NYALA 10(2), 1984

5017

Nyala 10(2): 77-90, 1984.

STATUS OF THE MWABVI RHINO *(DICEROS BICORNIS)*

H. JACHMANN
Bergsingel 72a
3037 GH Rotterdam
The Netherlands

SUMMARY

The status of the rhino in Mwabvi Game Reserve was investigated using footprint — and bolus-circumference measurements. The number of rhino present in the Reserve were estimated to be 6 or 7 and to occupy an area which overlaps part of the old extension of the Reserve. A new extension of 22km² is proposed to provide a corridor for rhino to cross the international border into Mozambique for the Mwabvi rhino are only considered viable as part of the more extensive population occupying eastern Tete District in Mozambique. Reasons why the Mwabvi rhino numbers have been kept low are discussed. A modified method which can be used to collect information on rhino numbers and distribution for larger populations using a stratified sample of foot-prints and boli is described. Finally, management recommendations are discussed.

INTRODUCTION

Because of the high price of rhino horn on the international market, black rhino populations all over Africa are currently suffering drastic reductions in numbers due to illegal hunting. Until recently, Malaŵi's rhino populations had not yet been effected in this way, mainly because numbers have always been low, limiting development of specialised hunting techniques and illegal marketing systems.

Malaŵi has two small populations of black rhino *(Diceros bicornis)*, one in Kasungu National Park, numbering between 10 and 20 animals and one in Mwabvi Game Reserve, numbering anywhere between a couple and 30 animals. The status of rhino in Kasungu National Park is fairly stable, partly as a result of a properly functioning anti-poaching force and a well run research unit and partly due to low numbers of rhino in combination with a dense vegetation. However, the status of rhino in Mwabvi Game Reserve is doubtful, firstly because the available information on numbers and occupance is at least superficial and most likely very inaccurate and secondly because the present status of part of the Game Reserve, presumably including part of the rhino range, is questionable. In order to clarify this last point we must look at the history of the Reserve. The Thangadzi River Reserve was established by the British Protectorate Government in 1928, in order to protect some of the few remaining black rhino in the country. In 1951, the 131 km² Mwabvi Game Reserve was proclaimed (Fig. 1). In 1975, a number of communities, consisting of small scale farmers and hunter-gathers were removed from the area situated between the Game Reserve and the Mozambique border, and the reserve was increased by another 220 km² (extension area in Fig. 1). The reasons to increase the original Game Reserve to a total of 351 km² were twofold. The first was political and falls beyond the scope of this contribution, while the second purpose was to prevent cultivation of the steeper slopes of the western Shire watershed. In 1982, the people that once inhabited part of the extension area were allowed to return to their old villages. In view of this recent action of the local authorities, in combination with the lack of knowledge on the Mwabvi rhino in general and the deteriorating status of rhino all over Africa, the Department of National Parks and Wildlife found it advisable to carry out a thorough survey of the species.

As a whole, very little scientific work has been carried out in the Reserve and estimates of numbers of rhino were usually based either on educated guesses (Ridding, 1975) or aerial survey data (Parker, 1976), the latter of which the accuracy is so poor under the given conditions of vegetation density that the method is not even worth attempting.

In 1926, an Officer of the King's African Rifles estimated less than 10 individuals present in the Reserve. Students of the Aberdeen University estimated between 8 and 30 individuals, while Ridding (1975) estimated only 5 individuals on the basis of data collected during the same expedition. Parker (1976) estimated the number of rhino between 4 and 7, based on aerial survey data and a single transect on foot through part of the presumably harsh terrain. From these data it appears that Mwabvi has probably contained only a small number of rhino over the past 50 to 60 years. This contribution describes the outcome of a survey of black rhino, undertaken in September and October 1983 (late dry season). The aim of the survey was to determine the number of rhino, collect information on their distribution and to make recommendations for their future survival.

