Report on Rufford Small Grant for Nature Conservation.

Award 8529-2 to L.M. Gosling: Conservation of Hartmann's mountain zebra in Namibia.

Aims listed in the application and *progress achieved*.

Extend the study from Gondwana Cañon Park and Fish River Canyon National Park to five other sites in Namibia (Canyon Nature Park; NamibRand Nature Reserve; Buellsport Guest Farm, Namib Naukluft National Park and Etosha National Park. Compare results to ensure conservation management recommendations are robust across different areas.

The study has continued in Gondwana Cañon Park and the Ai-Ais/Fish River Canyon National Park, and has been successfully extended to NamibRand Nature Reserve, Buellsport Guest Farm, the Naukluft National Park and the Neuhof Nature Reserve. ID libraries have been established for each of these sites and mark-recapture estimates of mountain zebra populations carried out using known individuals. Information about numbers and movements has been passed to park managers, owners and to the Ministry of Environment and Tourism to inform conservation management. Long term data from Gondwana Cañon Park shows that the population is increasing steadily and this represents an important conservation success for the park since its establishment in 1997.

A pilot camera trap was established in the Naukluft National Park, a major refuge for mountain zebras. The first batch of camera trap photos from the Panorama water hole (operating between October 2011 and January 2012) yielded 276 animals. A mark-recapture procedure for the single water hole sampled (called Panorama) with 5 day sampling periods yielded an estimate of 242+/-25. New animals were still appearing regularly at the end of the sampling period so it is anticipated that the known population will increase. The Naukluft NP is adjacent to an existing study site (Buellsport Guest Farm) and eventually it is hoped to quantify the connectivity between the two areas.

I could not get responses from Canyon Nature Park or the Etosha Ecological Institute and so no progress could be made at these sites. I visited Etosha and hope to start work on the problem of hybridization between mountain and plains zebra later this year (see below).

Produce posters and material for the Namibia Nature Foundation website to help promote mountain zebra as a flagship species for ecosystem conservation in Namibia.

The mountain zebra webpage on the Namibia Nature Foundation website has been updated, including a recent progress report to the Ministry of Environment and Tourism. Articles have been contributed to Barking Gecko, the web-based magazine of the NamibRand Nature Reserve and to the bi-monthly wardens' report produced by Gondwana Cañon Park. I have also contributed to the periodic report of the captive breeding programme for Hartmann's mountain zebra; and contributed to discussions with the chair of the IUCN Equid Specialist Group about the forthcoming update of the IUCN red book data entry for mountain zebras. Continue to develop a system for the individual recognition of zebras using stripe patterns and make a version of it available for wide use.

The individual recognition system using stripe variation has been used successfully at all study sites and an improved version using 13 characters established. At the time of writing the largest study population is in Gondwana Cañon Park with 557 individuals recognised and no problems have been encountered in dealing with such numbers. One or two refinements are planned (this is probably a continuous process) and I will then put a version of the system available on the Namibia Nature Foundation website.

Establish a mark-recapture system for estimating numbers of zebras visiting water holes and over wider areas. Use existing and new data to define operational details including optimum periods for mark and recapture periods, intervals between these periods and the samples needed for acceptable estimates.

A number of mark-recapture estimates have been carried out for individual water holes and for wider areas. Most notable was the first mark-recapture estimate for the mountainous northern area of Gondwana Cañon Park, an area of about 20,000, of 287+/-16 (+/-SE) mountain zebras. The total number of individuals actually identified in 6 day 'mark' and 'recapture' periods on October/November 2011 was 237 and the fact that this is high relative to the estimate, plus the reasonably small error estimate gives some confidence in the estimate.

A striking thing that has emerged from studies of known individuals is their long term movements. Some animals are seen every year but others reappear after absences of up to three years. These movements suggest the existence of a 'source population' which ranges over a wider area than the protected area itself. The ratio between the number of animals in a protected area and the size of the source population is crucial for population management. Where the numbers in the protected area a low relative to the size of the source population the viability of the mountain zebras within the protected area may be dependent on conservation measures (and threats) over the wider area.

Define the circumstances (visibility criteria) under which the assumptions of road transect sampling are violated and individual-based mark-recapture estimates are preferable.

Previous data and further field observations support the conclusion that the assumptions of road transect sampling, especially distance sampling, are generally violated due to mountain zebra escape behaviour in broken habitat. Mark-recapture estimates avoid this problem and have proved to be a flexible and useful tool for population estimates. However road transect counts are probably useful as an index when they employ a consistent approach and can be carried out more quickly than mark-recapture estimates.

Continue to develop networks of camera traps and develop rules for spacing using defined levels of overlap by known individual zebra. Test new traps that overcome problems of motion-blurring in infra-red mode.

