purchase cameras; use existing cameras and replace where necessary, but aim to standardise where possible (GSNL/MET).

18) Within Year 1, place 100-150 camera traps at identified localities (mainly water holes, but also established paths if applicable), using new traps to fill gaps in existing localities (MET/GSNL)
19) Collect camera cards on regular basis (MET/GSNL; possible student intern?).
20) Download data; analyse, optimise and turn into accessible data and information. Possibly use Reconyx software to standardise format and save on analysis time (see Table 5; Polytechnic student interns, N/a'an ku sê volunteers, disabled persons; overall guidance/ supervision M Gosling).
21) Locate source populations and sample one month apart for mark-recapture analysis for population estimates (M Gosling/MET/students/volunteers).
22) Determine individual IDs of MZ and map movement patterns according to camera trap data (M Gosling/students).

Table 4. Camera trap placing and management

Functional unit	Type of camera	No.	Responsibility Overall supervision: Dr Morris Gosling Jonas Heita will assist with day-to-day liaison where practical
A.Ganab-Gamsberg	To be determined – see Table 5	40	MET
B. Tsondab-Naukluft		40	MET (MSc student Vitalis Mushongo, who is doing a mark-recapture estimate of this population, MSc Unam); GSNL
C. Sossusvlei-Sesriem		35	GSNL
D. NamibRand-Nubib		35	GSNL
TOTAL		**150**	

Table 5. Comparison of available camera traps

Reconyx: HC600 Hyper HD Covert IR	Lynx Optics: Ranger BN055/6
Cost: N$5,000+	Cost: N$1,700
Software advantages: summarising a lot of data from each image (date time etc.) in a table to which (for example) MZ ID can be added as a separate column. This would save a lot of analysis time. (Protection boxes extra)	Quality of the Lynx images is much better (which is non-trivial given the need to detail to examine stripe details). (Protection boxes extra)

Outputs to track progress:

6. Camera traps purchased
7. Optimum localities finalised
8. Camera traps installed
9. Camera trap data downloaded and collated
10. Individual IDs of MZ determined
11. Movement patterns of MZ mapped according to camera trap data

5.2.3 Downloading of GPS collar data

Background (S Thompson pers. comm.)

Particulars about AWT collar data

- Data are downloaded collar by collar
- Data are provided in CSV format (see below), so are easily processed using Microsoft (MS) Excel

- All other procedures (database management, GIS mapping and analysis) are consequently performed using ESRI Arc INFO tools
- ArcMap can directly process MS Excel files. Accordingly, raw data are kept in MS Excel and a Geodatabase is created with ArcGIS tools. Geodatabases can be viewed in MS ACCESS.

ID	Local Date	Local Time	GMT Date	GMT Time	Lat	Lon	Temp (deg C)	True Speed (km/h)	Dir	Alt (m)	Cov	HDOP	Distance (m)	Count	symbol
SAT502	2012/09/25	15:24:21	2012/09/25	13:24:21	-25.821117	28.158267	29.5	0	0	1433	4	0	0	1	41177

File and data formats

- Raw data are assimilated in MS Excel.
- Geographical data files are created in Geodatabase format and SHP (Shapefile) format. Geodatabase files can be opened in MS ACCESS. Shapefiles can be opened in all GIS packages.
- For non GIS specialists, monthly KMZ file automations will also be created. KMZ files can be viewed in Google Earth, which is free open source software and very user-friendly and easy to use. The KMZ automation allows for simulations with the collar data:
    - One can trace animal movements interactively, but also choose to view different collar movements in relation to each other.
    - The KMZ allows the user to choose different collars for viewing, view all of them and choose intervals of time for viewing.
    - The files tend to become heavy after long periods of data and accordingly, KMZ files normally only contain the last 3 months of data. But this depends on the number of collars and interval of data capture.
- Maps can be provided in any image format. JPG is normally the best format for PowerPoint presentations and to incorporate into reports. However, GIF is also popular, as it is a good size/quality compromise.

Actions

Download data, carry out analysis and map GPS collar data (see Table 3; Natural Resources Working Group: Sylvia Thompson)

23) Data download
24) Database management
25) Set-up of map and processing templates
26) Mapping and animation
27) Data analysis
28) Ground-truth GPS collar mapping data (GSNL/MET)

Table3 : Downloading of GPS collar data	
Task description	**Particulars**
1. Data download	• From the AWT download site (http://www.awt.awetelemetry.com); collars have to be downloaded one by one
2. Database management	• Update master table • Create Geodatabase and shapefiles • Clean data
3. Set-up of map and processing templates	• The first time the collar data is mapped and animated, procedures and templates are put in place that will be used throughout the process

4. Mapping and animation	• Standard collar maps • Basic analysis maps (hot-spot identification and frequency of movements) • Creation of KMZ files for data automation in Google Earth
5. Data analysis	• Kernel density analysis (every 6 months) • Creation of maps and KMZ files of results

Outputs to track progress:

12. GPS data downloaded and collated
13. GPS movement patterns of three target species produced and updated
14. GPS movement patterns of MZ correlated with camera trap data and mapped
15. GPS movement data ground-truthed
16. Popular maps produced and updated on GSNL website regularly

