Monitoring the condition of mountain zebra habitat in the Mountain Zebra National Park

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The study aimed at determining an appropriate sampling design for monitoring the quality of mountain zebra habitat. The parameter used for monitoring was an index of habitat suitability. The value of this index was greater than 20 in the habitat that was most favoured by the mountain zebras, whereas values below 20 were characteristic of moderate to poor habitat. It is recommended that if the index in the most favoured habitat declines to below 20, management intervention in the form of a reduction in stocking rate of large herbivores should be considered. A sample size of 20 randomly located monitoring plots should be adequate to detect a decline to below the critical level. There was considerable patchiness in the distribution of grazing pressure within plant communities, and this needs to be taken into account in the design of the monitoring programme.

Key words: point surveys, habitat use, patch selection, random sampling.

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Introduction

The Mountain Zebra National Park (MZNP) (32°15′S, 25°41′E), South Africa, has the largest population of Cape mountain zebras *Equus zebra zebra* in existence. This population is the main source of animals for translocation to new conservation areas, and it plays a vital role in ensuring the future of the subspecies. It is important that mountain zebra habitat in the MZNP be maintained in good condition and for this an adequate monitoring programme is required.

The question of an appropriate parameter to use in monitoring was addressed by Novellie & Winkler (1993) who derived a habitat suitability index (HSI) for mountain zebras. This index is calculated from the abundance of the different grass species in the habitat (expressed in terms of canopy spread cover) and indices of acceptability of the grass species to zebras. The purpose of the present study was to determine a sampling design and sampling intensity appropriate for monitoring changes in the HSI in this national park.

Limited resources and time precluded monitoring all of the habitats in the MZNP. Instead attention was focused on the three plant communities that carried the highest biomass of grazing ungulates — the plateau sandstone (PS), the plateau mudstone (PM) and the lower slope sandstone (LSS) (Novellie 1990, 1991). The rationale behind this choice is that, because of the high grazing pressure to which they are subjected, these communities are the most vulnerable to degradation. Of all the communities in the MZNP, the PS carries the highest density of mountain zebras (Winkler 1993). It may be expected that the performance of the zebra population would be particularly sensitive to the condition of this community. The PM and the LSS also carry moderate numbers of zebras but are consistently less favoured than the PS (Novellie 1991; Winkler 1993).

The plant species composition of the three communities is given by Novellie (1990). In terms of species composition the PS is essentially the same as the rocky plateau grassland of Van der Walt (1980) while the PM and LSS are closely similar to Van der Walt's (op. cit.) communities degraded plateau grassland

and lower slope degraded dwarf shrubland respectively. However the boundaries of the PS, PM and LSS were defined in terms of the substrate type (sandstone and mudstone) and differ slightly from those mapped by Van der Walt (1980).

Spatial variation in the use of the PS by zebras was also investigated. The reason for this is that habitat selection by herbivores may be determined by spatial variations in plant species composition that are finer in scale than those that determine the extent of plant communities (Fabricius 1989). As a result, grazing pressure may be patchily distributed within a particular plant community. Knowledge of the degree of patchiness of grazing pressure within communities can help to improve the design of the monitoring programme.

If the monitoring programme is to be used as a guide to decision-making it is necessary to determine the limits within which the HSI could vary before management intervention (for example reducing large herbivore numbers) would be warranted.

Once allowable limits have been identified a sampling intensity can be determined that would have a specified probability of yielding a statistically significant difference if the HSI declined beyond the allowable limits.

In order to determine tolerance limits a predictive knowledge of the relationship between the HSI and the performance of the mountain zebra population would be required. However, this information is lacking at present. Instead, a preliminary indication of acceptable limits was derived by comparing values of the HSI typical of favoured habitat with those of habitat that is less favoured by zebras. The intensity of sampling in favoured habitat was then set at a level sufficient to detect a decline of the HSI to values characteristic of poor habitat.

Methods

Sampling vegetation composition

The procedure for locating sampling plots was that proposed by Mentis (1984), i.e. plot locations were chosen at random within the three communities (PS, PM and LSS). The plots were not permanently marked, so that a fresh random sample would need to be drawn in follow-up surveys. Randomly located plots that happened to lie on borders or transition zones between different communities were rejected.