The best functioning networks of camera traps are in Gondwana CP and NamibRand NR where the owners have purchased cameras to add to those bought with Rufford funding. There are a total of five in NamibRand and ten in Gondwana. Cameras in Buellsport are now up to three and spatial information is growing quickly. A key element in camera trapping is to establish the level of connectivity between waterholes to help define the population that is being sampled and to avoid sampling redundancy. New camera traps are appearing on the market all the time and much recent development has been on mini cameras, many manufactured in China. The latest cameras used in the project are distributed by Lynx Optics in South Africa and there are many benefits in having a local supplier. But there has been no progress regarding the aim of overcoming motionblurring: all the cameras tested (seven makes/models), regardless of price, show motionblurring in infra-red mode when animals are moving. As a result I have moved away from setting cameras on trails and switched to positions next to drinking places. The cost is that not all animals are in the best orientation for IDs but since very large numbers of photos (thousands) are possible with modern cameras, there are generally enough images for good recognition; in fact, the problem is often how to sub-sample.

Further develop a system of body condition categories and relate to forage characteristics and, if possible, carrying capacity.

A 5 category system of body condition categories, based on muscle mass and bone protrusion has been developed and is supported by sample photographs. This system has been used systematically to determine the distribution of condition categories in samples of individually known animals. In general, mountain zebra have remained in good condition at all sites, despite increasing populations, suggesting that they are below carrying capacity. The main exceptions are lactating females which sometimes become thin, presumably due to the costs of lactation, and it may be possible to use this vulnerable group as an indicator of early response to environmental stress.

Improve age estimation from camera trap images including estimates of body size and extend preliminary analysis of birth rates in relation to rainfall to include further aspects of survival.

Analysis of survivorship has been carried out as a preliminary to population viability analysis. The best data are from Gondwana CP which has now been observed since 2005. Of the 78 individuals photographed and identified in 2005, 49 (63%) were known to be alive in 2011 (actually seen or, in two cases seen subsequently), giving an annual mortality rate of about 6.2%. Lions and spotted hyaenas, the main potential predators of zebras are absent from the park; leopards are quite common and may kill a few foals. When new animals are under two years old when first identified they can be accurately assigned to a year of birth. This is carried out routinely and I am starting using the birth rates obtained in standard reporting.

Observe the behaviour of mountain and plains zebra in areas where both occur; extend pilot observations to define the circumstances under which interspecific mating might occur. Photograph individuals of both species in overlap areas; identify putative hybrids, their likely parents and any possible offspring. Document these individuals as a basis for future molecular sampling using faecal DNA.

I continued to look for interaction, both ecological and behavioural, between mountain zebra and plains zebra. In general, the two species remain ecologically separated (in the habitats implicit in their names) but there are times when they overlap. In NamibRand NR this occurred most conspicuously in the late dry season of 2011 when the plains habitat became heavily grazed and plains zebra started to move into the foothills of the adjacent Nubib mountains to feed on the relatively abundant grass swards there. As this time there was some overlap in waterhole use although this was only at lower altitude water holes and the two species never drink at the same time. In Gondwana CP known overlap in drinking occurred for the first time but in this case it followed mountain zebra moving out onto the plains habitat onto green flushes following rain. This may have been a result of the increasing population of mountain zebra putting pressure on grazing at higher altitudes or it may have been due to progressive increase in the use of open habitats (where mountain zebra may feel more vulnerable), as time passes since shooting stopped when the park was formed in 1997.

Perhaps more worrying in terms of the potential for hybridization, were specific behavioural interactions. In NamibRand, a male mountain zebra that attached itself to a plains zebra breeding group, disappeared, but another male adopted the same behaviour and is currently following group/s of plains zebras around their open habitat. The first male accumulated extensive fighting injuries and it seems likely that it was subordinate to the plains zebra stallion in the group. This also appeared to be the case in another example of the same phenomenon in Gondwana CP where the attached mountain zebra followed but usually remained just outside the plains zebra group. This mechanism may prevent male mountain zebra genes passing into the plains zebra population and there may be more cause for concern when female mountain zebra are accessible to male plains zebra. But the observations do show that behavioural attachments can occur across the two species which has worrying implications for mechanisms of mate choice and thus the possibility of hybridization.

As envisaged in my application for the present grant, I approached the Etosha Ecological Institute and submitted a proposal to carry out pilot work in western Etosha NP where the largest known group of putative hybrids between plains and mountain zebra exists but no response was received. Later in the year I visited the park and spoke to a senior warden who said he believed that there were "hundreds" of hybrids and that the problem was now past the stage at which intervention is possible. Some confirmation of the scale of this problem has been obtained a post-doctoral researcher who extracted faecal DNA from zebra faeces in the area (the samples were collected for another research project) and found genetic evidence of hybridization. Taken together with my preliminary behavioural observations, these findings, if confirmed, suggest that hybridization may be the most important threat to the conservation of Hartmann's mountain zebra.

Morris Gosling, 29 March 2012, Newcastle-upon-Tyne, UK.