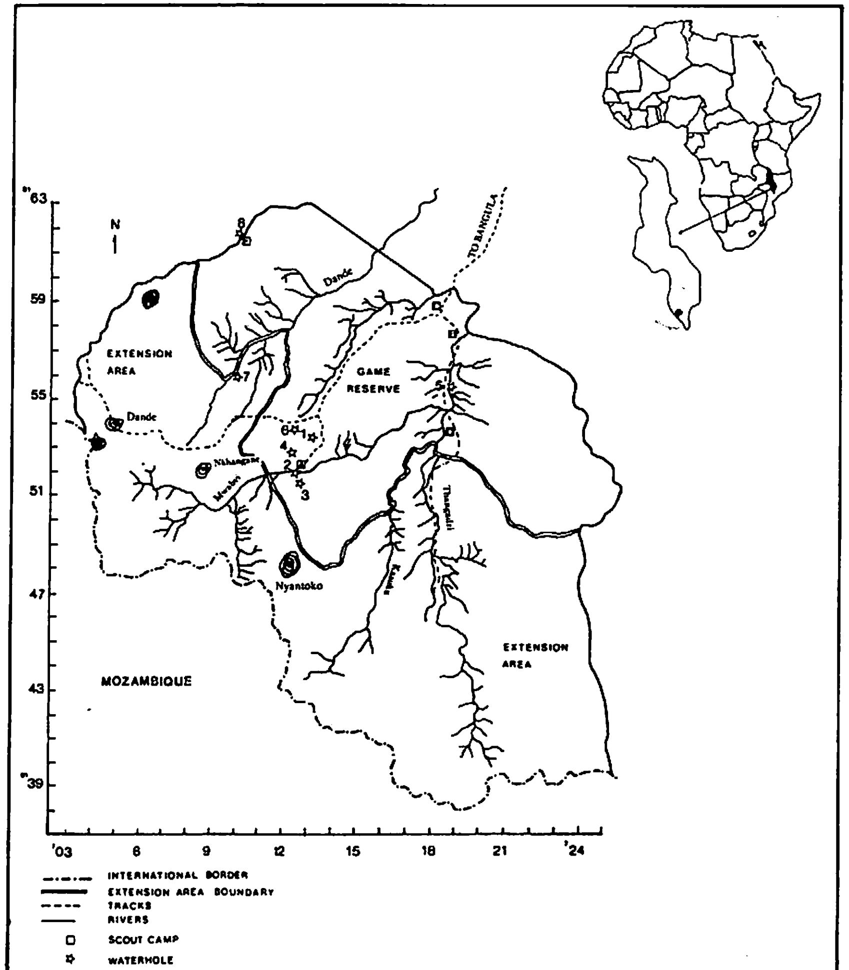

Fig. 1. The Mwabvi Game Reserve and the extension area. Scout Camps: Mwabvi (A), Migudu (B), Gate (C), Matope (D), and Madziabango (E), Waterholes that contains water throughout the year: Fodya (1), Mwabvi (2), Mvera (3), Kukondwera (4), Daelo (5), Chepa (6), Dande (7), and Madziabango (8).

BRIEF DESCRIPTION OF MWABVI GAME RESERVE

The Reserve (original Reserve and extension area) is situated in the Lower Shire valley in southern Malaŵi, between latitudes 17° 11' and 17° 23's and longitudes 34° 58' and 35° 07'e. Its geology is mainly formed by sedimentary rocks of the Shire-Zambezi Karoo system, of which the lowest stratum has been uplifted as blocks along faults to form the Nyantoko ridge and the hills and rocky areas in the south of the Reserve and near Migudu camp in the north (B in Fig. 1). The Mwanza series of grits, sandstones and calcareous shales overlie the lower sandstone stratum and are exposed at the surface over most of the Reserve. Differences in composition and thickness of this upper stratum, in combination with dolorite dikes and sills that occur in the south and central north and basalt flows that occur in the west of the Reserve, provide a complex mosaic of parent material resulting in a tessalated landscape with a large number of different distinct vegetaton types and ecotones. Fig. 2 shows the major vegetation types within the Reserve (modified and simplified after Riding (1975)).