5.3 Objective 2 & 3:

Objective 2: To interpret and understand the spatial distributions and above movement patterns and the associated land uses by wildlife in response to natural resource conditions and issues, including rainfall and other climatic conditions, veld condition, water availability, wildlife densities and land uses; and

Objective 3: to understand the impacts on movements and land uses by the selected species resulting from fencing conditions and issues, including fence removal, breaching and the creation of corridors, and to identify remaining barriers and bottle-necks

5.3.1 Collate and map baseline data below in the form of dynamic GIS layers (Table 6; Jonas Heita/ student intern?)

Actions: collate data on

29) Rainfall: map east/west and north/south gradients
30) Land use
31) Water availability for game
32) Fire mapping
33) Veld condition/food resources available (student projects)
34) Habitat type
35) Topography-slopes/gradients/altitude

Table 6: Baseline data

Item	Detail
2.1.1 Rainfall: E/W and N/S gradients	Existing gauges
	Identify gaps and install new gauges (remote gauges?)
	Collate and document rainfall data
2.1.2 Land use	Farming
	Wildlife/conservation/tourism
2.1.3 Water availability for game	Natural/artificial
	Perennial/seasonal
2.1.4 Fire mapping	Historical data
	Ongoing updates
2.1.5 Veld condition/food resources available	Transects/plots: - Species composition - Cover - Biomass

2.1.7 Habitat type	Mountains, rocky slopes, inselbergs, gravel plains, sand dunes, water courses
2.1.8 Topography-slopes/gradients/ altitude	Contour mapping

Outputs to track progress

17. Electronic field rain gauges purchased and installed
18. E/W and N/S rainfall measuring gradient in place and rainfall data documented
19. Land use mapped
20. Water availability mapped
21. Fire mapped
22. Veld condition determined on a seasonal basis
23. Habitat types identified and mapped
24. Topography-slopes/gradients/altitude mapped
25. Baseline data on natural resources collated in GPS layers and updated regularly

5.3.2 Determine wildlife densities

Wildlife densities and distribution will be determined using a combination of methods, primarily game counts in key areas.

Actions

36) Road count transects in key areas (for oryx and springbok; in some cases less successful for mountain zebra); (GSNL/MET/partners)
37) Helicopter survey (mountain zebra; MET)
38) Camera traps (mountain zebra: mark-recapture technique; M Gosling/students)
39) Self-assessment using presence/absence data on a grid square basis (GSNL partners/ owners of commercial farms)

Outputs to track progress

26. Data collated and mean population sizes and distribution determined

5.3.3 Rigorous research analysis

Background

Types of projects

Two types of (complementary) projects have been identified:

- principle/local projects
- larger-scale projects involving landscape dynamics

Integration of results

Integrate the findings from collared individuals with parallel studies of populations using one of the survey techniques mentioned above (see 5.3.2). However, there are also benefits from doing this sort of work in areas where individual-based studies are already underway and if practical, where the individuals that are collared are already known. This allows information about what, if any, effect the experience of immobilisation and collaring has on an individual and its subsequent movements (M Gosling pers. comm.).

Landscape based analysis A landscape database will be used that includes all of the land holdings as part of the NAMPLACE initiative. For all species densities will be produced per land holding, per habitat type, per functional unit and overall. Changes from year to year will be shown (numbers, distribution) and if possible, also seasonally, though this might be too demanding of stakeholders and more insight could come from collared animals.

For MZ a practical aim should also be to include time-based population estimates to all of these holdings and to identify patterns of connectivity between holdings, that is, where fences have been removed (or never existed) so that there is the potential for free movement of MZ populations. This will effectively define functional units, where free movement or potentially free movement is possible. Subsequent analysis to calculate overall population size could become complicated because of the different types of data, including some missing values. Population movements will require GIS-based analysis with layers that include the spatial distribution of rainfall, water holes (categorised by reliability of supply if possible) and forage plants (or at least major vegetation zones). The data will be managed according to procedures already established in Namibia for ground-based fixed-route wildlife counts. The way in which the distribution data are presented for this analysis will be (i) densities per map grid square and (ii) per land holding. The latter will require some assumptions (such as assuming the same density throughout a landholding).

Synoptic modelling

A futher type of investigation could be the application of synoptic modelling, as described by Edward (Oz) Garton, Jon S. Horne, Adam G. Wells, Moses M. Okello: Synoptic Modeling of Animal Location Data Combining Animal Movements, Home Range andResource Selection: a new approach to analysis of animal location data that combines animal movements, home range and resource selection analyses into a synoptic model of space use and to provide them with experience using analytical software to perform the statistical analyses required (N Odendaal pers. comm.). This could possibly comprise a student project at MSc or PhD level. For further information see http://www.cnr.uidaho.edu/population_ecology/Synoptic_Modeling_Workshop_IWMC_Durban_South_Africa.htm or choose the Synoptic Model link at top of first page from http://www.cnr.uidaho.edu/population_ecology (at the bottom of the Synoptic Model page, following the abstract for the workshop, there are links to download everything as a single large zipped file (40 Megs in size) or links to individual portions of the workshop materials (smaller in size).

