The Mountain Zebra Project

Introduction

Hartmann's mountain zebra (*Equus zebra hartmannae*) is Namibia's only endemic large mammal and a protected species in Namibia. It is a subspecies of mountain zebra and together with the Cape mountain zebra (*E.z.zebra*) in South Africa is of global conservation importance (IUCN Red List Category: Vulnerable). Cape mountain zebras were reduced by overhunting to less than 100 animals in the 1940s although protection in parks and reserves has allowed their numbers to expand again. Hartmann's populations in Namibia are healthier but they still numbered only about 25,000 in 2002 (Novellie *et al*, 2002), mainly in protected areas, conservancies and farms devoted partly or wholly to wildlife.

Mountain zebra group in Gondwana Cañon Park. (Photograph: Rachel Brand).

Mountain zebra habitat in Gondwana Cañon Park. (Photograph: Morris Gosling).

The aims of the Mountain Zebra Project are to promote the study of mountain zebras for scientifically based population management and as a flagship species for wider ecosystem conservation in Namibia. Like many large mammals, mountain zebras have a complex relationship with people. They are a threatened sub-species and in places suffer from unsustainable exploitation, but they can also become locally abundant and cause overgrazing, particularly in the arid, fragile habitats that are typical of most of their range in Namibia. In addition to their significance as an iconic member of Africa's equids and deserving of conservation in their own right, they are also an economic resource of great value when properly managed. They represent a subtle variation on the equid theme and their biology, particularly in comparison to the numerically more successful ruminants of the African savannahs, still poses many unsolved riddles.

The Mountain Zebra Project is co-ordinated by Professor Morris Gosling of the University of Newcastle in the UK, in an active collaboration with landowners and conservationists who share the aims of mountain zebra

conservation, of scientifically based management and of affection for this tough and charismatic species. The Namibia Nature Foundation provides an administrative base for the project and also helps with many practical matters. The mountain zebra study started in 2005 in Gondwana Cañon Park and the neighbouring Ai-Ais/Fish River Canyon National Park and has since expanded to the NamibRand Nature Reserve, Büllsport Guest Farm, the Namib Naukluft Park and Etosha National Park. The aim of the project is to compare the ecology and behaviour of the species across a variety of habitats and to develop study techniques that are useful in sites with different conservation management objectives. The initial proposal to the Ministry of Environment and Tourism and progress reports are available as downloads from the Namibia Nature Foundation website:

- Research proposal to the Ministry of Environment and Tourism 2006 [pdf 38kb]
- Progress report November 2007 [pdf 664kb]
- Progress report November 2009 [pdf 750kb]
- Progress report November 2011 [pdf 422kb]
- Mark-recapture estimate of the Etosha National park mountain zebra population in 2012 [pdf 540kb]

Conservation management

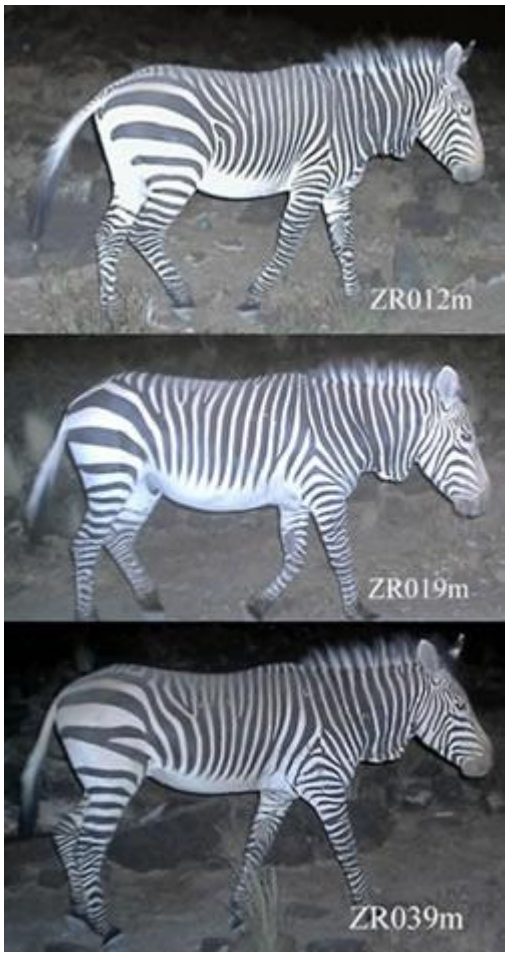
Before land was enclosed for agricultural purposes in Namibia, mountain zebra must have ranged widely in search of food and water. Rainfall and consequent primary production is typically patchy in arid areas and ungulates are adapted to detecting and moving to areas of new grazing, sometimes over very large distances. Enclosure by fencing, to designate ownership and to confine livestock and exploited game populations, has limited or prevented these movements and this situation poses new management challenges. Where natural predators (especially lions and spotted hyaenas) have been eliminated, mountain zebra populations can potentially expand beyond carrying capacity and fences then prevent movements to other areas that would allow vegetation to recover. Consequently, mountain zebra populations that might have continued to thrive if they were able to move to new grazing are, instead, put at risk of population collapse from declining food reserves. As a result, enclosed populations, particularly those in relatively small land units, must be managed and this demands particular knowledge including numbers and carrying capacity. The practical objectives of the Mountain Zebra Project include the development of techniques to determine these values for scientifically informed conservation management.