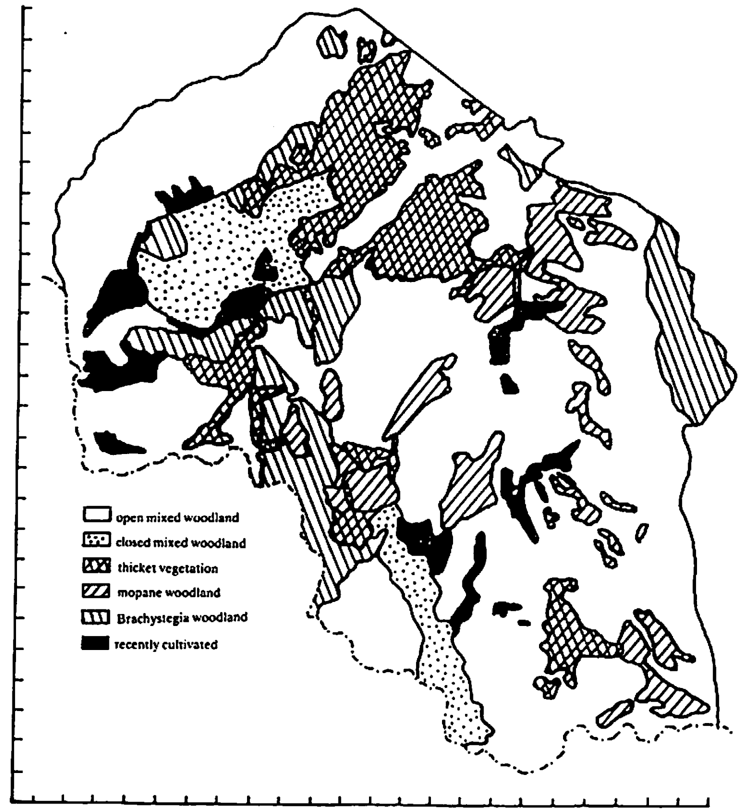

Fig. 2. Vegetation map of Mwabvi area, modified and simplified after Ridding, 1975.

Open mixed woodland is dominated by *Albizia, Acacia* and *Combretum* spp., interrupted by small stretches of riverine thicket and patches of mopane woodland on top of the ridges of the slightly undulating terrain where the soil is relatively shallow.

Closed mixed woodland is also dominated by the above noted species, but at higher densities and including species like *Dalbergia melanoxylon* and *Crossopteryx febrifuga*.

The thicket vegetation covers only 8.5% of the Reserve (Ridding, 1975), but appears to be the main rhino habitat. The diversity of tree species in this impenetrable vegetation type is very high, dominated by *Brachystegia bussei, Pterocarpus angolensis* and *Adansonia digitata*. The main thicket areas are Ntaya Thumba in the north, Maleme, situated south east of Ntaya Thumba and the smaller Nyantoko thickets near the international border, straight south of Maleme.

Mopane woodland can be found in a number of discrete stands, covering 7.5% of the Reserve (Ridding, 1975).

Brachystegia woodland is dominated by 'miombo' species like *Brachystegia bussei, Julbernardia globiflora, Julbernardia paniculata, Diplorynchus condylocarpon* and *Burkea africana* and covers the areas with relatively poor eroded soils.

The recently cultivated areas have partly been recolonised by the indigenous vegetation, while the remainder has been put under the hoe after the extension area was resettled in 1982. Although the area brought into cultivation will progressively increase in the coming years, the ultimate area available to agricultural practises is limited. Another factor limiting human habitation is the water availability during the dry season. In Fig. 1, only those waterholes that contain water at the end of the dry season have been indicated by open stars. Kukondwera and Chepa waterholes (4 and 6 in Fig. 1) have both been discovered during this survey and occur at the foot of a rocky outcrop of the Mwanza series. Total rainfall in the Reserve is approximately 800 mm per annum, falling between December and March.