Potential Research Team participants
Lead scientists: Dr Chris Brown, Kenneth /Uiseb, Dr Morris Gosling
Institutions: University of Namibia, University of Newcastle UK, Polytechnic of Namibia
Other partners: GSNL (Jonas Heita), MET

Actions

40) Identify prospective participants and put together a Research Team. This team will:

41) Correlate wildlife movements / densities with above baseline data on natural resources to determine:
    - Population sizes/densities; mean population size with a measure of variance
    - Key wet and dry season movements
    - Quantitative population distribution at the two extremes of the annual east-west movement cycle
    - Link to food plant distribution
    - Link to habitat type
    - Link to topography - gradients

42) Correlate the above wildlife movements/densities with fenceline conditions and removals
    - Identify corridors between functional ecological units
    - Correlate key wet and dry season wildlife movements with fenceline data (and with baseline data above)
    - Understand how animals move within constraints of fences, and identify remaining barriers and bottle-necks in fencing according to the above data

Outputs to track progress:

27. Research Team in place
28. Composite map based on GIS data
29. Map showing corridors and functional units
30. Composite map correlating key wet and dry season movements with fenceline data & other baseline data, including barriers to movement

5.3.4 Provide ongoing feedback

Background

It is essential to provide feedback on an ongoing basis, with a view to maintaining motivation of participants as well as to track and evaluates progress, in order to identify any adjustments that need to be made.

Actions: provide feedback

43) GSNL website (Sylvia Thompson/Alice Jarvis)
44) Scientific reports including to land managers (Research Team/GSNL)
45) Other popular articles/media items (GSNL)

Outputs to track progress

31. Regular feedback reports on GSNL website
32. Scientific reports
33. Popular articles/media items

5.4 Objective 4:

To develop management guidelines for the three selected species in the GSNL based on an understanding of their movements and land uses, and using wildlife population densities to be derived from game counts

5.4.1 Compile a comprehensive species management plan

The development of management guidelines is the ultimate outcome of the research investigations. These guidelines should be based on an understanding of the movements and land uses for the three selected species, and should incorporate wildlife population densities (to be derived from landscape game counts and other monitoring sources) on an ongoing basis.

Actions

46) Initial recommendations (three years):
    - Fence removals
    - Key waterholes
    - Planned burns (strategic)
    - Game counts for key areas
    - Stocking rates in fenced areas

47) Compile a comprehensive species management plan including the above aspects and further recommendations (five years):
    - Long term monitoring
    - Further research

Outputs to track progress:

34. Recommendations listed on GSNL website after three years
35. Further recommendations listed on GSNL website after five years
36. Comprehensive, dynamic species management plan

6. Expected outputs

Expected outputs include ongoing feedback in the form of updates of the GSNL website, scientific reports and popular articles/media items (see 5.3.4). Ideally, these guidelines could be included in a comprehensive management plan for the three species, that integrates all the findings but makes provision for individual requirements per species.

Examples of reporting outputs have been provided by Sylvia Thompson (pers. comm.):

- Map products andanimation file (Figure 3a and 3b)
  *Note that the animation file (KMZ) file is available on request by email for testing.
- Possible analysis product, showing kernel density analysis (Figure 4)
  Please note that all map products above belong to The Ministry of Environment and Tourism and may not be used or distributed without their consent. The maps are provided purely for demonstration purposes (S Thompson pers. comm.).

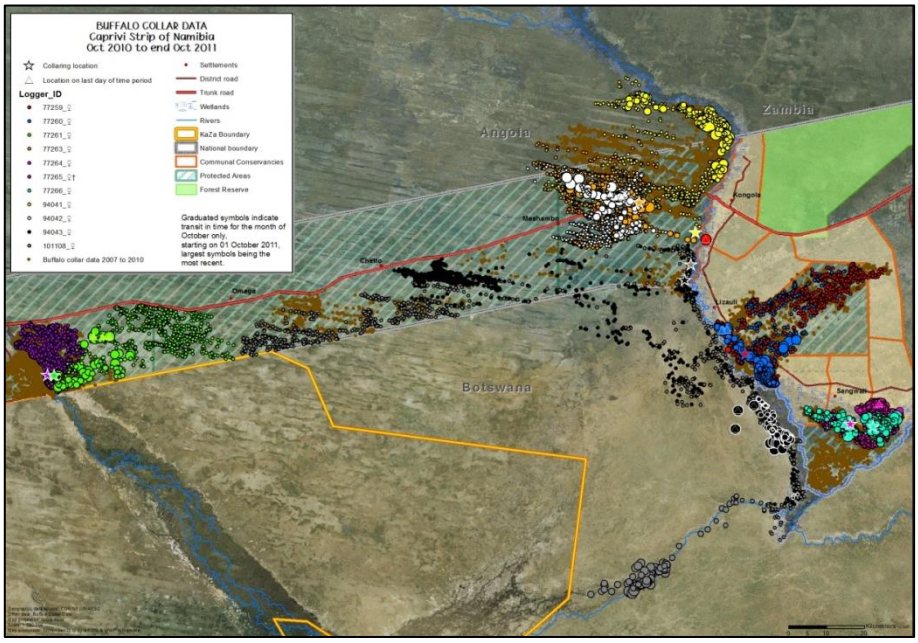

Figure 3 a. Map products and animation file for GPS tracking data (S Thompson).
Note: The animation file (KMZ) file is available on request by email for testing.