Fifteen plots were surveyed in each community. The method used was the descending point survey for canopy spread cover as described by Novellie & Strydom (1987) and Novellie & Winkler (1993). Two hundred points were examined in each plot, the points being arranged in eight rows of 25 each, with one metre spacing between points and between rows. The HSI was calculated for each plot as described by Novellie and Winkler (1993). These surveys were all conducted in the spring and early summer of 1988 (October to December).

Determining allowable range of variation in the HSI

In order to test the HSI Novellie & Winkler (1993) compared its value between ten different habitat patches in the MZNP. Linear regressions were derived relating the HSI to the frequency of use of the patches by zebras. These results suggested the following categories of habitat quality:

- Good habitat: HSI greater than 20
- Moderate habitat: HSI from 10 to 20
- Poor habitat: HSI below 10.

Good habitat patches generally had frequencies of sightings of zebras of 2-9%, moderate habitat had sighting frequencies of 1-2%, whereas poor habitat had sighting frequencies of below 1% (see Novellie & Winkler 1993). Thus the minimum desirable level of the HSI was set at 20 for the best habitats (the PS) and at 10 for the moderate habitats (the PM and LSS).

Assessing the sampling intensity necessary to detect changes in the HSI beyond the desirable limits

Minimum detectable differences between mean HSI (i.e. that difference which has a 90% chance of being detected at the 5% level of significance) were calculated for a range of different sample sizes (Zar 1984). In this way an appropriate sampling intensity required to detect changes of a given magnitude could be determined.

Patchiness in the use of the PS by zebras

The data used in this analysis came from the programme for monitoring the distribution of large herbivores in the MZNP (Novellie 1991). This programme, which continued from December 1983 to March 1989, involved surveying the distribution of animals from the roads once or twice each month. The approximate position of each group of animals seen during each survey was marked on a 1:50 000 map. The map was partitioned into grid squares, the size of each grid being 500 m x 500 m (25 ha). It was therefore possible to assign each group of animals sighted to a specific grid square. For the purpose of the present study the mean numbers of mountain zebras counted in each of the 25 ha grid squares that fell within the PS community were calculated. Only grid squares that were completely within the PS were considered, those including borders with other communities were excluded.

Results

As would be expected, the mean HSI in the PS, the community most favoured by the zebras, was significantly higher than that of the other two communities (Table 1). Minimum detectable differences between mean HSI's in the three communities are shown in Table 2 for a variety of sample sizes. As noted, the minimum desirable HSI for the PS was set at 20. A decline from the observed mean of 36,6 in the PS to 20 would mean a minimum detectable difference of 17. Table 2 shows that a sample size of 15 randomly located plots in the PS has a 90% chance of declaring a difference between means of about 16 to be significant at the 5% level. Thus a sample size of 15 plots would be about the minimum required. However, to allow for a margin of safety, it would seem preferable to sample 20 plots in the PS.

For the PM and LSS the minimum desirable value of the HSI was set at 10. Thus the required minimum detectable differences would be 9 and 8 for the PM and LSS respectively. Table 2 shows that a sample size of between 10 and 15 randomly located plots in each of the two communities would be adequate to detect a decline of this magnitude.

Table 1

Mean habitat suitability index (HSI) compared between three plant communities in the Mountain Zebra National Park. The Tukey test (Zar 1984) shows the mean of the plateau sandstone (PS) to be significantly higher than those of the plateau mudstone (PM) and lower slope sandstone (LSS) ($F = 18{,}5$ $df = 2{,}42$; $P < 0{,}01$. *Analysis performed on data transformed to logarithms)*

	PS	PM	LSS
Mean	36,6	19,2	18,2
Standard Deviation	13,1	5,6	6,1

Table 2

Minimum detectable differences for the habitat suitability index in three plant communities in the Mountain Zebra National Park. The minimum detectable difference is that difference between means which has a 90% chance of being detected at the 5% level of significance, given a specified sample size. PS = plateau sandstone; PM = plateau mudstone; LSS = lower slope sandstone

Sample Size (number of plots)	PS	PM	LSS
10	20	9	9
15	16	7	7
20	14	6	6
25	12	5	6
50	9	4	4

The mean density of zebras varied considerably between the different 25 ha grid squares situated in the PS. Table 3 shows that the differences between grid squares remained consistent, some were highly favoured throughout the six-year period of observations whereas others were consistently avoided. The reasons for these differences are not clear. They may relate to spatial variations in the relative abundance of grass species, but may also reflect other factors such as disturbance from passing traffic in those parts of the community that are near to roads.