METHOD

The usual method to count rhino is by means of aerial survey or visual identification on the ground. On account of the vegetation density in Mwabvi, aerial survey is an expensive and worthless exercise, while the method of visual identification cannot be used due to the shyness of the animals and the poor visibility in most of the rhino habitat. Because of these reasons, information on numbers and distribution of black rhino was collected on foot, by covering a number of parallel transects from north to south (v.v.) and west to east (v.v.) at 1 km intervals (Fig. 3). Each transect was covered by a game scout, a carrier and the author, walking at about 10 m intervals, giving a total transect width of about 30 m and a sample intensity of approximately 11%. All signs of rhino presence were noted for location and age, i.e. browsing, middens and footprints. If a midden contained boli that were still in one piece, they were measured for circumference, which is a rough indication of the age of the animal (Jachmann, 1984; Jachmann & Bell, in press). Footprints were measured for diameter, i.e. the widest point between the left and right toe. Measuring of footprints was complicated by the following factors:

(i) differences between the diameters of the fore — and hind-feet were found to be as much as 3 cm in the Mwabvi rhino,
(ii) slight differences between the diameters of the left and right fore-feet and left and right hind-feet.
(iii) different soil textures and differences in the weight of rhino produced footprints of a different clearness.

In order to avoid bias in the results, a single spoor was followed as long as the footprints were measurable. Means and standard deviations were calculated for both the fore — and hind-feet. The difference in diameter between fore — and hind-feet (Δf), was a useful factor in distinguishing between different rhino of similar age and sex. For each set

of footprints, the means were compared with the means of other footprints and, in combination with differences in Δf, different animals could be recognised by their spoor.

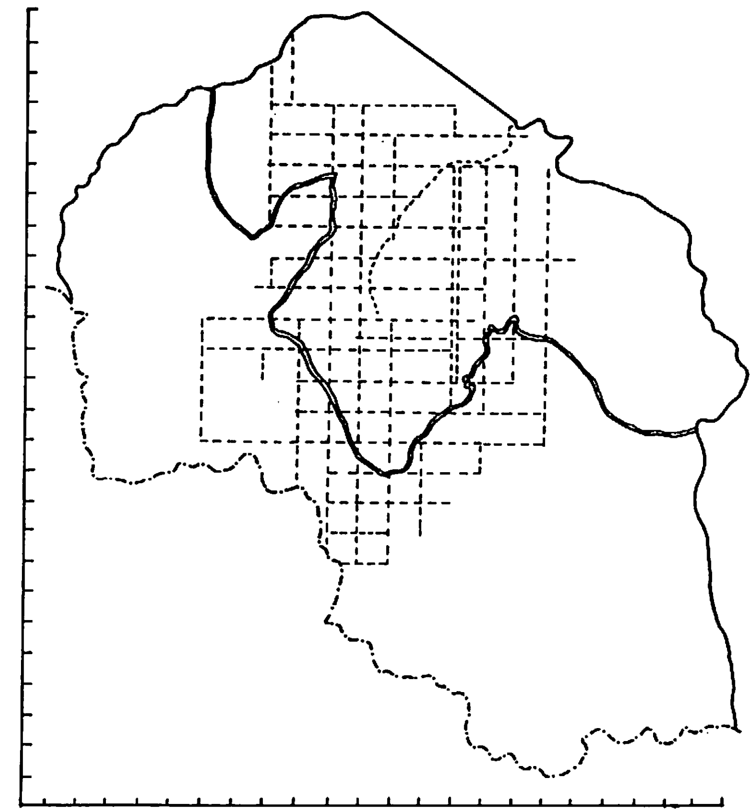

Fig. 3. Main transect samples for rhino footprints and middens.