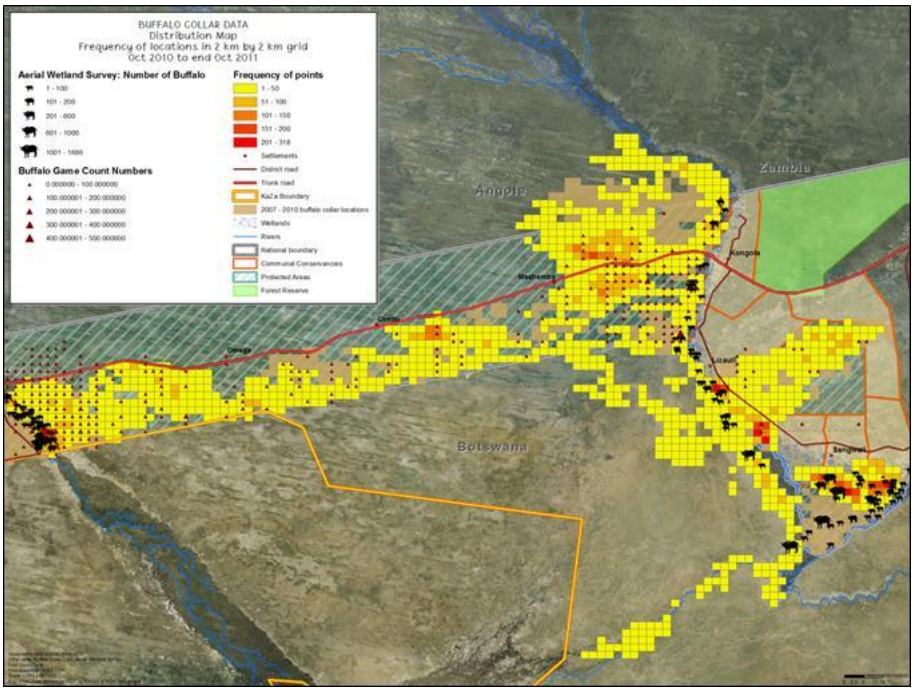

Figure 3 b. Map products and animation file for GPS tracking data (S Thompson).
Note: The animation file (KMZ) file is available on request by email for testing.

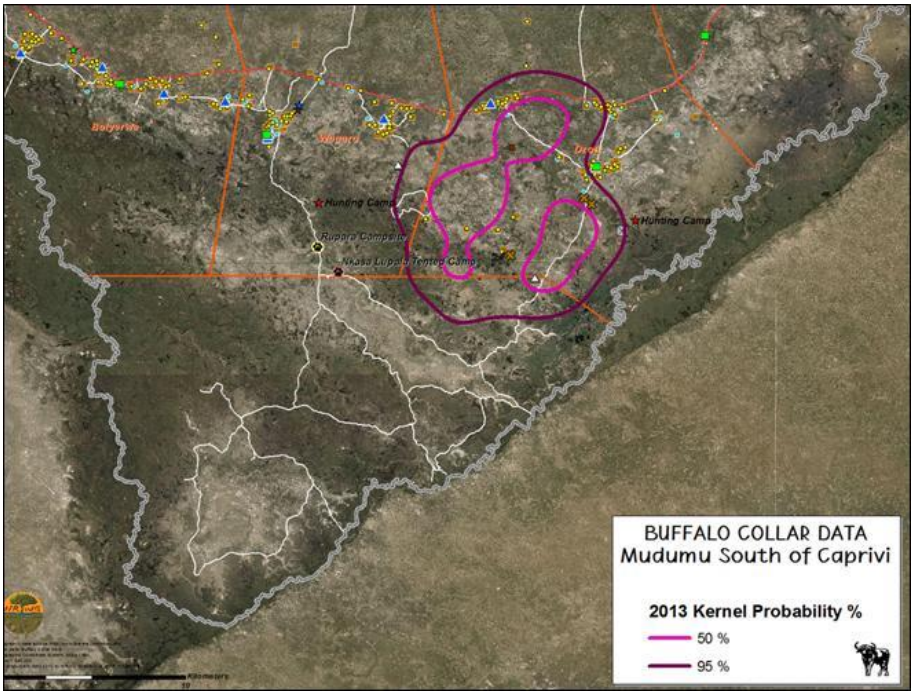

Figure 4. Possible analysis product for GPS tracking data, showing kernel density analysis.

The results of satellite tracking exercises in Kunene by Jeff Muntifering and Tara Harris (Muntifering & Harris 2011) show the value of such studies for starting to define seasonal ranges (Figure 5) and to show how different individuals adopt different patterns of movement (Figure 6 ; M Gosling pers. comm.). In particular, the bottle-neck caused by the veterinary fence to movements of two MZ mares is indicated (Figure 7).