A harem group in Büllsport Guest farm in the Namib Naukluft mountains. The group is leaving a water hole and climbing to their daytime resting location. Note the newborn foal which can already cope with this challenging terrain. (Photograph: Morris Gosling).

Population estimates

The first priority for most wildlife managers is population estimation and there are a number of techniques that can be used. When appropriate, the most cost-effective are air surveys and the Ministry of Environment and Tourism carries out extensive surveys of this kind. The results form the basis of nationwide summaries of mountain zebra numbers and distribution such as that summarised by Novellie *et al* (2002). An alternative for smaller areas are road transect counts with some form of distance sampling. Straight line sampling, while not subject to some of the biases of road transects, is impossible in most mountain zebra habitat. Unfortunately, mountain zebras often have long flight distances and their escape behaviour when vehicles approach often involves flight into gullies or over ridges, sometimes before they have been seen. Even without this behaviour the broken terrain typical of mountain zebra habitat means that the assumption of uniform visibility away from the transect line in distance sampling is often violated. Distance sampling can be useful to detect trends but population estimates from this technique are best regarded as indices. A third alternative is estimation using mark-recapture. This involves close contact with individual animals which has a number of benefits over more

remote techniques such as aerial surveys (see below) and it is the main technique that is being developed in our study. It is particularly appropriate for mountain zebras because their stripe patterns are extremely variable and, as with human fingerprints, all individuals are distinct. This means that individuals can be 'marked', using photography, and 'recaptured' simply by resighting, thus avoiding the costs and disruption of capture and artificial marking.



Side views of three mature stallions from Gondwana Cañon Park to show variation in the stripe patterns used for individual recognition. Note the large dewlaps which are characteristic of the species and become this large only in dominant mature males. (Camera trap photographs).

Individual recognition

Individual recognition is facilitated by the use of digital photography which allows images to be collected, stored and used for comparison with relative ease. A new image can be identified by direct comparison with reference photographs of animals collected from the same population. This sort of comparison can be carried out using conspicuous and variable areas of stripes, such as the large rump stripes. When a potential match is obtained it should be checked using up to 4 or 5 other features because similar patterns sometimes occur in single stripes. This sort of approach, which improves as an observer becomes familiar with the range of variation in stripes, works well for small populations. But when more than about 60 or 70 animals are involved a more systematic approach becomes worthwhile.

The approach adopted is a type of bar code based on stripe variation at defined stripe positions. Stripe patterns are highly variable in mountain zebras and any part of the body can potentially be used in an individual recognition system including the bars down the legs, the neck and face. However, the 'gridiron stripe' which descends obliquely forwards from the gridiron pattern over the base of the tail is the most useful starting point.

Thus the gridiron stripe itself, the 'rump stripes' below it, and the 'body stripes' in front of it form part of the system currently in use. They are also the largest stripes on the body and this is helpful because image quality is variable in both normal photography and camera traps. Another system can be based on the stripes which form a vertical pattern at the shoulder, the 'shoulder stripe', and the 'rib stripes' behind it. Having two separate systems, based on the rump and shoulder is useful when the photograph being checked is incomplete. Individual stripes are separated into different variants (simple, branched, y-shaped, etc.) and each variant coded. When a new individual is found the code for each stripe is entered into an Excel database consisting of a row of *n* stripes for each individual. The database can then be interrogated using the stripe codes of animals in new photographs. The number of candidate individuals is usually reduced to one or a few possibilities thus saving a large amount of time searching though reference photographs. A detailed account of the recognition system is being written and will be added to this site.