RESULTS

RHINO DISTRIBUTION

The locations of rhino middens, footprints and browsing were plotted on a map (1:50.000) and the outmost points connected by lines to give a distribution pattern (Fig. 4). The area occupied by the rhino covers 52 km², including Malema and Nyantoko thickets, the southern part of Ntaya Thumba thickets and a large area of open mixed woodland interrupted by patches of mopane and *Brachystegia* woodland (Mwabvi camp area). Although the rhino spent most of the daytime in the thicket and riverine vegetations, it was observed from spoor and middens that during the night they spent significant amount of time browsing in the open mixed woodland. Well-used rhino tracks connect the thicket areas and stretches of riverine vegetation. One major track starts at Nyantoko thicket from where it runs straight north following mopane woodland, crossing the Mwabvi river west of the camp into the *Brachystegia* woodland to Fodya waterhole, from where a number of tracks start in different directions. The other major track starts at Nyantoko, 1 km east of the other track, also following mainly mopane woodland and terminating in the riverine vegetation along the Mwabvi river east of Mwabvi camp. Another major track runs from the east side of Maleme to Dayelo waterhole in the Thangadzi river (5), also crossing through mopane woodland. The overall distribution of rhino does not seem to change much over the seasons, as old and fresh middens and spoor were evenly distributed over the entire area. The availability of water appears to be the main factor determining minor occupance differences over the seasons, where rhino concetrated near Kukondwera, Chepa and Fodya waterholes (4, 6 and 1) for a short period at the end of the dry season. After the first short rains on October 8th, the rhino dispersed and did not visit any of the above mentioned waterholes for the remaining survey period. During the latter part of the dry season, rhino obtained some of their water ration by eating the tops of young highly poisonous ***Euphorbia ingens*** trees. This was frequently observed in the Nyantoko area.

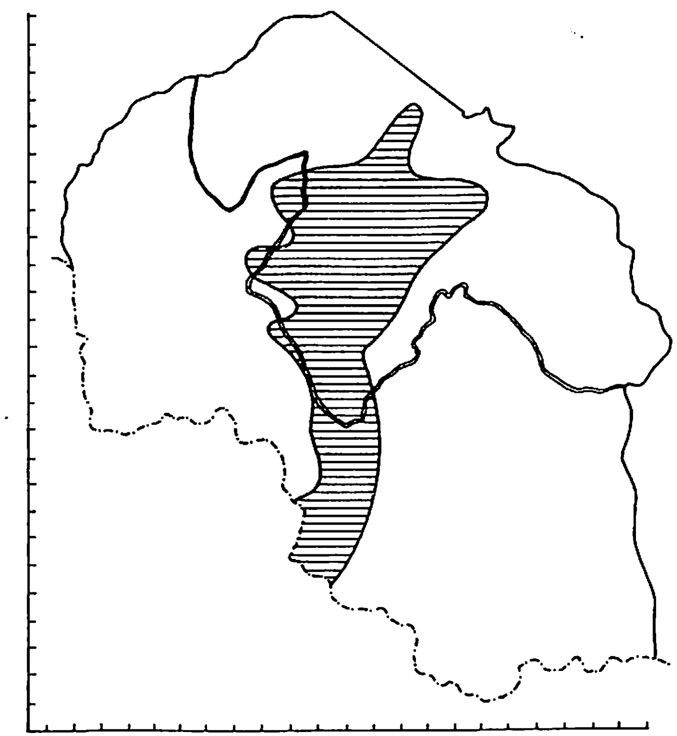

Fig. 4. Rhino distributions.

RHINO NUMBERS

Using the footprint method

By comparing the means of the different sets of footprint measurements, in combination with differences in Δf, the minimum number of rhino was estimated to be five. Table 1 summarizes the different set of footprints found during the survey. Rhinos 1 and 2 spent a considerable amount of time in the area around Mwabvi camp, which was sampled at a far higher intensity than the rest of the Reserve. Of rhino 4, several prints of only the fore-feet were found, while it was not certain if the footprints of rhino 5 represent a fore-and hind-foot of one rhino or the hind-foot of rhino 1 (18.20 cm) and a fore- and hind-foot of rhino 5. Because of their weight, footprints of young rhino are not as clear or frequently discovered as those of the older heavier rhino, while in addition large areas of the Reserve are not suitable for this exercise because of the structure of the soil or large rock formations. Therefore it is most likely that using this method, a few young rhino were missed.