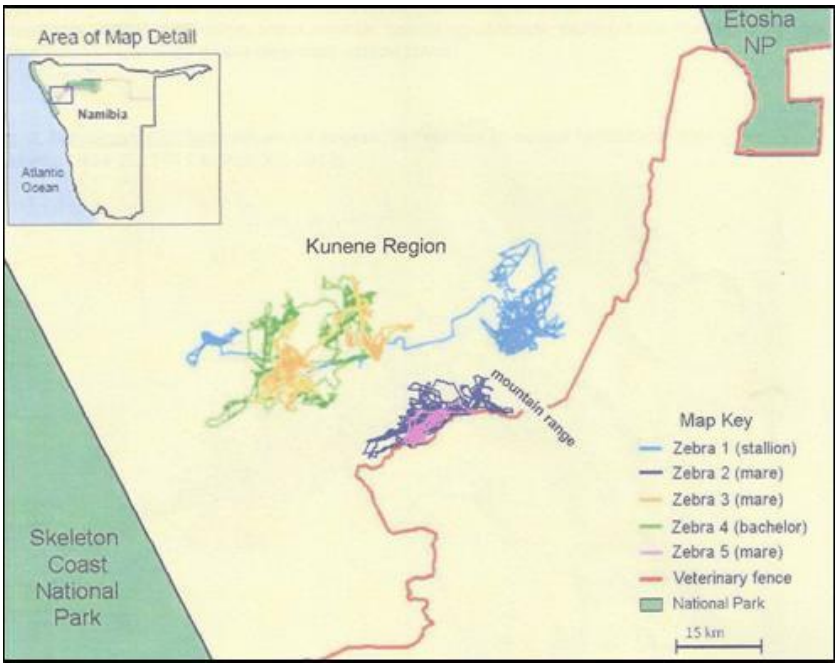

Figure 5. Overview of movement of satellite-tracked mountain zebras in the Kunene Region (20 Nov 2011 to 23 Apr 2012; Muntifering & Harris 2011).

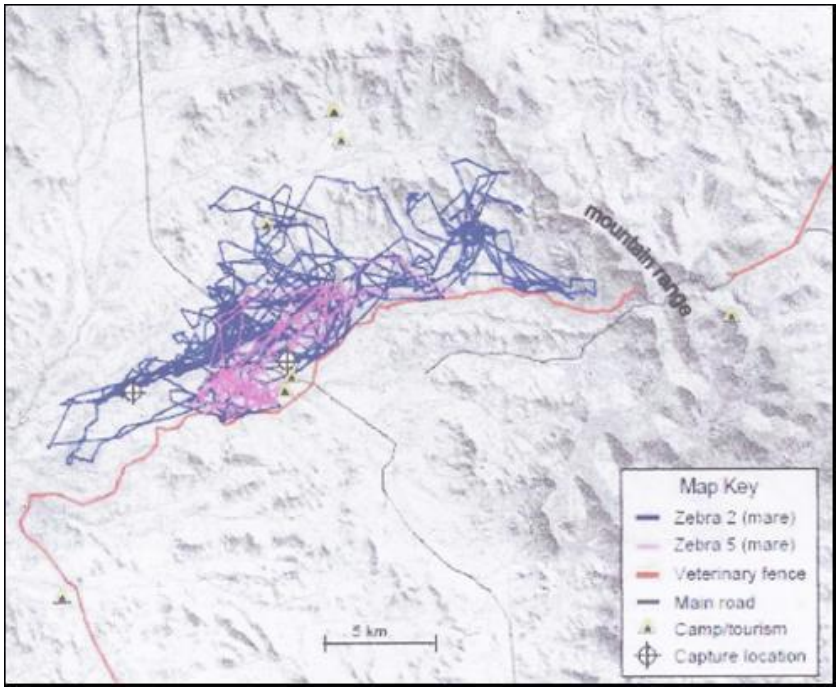

Figure 6. Movements of two satellite-tracked mountain zebras, in relation to select landscape and other features in the Kunene Region; note how the veterinary fence (red) effectively prevents movement south (20 Nov 2011 to 23 Apr 2012; Muntifering & Harris 2011).

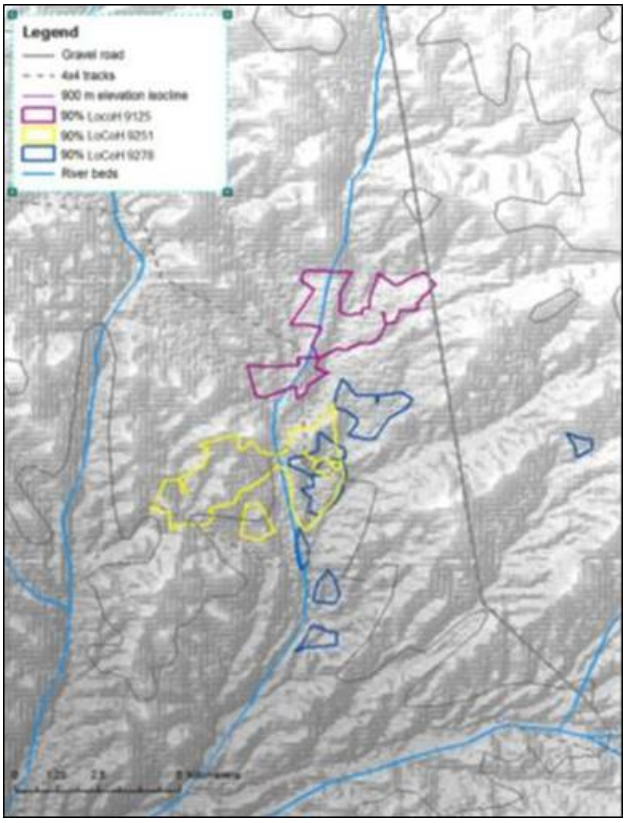

Figure 7. Preliminary results for home ranges, determined by GPS tracking seven adult female oryx in the Kunene Region; one fix every seven hours; study period: April-August 2011 (Lehmann, Mfune & Voigt undated).