Mark-recapture estimates of mountain zebra numbers

The number of animals recognised can simply be summed but this will not take account of animals that are missed by chance. An alternative which gives estimates of mean population size with measures of statistical error is mark-recapture procedure. Such estimates generally involve marking a sample of a population, releasing the marked animals then, after an interval, capturing a second sample and calculating the population size from the proportion of the second sample that is marked (i.e. recaptured). In our work the difficult and disruptive practice of capture can be avoided by individual recognition. Estimates are usually carried out using camera traps which switch from normal daylight photography to infra-red flash (or normal flash) at night. Most mountain zebra drink at night, and daytime observations alone would underestimate numbers.

Mountain zebra drinking at night in NamibRand Nature Reserve. Most mountain zebra drink at night and so camera traps at water holes are a good way to sample whole populations. (Camera trap photograph).

Mountain zebras are water dependent and since all must visit waterholes in the dry season the whole population can potentially be sampled as they walk to water or as they drink. Cameras are placed at the main waterholes for an initial period (often about 4 weeks), left for an interval of about 2 weeks, then replaced for a second sampling period of the same length as the first. In the first sampling period all animals where the image is clear enough are identified ('marked'). In the second period all animals are identified again and divided into those seen in the first sample (i.e. 'recaptured') and new individuals, and a population estimate is calculated using standard mark-recapture formulae. Sampling periods can be shorter when numbers of zebra are high and need to be extended when they are low.

Information for notional sampling periods can be extracted from cameras left in position for long periods. Indeed, in practice, camera traps can be left indefinitely at important waterholes and these allow the collection of invaluable long term information on many aspects of the zebra population (as well as other wildlife).

One camera is usually enough to sample a single water hole and such estimates are useful to calculate the number of zebras visiting the waterhole and infer their water consumption. More cameras are needed to estimate the population in a wider area and they need to be carefully spaced. Cameras should aim to sample the entire area and locations can be decided using field signs, particularly freshly used trails. They should not be too close together because the same animals will be sampled or too far apart as some may be missed. Camera spacing can be checked by calculating overlap in recognised individuals at neighbouring water holes. If there is no

overlap then some animals may be completely missed. If there is too much overlap then one camera is redundant and would be better placed further away.

Individual based information: life histories and movements

Apart from its use in obtaining basic population data, this photography-based system allows the collection of detailed information about individual animals. The animals photographed can be aged (using field age classes), sexed and their body condition assessed. Condition estimates are under development because, potentially, they can be used as a surrogate for forage quality and thus to predict the need for management intervention. Individuals can be followed over long periods giving life history information such as year-to-year survivorship; and pregnancy stages can be observed to give breeding rates for individual females. Individuals are sometimes photographed in the same frame as others and this allows the calculation of associations between pairs of individuals and thus social group membership. The social life of mountain zebras follows the general equid pattern (harem groups of 1-3 mares and bachelor groups) but there are interesting variants and much remains to be discovered.

Bachelor group arriving at Jakkalswater in Gondwana Cañon Park. When more than one individual is photographed the records can be used to define group membership. All four of these individuals can be recognised from their stripe patterns. (Camera trap photograph).

Individual-based information also allows the study of movements. Repeat observations of known animals have confirmed that animals move between the Fish River Canyon National Park and Gondwana Cañon Park and also that animals use a number of the permanent water holes in the latter park, perhaps in relation to variation in local grazing conditions. These studies will eventually have to be supplemented by radio or GPS tracking to fully define the habitat needs of mountain zebra populations and this objective becomes more important in larger management units. Large areas of this kind are increasingly being created by fence removal, to benefit from the reduced need for management intervention as units become larger and natural movements in relation to forage variation are resumed. Several well-known attempts are being made in Namibia to take advantage of these increases in scale, including the creation of the Greater Fish River Canyon Complex and the Greater Sossusvlei-Namib Complex, which includes the NamibRand Nature Reserve.

Impact on plant communities and body condition

A key objective for the conservation ecology of mountain zebras is to understand the dynamic relationship between these herbivores and the plant communities on which they depend. The impact of grazing is complex, particularly since some of the plant communities being studied, such as that in Gondwana Cañon Park, are recovering after long periods of intense use by livestock. Preliminary work has considered the species composition of preferred habitats but, at present, we do not have the resources to investigate plant-herbivore dynamics and thus to detect overuse. Instead we are developing techniques to monitor the outcome of these processes by exploring links between body condition and rainfall (as a surrogate of primary production). As mentioned above, body condition can be assessed from camera trap images and we aim to use decline in condition as a predictor of a population that is at or beyond carrying capacity.