Table 3

Mean numbers of Cape mountain zebras counted in 13 grid squares (each 25 ha in area) in the plateau sandstone community, Mountain Zebra National Park. Numbers are compared between the years 1984 to 1989. Sample sizes are the numbers of counts conducted in each year. The differences between grid squares are highly significant (Friedman test statistic = 47,3; P < *0,001 — Zar 1984)*

Grid	1984	1985	1986	1987	1988	1989	Mean
1	1,8	6,4	4,2	2,0	5,1	3,8	3,9
2	2,3	1,6	3,3	2,4	4,9	3,7	3,0
3	2,6	4,1	2,7	1,1	1,6	3,5	2,6
4	4,1	1,5	2,3	0,4	2,4	1,3	2,0
5	1,8	2,4	1,3	2,0	1,6	0,5	1,6
6	2,8	0,7	2,1	0,2	1,5	2,0	1,6
7	0,9	0,1	0,6	0,4	2,1	3,1	1,2
8	0,5	0,2	0,0	1,7	2,5	1,6	1,1
9	2,2	1,2	0,3	0,3	0,7	1,1	1,0
10	1,1	0,6	0,0	0,3	0,5	0,2	0,4
11	0,5	0,1	0,9	0,3	0,6	0,0	0,4
12	0,0	0,3	0,2	0,3	0,3	0,6	0,3
13	0,7	0,0	0,0	0,4	0,0	0,0	0,2
Sample size	15	19	17	17	14	16	

Discussion and conclusions

Monitoring the quality of the habitat for a particular herbivore species requires identification of the most important parts of the habitat. If the key habitat patches can be reliably identified sampling can be concentrated on these, thereby reducing the effort required to detect vegetation changes that are important from the point of view of the animals.

The approach used in the present study was to concentrate sampling on the plant communities that carried the highest density of mountain zebras. However, the patchy distribution of grazing pressure within the plant communities shows that the community was not a homogeneous entity as regards habitat quality for mountain zebras. This suggests certain modifications in the sampling design. The three plant communities could be stratified according to the degree of use by zebras and sampling could be restricted to the most heavily utilised strata. This would more closely reflect those parts of the habitat that are the most important for the zebras.

As Mentis (1984) pointed out, random sampling allows the degree of representativeness to be assessed. Judgementally selected plots run the risk of being non-representative of the area being sampled. The risk of misrepresenting the impact of grazing is particularly high if the distribution of grazing pressure (which is commonly very patchy — Mentis 1980; McNaughton 1983) is not taken into account in the sampling design.

As noted, the allowable limits of variation of the HSI were arbitrarily identified. A knowledge of the relationship between the HSI and the performance of mountain zebra population is required in order to place the limits of tolerance on a sound basis. It should be mentioned, however, that at the time this study was conducted (1988) the zebra population was expanding rapidly. The mean HSI values reported here should therefore be representative of favourable conditions. This gives added confidence that the allowable limit set for the PS is within the range of tolerance of the zebra population.

To summarise, the following procedures are recommended:

- Acceptable sample sizes are 20 randomly located plots in the PS, and 15 in each of the PM and LSS.
- If the mean HSI in the PS declines to below 20, or if the means for the PM or LSS decline to below 10, then management action is recommended. This should take the form of reduction of populations of grazers that may compete with zebras (red hartebeest, black wildebeest, blesbok and springbok) and possibly also an increased rate of capture and translocation of mountain zebras to other conservation areas. Monitoring should then be continued to determine whether the measures have had the desired effect.
- A frequency of follow-up surveys of once every three to five years should be satisfactory. However surveys should be conducted more frequently in the event of bad droughts, or if the mountain zebra population performs poorly.

The time required to survey each plot was about 1,5 hours including the time taken to locate the plot and to complete the 200-point survey. Thus the required sample (20 plots in the PS, 15 in each of the PM and LSS) should take about 75 hours or about 10 days field work.

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