A recent study, involving a collaboration between Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, Germany and University of Namibia (UNAM), is investigating eco-physiological responses of ungulates towards heat and drought were investigated in the Damaraland desert of Namibia (Lehmann, Mfune & Voigt undated). The approach involves using stable isotope analyses and GPS based radiotracking of animals. Some preliminary data (reproduced in Figure 7 [Appendix 1] from GPS collars on seven adult female oryx (one fix every seven hours; study period: April-August 2011) indicate a home range of around 9,2000 km^2.

The main output will be a comprehensive species management plan, based on the research findings. This plan will be dynamic in nature, with regular assessments and updates.

7. Budget

See Appendix 2 for details of budget.

Sources of finance:

- NAM-PLACE
- Co-financing with MET, including in-kind support such as veterinary and flying time
- Other potential funders: MET Game Product Trust Fund, Wilderness Wildlife Trust, Environmental Investment Fund, Whitley Fund

8. Other components

8.1 Project management

Background

The GSNL will be responsible for managing the project, initially for 5 years. This will include the planning, coordination and implementation of approved actions, as well as involvement in any aspect of the project as required. The GSNL may allocate certain actions on a contract basis. Finance will be managed in terms of the budget (ongoing/annual review), with financial reporting on a quarterly basis. Project reporting will also take place on a quarterly basis. Monitoring and evaluation (M & E) will take place according to the identified indicators by both the PC and the GSNL committee (or an identified sub-committee/working group).

Actions

48) Planning & implementation of actions
    Finance
    - Budget
    - Financial management/report

    Project reporting
    Monitoring & evaluation

Outputs to track progress

37) Actions proceed according to plan
38) Annual updated budget
39) Quarterly financial management report
40) Quarterly project report
41) M & E according to above identified indicators

References/further reading

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Fynn RWS, Bonyongo MC 2011. Functional conservation areas and the future of Africa's wildlife. African Journal of Ecology 49(2): 175-188

Garton Edward (Oz), Jon S. Horne, Adam G. Wells, Moses M. Okello. Synoptic Modeling of Animal Location Data Combining Animal Movements, Home Range and Resource Selection. IWMC Durban, South Africa, 7/9/12.
http://www.cnr.uidaho.edu/population_ecology/Synoptic_Modeling_Workshop_IWMC_Durban_South_Africa.htm or choose the Synoptic Model link at top of first page from http://www.cnr.uidaho.edu/population_ecology (at the bottom of the Synoptic Model page, following the abstract for the workshop, there are links to download everything as a single large zipped file (40 Megs in size) or links to individual portions of the workshop materials (smaller in size)).

Lehmann D[1], J. K. Mfune[2]& C. C. Voigt[1]. Eco-physiological responses of ungulates towards heat and drought in the Damaraland desert of Namibia ([1]Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, Germany;[2]University of Namibia (UNAM), Windhoek, Namibia). Poster.www.oryxproject.com.

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Further reading (www.oryxproject.com)

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Ostrowski S., Williams J.B., Bedin E., Ismail K. 2002. Water influx and food consumption of free living oryxes(*Oryx leucoryx*) in the Arabian desert in summer**.** J. Mamm**.** 83*:* 665-673

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Appendix 1. Logframe

Acronyms: GSNL- Great Sossusvlei-Namib Landscape; PC = Project Coordinator; AWT – African Wildlife Tracking; MZ = mountain zebra; NRNR – NamibRand Nature Reserve

Activity	Responsibility	Timing	Funding		Indicators of progress
5.1 Stakeholder consultation and planning					
1) Initial consultation 2) Follow-up consultation	GSNL/MET	Apr - May Ongoing	Request	Match N$20,815	*1) Stakeholders consulted and inputs incorporated into project plan on a dynamic basis*
5.2 Objective 1: To document the abundance, distribution and movement patterns of oryx, springbok and mountain zebra in the central Namib and Naukluft area with a particular focus in and around the GSNL					
5.2.1 Capture and fitting of GPS collars (oryx, springbok and mountain zebra)					
3) Identify provisional functional units within the GSNL, and target capture sites	GSNL/MET	May	Request N$1,156,500	Match N$405,000	*2) Project plan in place and finalised* *3) GPS trackers (satellite) acquired and download service registered (AWT)* *4) Target animals captured, fitted with GPS trackers and monitored*
4) Determine target animals for fitting GPS collars per unit in target areas					
5) Determine optimal tracking frequencies					
6) Investigate remote-release collars					
7) Purchase 54 (27 year 1; 27 replacements year 2) GPS satellite collars (AWT)	GSNL/MET	Jun-Jul			
8) Register download service (AWT)					
9) Test collars					
10) Set potential capture dates for each unit (before first rains)					
11) Book helicopter time and vet time					