Hybridization

A potential problem for the conservation of any threatened species is hybridization with a related species. This problem of genetic integrity arises in the case of mountain zebra which may hybridize with plains zebra (*Equus quagga*). Similar problems are known elsewhere, particularly between Grevy's zebra (*Equus grevyi*) and plains zebra, but nothing has been done to investigate this problem for mountain zebra. At first sight, the problem may seem trivial because, while mountain zebra and plains zebra overlap geographically, they have clearly remained separate over recent evolutionary time and they have different habitat requirements. But the two species do intermingle at waterholes and sometimes during grazing. In fact most equid species can potentially interbreed and this becomes more likely when their movements are restricted by enclosure as in fenced reserves and farms. An understanding of the potential for hybridization and the risks for mountain zebra populations is a priority for the Mountain Zebra Project. If we find that it occurs, our long term aims are to define the circumstances and explore the procedures needed to minimize it. Preliminary observations suggest that hybrids may exist (for example in Etosha NP) and behavioural observations in Gondwana Cañon Park and NamibRand Nature Reserve show that mountain zebra stallions can form long term attachments to plains zebra harem groups even in areas where space does not seem to be limiting. The study of hybridization will eventually need to include genetic techniques both for confirmation of the phenomenon and to investigate the reproductive success of any hybrids.

A dominance interaction between the stallion of a harem group of plains zebra (left) and a mountain zebra stallion in NamibRand Nature Reserve. Note differences in body size and the subordinate posture of the mountain zebra. The mountain zebra is attached to the plains zebra group and such associations could lead to hybridization. (Photograph: Maria Wilen).

IUCN Equid Specialist Group aims

The aims of the Mountain Zebra Project are guided by the SSC Equid Specialist Group's Status and Action Plan for Mountain Zebra (Novellie, *et al*, 2002) which includes the Recommended Action of 'Improving the protected area system'. The project will contribute to the ecological knowledge needed to support this objective. It is also relevant to the Recommended Action of 'Promoting the maintenance of mountain zebras on farmland' since many of the mountain zebra populations under study either live in or move across private land as well as government-owned protected areas.

For further details see Novellie, P., Lindeque, M., Lindeque, P., Lloyd, P. & Koen, J. 2002. Status and action plan for the mountain zebra (*Equus zebra*). Chapter 3 in: Equids: Zebras, Asses and Horses: Status Survey and Conservation Action Plan (Ed Patricia D. Moehlman) IUCN.

How you can help the project

You can help the Mountain Zebra Project by sending copies of your photographs of mountain zebras. All photographs are useful but good quality side views are particularly valuable. These photographs help maintain long term records of known individuals and build up records of variation in stripe patterns between sub-populations. Please send them as attached files by email to l.m.gosling@ncl.ac.uk or on CDs or other storage media to Prof. Gosling c/o the Mountain Zebra Project at the NNF. If you have the information, add a date (if the photo is not date tagged) and the location (including a GPS reading if available) and any other information about the sighting.

Please contact Prof. Gosling if you are working on mountain zebras or are interested in doing so, or if you have them on your land and would like to collaborate in the project.

The work has been carried out under Ministry of Environment and Tourism permits (currently 1874/2014) with help and support from MET staff including Manie le Roux, Kenneth /Uiseb, Vitalis Mushongo, Holger Kolberg, Timothy Iita, Vinte Mendes, Bonny Simaata, Shayne Kötting and Werner Kilian. Financial support has been provided by the Rufford Foundation, the Whitley Fund for Nature and the Parc Zoologique de Montpellier. The research is carried out with collaborators in Gondwana Cañon Park, Ai-Ais-Richtersveld Transfrontier Park, NamibRand Nature Reserve, Büllsport Guest Farm, the Namib Naukluft Park and Etosha National Park. The Namibia Nature Foundation has provided an administrative base and consistent help and support and I am particularly grateful to Chris Brown, Angus Middleton, Sally Wood and Theo Christoff. Generous support and collaboration has been given by Manni Goldbeck, Otto and Brigitte von Kaschke, Sue and Trygyve Cooper, Ignatious Sikongo, Nils Odendaal, Ann and Mike Scott, Quintin and Vanessa Hartung and Ernst and Johanna Sauber. Theo Wassenaar and Jeff Muntifering have provided helpful discussion and much wisdom about mountain zebra ecology.

Donations are much needed and will contribute directly to mountain zebra conservation research with no administrative costs. They can be sent to:

Account name: Project Support Fund (Mountain Zebra research)
Account No.: 11000049923
Branch code: 461609
Bank: Nedbank Namibia, 12-20 Dr Frans Indongo Street, P O Box 1, Windhoek

A mixed group of mountain zebras in Gondwana Cañon park. Most of the members are bachelor males but at least three are adult females that have joined the group after leaving their birth groups. Some females form associations with males while in these groups and the pair then leaves to establish a new breeding group. (Photograph: Morris Gosling).

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