12) Capture target animals and fit collars		Aug-Sep-Oct			
13) Monitor collared animals post-capture		Ongoing			
14) Locate collared animals and remove collars (before expiry time)		Aug-Oct 2015			*5) Collars removed after two years and re-fitted/refurbished as required*
15) Evaluate results from collared animals and replace key collars as required		Aug-Oct 2015			
5.2.2 Camera traps (mountain zebra)					
16) Identify and map optimum localities and types/numbers of camera traps	GSNL/ MET /M Gosling	May	Request N$730,000	Match N$1,188,000	*6) Camera traps purchased* *7) Optimum localities finalised* *8) Camera traps installed* *9) Camera trap data downloaded and collated* *10) Individual IDs of MZ determined* *11) Movement patterns of MZ mapped according to camera trap data*
17) Purchase cameras: - 75 Reconyx HC600 - 75 Ranger BN055 - protection boxes (purchase/make up)	GSNL/ MET	Jun-Jul			
18) Place 100-150 cameras at identified localities	GSNL/MET (student)				
19) Collect camera cards on regular basis	GSNL/MET (student)	Jul - ongoing			
20) Download data; analyse, optimise and turn into accessible data and information	GSNL/M Gosling/MET/ students/ volunteers				
21) Locate source populations; sample one month apart (mark-recapture analysis)	GSNL/M Gosling/MET/ students/ volunteers				
22) Determine individual IDs of MZ and map movement patterns according to camera trap data	GSNL/M Gosling				

5.2.3 Downloading of GPS collar data					
23) Data download 24) Database management 25) Set-up of map and processing templates 26) Mapping and animation 27) Data analysis	GSNL/NRWG (consultant)	Aug-Oct/ ongoing	Request N$222,420	Match	*12) GPS data downloaded and collated* *13) GPS movement patterns of three target species produced and updated* *14) GPS movement patterns of MZ correlated with camera trap data and mapped* *15) GPS movement data ground-truthed* *16) Popular maps produced and updated on GSNL website regularly*
28) Groundtruth major GPS movement data: - Ground - Aerial (fixed wing)	GSNL/partners GSNL/Dr Nad Brain	Summer/ winter			
5.3 Objective 2 & 3: **Objective 2: To interpret and understand the spatial distributions and above movement patterns and the associated land uses by wildlife in response to natural resource conditions and issues, including rainfall and other climatic conditions, veld condition, water availability, and wildlife densities and land uses; and** **Objective 3: To understand the impacts on movements and land uses by the selected species resulting from fencing conditions and issues, including fence removal, breaching and the creation of corridors, and to identify remaining barriers and bottle-necks**					
5.3.1 Collate and map baseline data below in the form of dynamic GIS layers					
29) Rainfall: map east/west and north/south gradients 30) Land use 31) Water availability for game (natural/ artificial; perennial/ ephemeral) 32) Fire mapping	GSNL/student intern?	Year 1/ ongoing	Request	Match N$210,000	*17) Electronic field rain gauges purchased and installed* *18) E/W and N/S rainfall measuring gradient in place and rainfall data documented* *19) Land use mapped* *20) Water availability mapped* *21) Fire mapped* *22) Veld condition determined* *23) Habitat types identified and mapped*
33) Veld condition/food resources available	GSNL/Polytech/Unam	Summer/ winter			
34) Habitat type	GSNL	Year 1			
35) Topography - slopes/gradients/altitude	GSNL	Year 1			

					24) Topography – slopes/gradients/ altitude mapped *25) Baseline data collated in GPS layers & updated*
5.3.2 Determine wildlife densities					
36) Road count transects in key areas (for oryx and springbok; in some cases less successful for mountain zebra)	GSNL/Partners	Winter Summer?	Request	Match N$50,000	*26) Data collated and mean population sizes and distribution determined*
37) Helicopter survey (mountain zebra)	MET	Oct?			
38) Camera traps (mountain zebra: mark-recapture technique)	GSNL/M Gosling/ students	Ongoing			
39) Self-assessment, e.g. by owners of commercial farms using presence/ absence data on a grid square basis	GSNL/Partners (commercial landowners)				
5.3.3 Rigorous research analysis					
40) Identify prospective participants and put together a Research Team	GSNL/MET	Jun	Request	Match N$100,000	*27) Research Team in place*
41) Correlate wildlife movements / densities with above baseline data on natural resources to determine: - Population sizes/densities; mean population size with a measure of variance - Key wet and dry season movements - Quantitative population distribution at the two extremes of the annual east-west movement cycle	GSNL Research Team: Unam and Polytech, led by Dr Chris Brown, Kenneth /Uiseb & Dr Morris Gosling	Year 2-3			*28) Composite maps based on GIS data*

- Link to food plant distribution - Link to habitat type - Link to topography-slopes/gradients/ altitude					
42) Correlate the above wildlife movements/densities with fenceline conditions and removals - Identify corridors between functional ecological units - Correlate key wet and dry season wildlife movements with fenceline data (and with baseline data above) - Understand how animals move within constraints of fences, and identify remaining barriers and bottle-necks in fencing according to the above data	GSNL Research Team: Unam and Polytech, led by Dr Chris Brown, Kenneth /Uiseb & Dr Morris Gosling	Year 2-3			*29) Map showing functional units and corridors* 30) *Composite map correlating key wet and dry season movements with fenceline data and other baseline data, indicating barriers to movement*
5.3.4 Provide ongoing feedback					
43) GSNL website	GSNL/NRWG/JaRo (consultant)	Ongoing & End year 3 & End year 5	Request N$168,000	Match	*31) Regular feedback reports, maps etc. on GSNL website*
44) Scientific reports (land managers)	GSNL Research Team: Unam and Polytech, led by Dr Chris Brown, Kenneth /Uiseb & Dr Morris Gosling				*32) Scientific reports*
45) Other popular articles/media items	GSNL				*33) Popular articles/media*

5.4 Objective 4: To develop management guidelines for the three selected species in the GSNL based on an understanding of their movements and land uses, and using wildlife population densities to be derived from game counts					
5.4.1 Compile a species management plan					
46) Initial recommendations: - Fence removals - Key waterholes - Planned burns (strategic) - Game counts for key areas - Stocking rates in fenced areas	GSNL	Apr 2016 (three years)	Request N$28,000	Match	*34) Recommendations listed on GSNL website*
47) Compile a comprehensive species management plan including above aspects and further recommendations: - Long term monitoring - Further research	GSNL	Apr 2018 (five years)			*35) Further recommendations listed on GSNL website* *36) Species management plan*
6. Project management					
48) Planning, coordination and implementation of actions: - Budget - Financial management/report - Project reporting - Monitoring & evaluation	GSNL	Ongoing Annual review Quarterly Quarterly Quarterly/ annual	Request N$401,280	Match	*37) Actions proceed according to plan* *38) Annual updated budget* *39) Quarterly financial management report* *40) Quarterly project report* *41) M & E according to above identified indicators*
		Sub-Totals	N$2,706,200	1,973,8125	
			TOTAL	**N$4,680,015**	

Appendix 2: Detailed budget

	Year 1		Year 2		Year 3		Year 4		Year 5		
	Request	**Match**	**Request**	**Match**	**Request**	**Match**	**Request**	**Match**	**Request**	**Match**	**TOTAL**
5.1 Stakeholder consultation											
Consultation and planning		N$ 20,815									N$ 20,815
	N$ 0	N$ 20,815	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 20,815

Sub-total	**Request**	N$ 0
Sub-total	**Match**	N$ 20,815
	Total 5.1	**N$ 20,815**

5.2 Objective 1											
5.2.1 Capture and fitting of 27 GPS collars + 27 replacements (oryx, springbok and mountain zebra)	N$ 578,250	N$ 135,000	N$ 578,250	N$ 135,000		N$ 135,000					N$ 1,561,500
5.2.2 Camera traps with protection boxes (100 units year 1; 50 units year 2)	N$ 365,000	N$ 280,000	N$ 182,500	N$ 280,000	N$ 182,500	N$ 280,000		N$ 174,000		N$ 174,000	N$ 1,918,000
5.2.3 Downloading of GPS collar data	N$ 45,540		N$ 44,220		N$ 44,220		N$ 44,220		N$ 44,220		N$ 222,420
	N$ 988,790	N$ 415,000	N$ 804,970	N$ 415,000	N$ 226,720	N$ 415,000	N$ 44,220	N$ 174,000	N$ 44,220	N$ 174,000	N$ 3,701,920

Sub-total	**Request**	N$ 2,108,920
Sub-total	**Match**	N$ 1,593,000
	Total 5.2	**N$ 3,701,920**

5.3 Objective 2 & 3											
5.3.1 Collate and map baseline data below in the form of dynamic GIS layers		N$ 70,000		N$ 50,000		N$ 30,000		N$ 30,000		N$ 30,000	N$ 210,000

5.3.2 Determine wildlife densities		N$ 10,000		N$ 10,000		N$ 10,000		N$ 10,000		N$ 10,000	N$ 50,000
5.3.3 Rigorous research				N$ 50,000		N$ 50,000					N$ 100,000
5.3.4 Provide ongoing feedback	N$ 33,600		N$ 33,600		N$ 33,600		N$ 33,600		N$ 33,600		N$ 168,000
	N$ 33,600	N$ 80,000	N$ 33,600	N$ 110,000	N$ 33,600	N$ 90,000	N$ 33,600	N$ 40,000	N$ 33,600	N$ 40,000	N$ 528,000

Sub-total	**Request**	N$ 168,000
Sub-total	**Match**	N$ 360,000
	Total 5.3	**N$ 528,000**

5.4 Objective 4											
5.4.1 Compile a species management plan					N$ 14,000				N$ 14,000		N$ 28,000
	N$ 0	N$ 0	N$ 0	N$ 0	N$ 14,000	N$ 0	N$ 0	N$ 0	N$ 14,000	N$ 0	N$ 28,000

Sub-total	**Request**	N$ 28,000
Sub-total	**Match**	N$ 0
	Total 5.3	**N$ 28,000**

6. Project management											
6.1 Planning, coordination and implementation of actions	N$ 200,640		N$ 200,640								N$ 401,280
	N$ 200,640	N$ 0	N$ 200,640	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 0	N$ 401,280

Sub-total	**Request**	N$ 401,280
Sub-total	**Match**	N$ 0
	Total 5.3	**N$ 401,280**

TOTAL PER YEAR	N$ 1,223,030	N$ 515,815	N$ 1,039,210	N$ 525,000	N$ 274,320	N$ 505,000	N$ 77,820	N$ 214,000	N$ 91,820	N$ 214,000
	Request	**Match**	**Request**	**Match**	**Request**	**Match**	**Request**	**Match**	**Request**	**Match**
	Year 1		**Year 2**		**Year 3**		**Year 4**		**Year 5**	

Request	**N$ 2,706,200**
Match	**N$ 1,973,815**
TOTAL FOR 5 YEARS	**N$ 4,680,015**