Table 1. Fore-foot and hind-foot diameters and differences between fore and hind-feet (Δf) for five rhino. Standard errors are indicated after mean values.

	diameter (cm)		Δf
Rhino	fore-foot	hind-foot	
1	20.40 ± 0.63	18.52 ± 0.32	1.88
2	22.14 ± 0.61	19.47 ± 0.52	2.67
3	24.06 ± 0.41	21.20 ± 0.38	2.86
4	25.50 ± 0.58	—	—
5	18.20?	16.50?	1.70?

The droppings method

Rhino tend to scatter their droppings with their hind-feet, fortunately often missing some of the boli, which can be measured for circumference. Fig. 5 shows the circumference class frequencies of 57 boli in total. A second-order average has been drawn. The

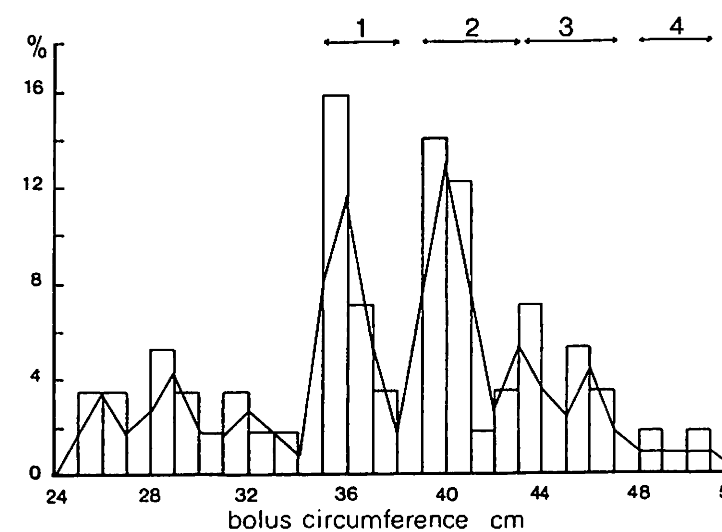

Fig. 5. Histogram showing circumference frequencies of 57 boli.

area directly west of the camp (about 1 km²) was solely used by rhinos 1 and 2, for which two ranges of boli-circumference measurements were found. For rhino 1, circumference measurements ranged from 36 to 38 cm and for rhino 2 from 40 to 43 cm. It is striking that the distribution of circumference values for both rhinos is skewed. We can interpret this as follows; during the latter part of the dry season, rhino mainly eat woody browse (pers.obs.) and some leaves. A maximum intake of highly fibrous material will stretch the intestines, producing boli with a maximum circumference. A lower intake of food in general or a larger ratio of digestable to fibrous material will produce boli with a slightly smaller circumference. Hence the distribution of bolus circumference values per rhino will always be skewed, with a maximum value decreasing to a minimum value, both depending on the quality of the diet. Of the total sample, a large percentage of boli belonged to rhinos 1 and 2, solely because the area next to the camp was surveyed more thoroughly than the rest of the Reserve. Fresh footprints next to fresh droppings were also found of rhino 3, leaving the remaining circumference values for rhino 4. In order to check on the method, the mean bolus circumference value was plotted against the mean fore-foot diameter for rhinos 1 to 4 (Fig. 6). Regression analysis was applied and the relationship appeared to be highly significant ($P < 0.001$, $r = 0.997$; $y = 0.384x + 6.456$), supporting the results of both the footprints and droppings method. The remaining boli with circumference ranging from 26 to 27, 29 to 30 and 32 to 34 cm belong to rhino 5 and one or perhaps even two more unidentified young rhino. A fore-foot diameter of 18.2 cm (rhino 5) would give a mean bolus circumference of 30.8 cm (Fig. 6), located halfway between the second and third peak of the second-order average in Fig. 5. This would imply that rhino 5 is possibly represented by a bolus circumference range of 29 to 34 cm, which seems unlikely given the circumference ranges of rhino 1 to 4. Therefore we reject 18.2 cm as fore-foot diameter of rhino 5, but maintain 16.5 cm as either fore — or hind-foot diameter. Using the droppings method, we may conclude that Mwabvi Reserve contains 6 or 7 rhino.

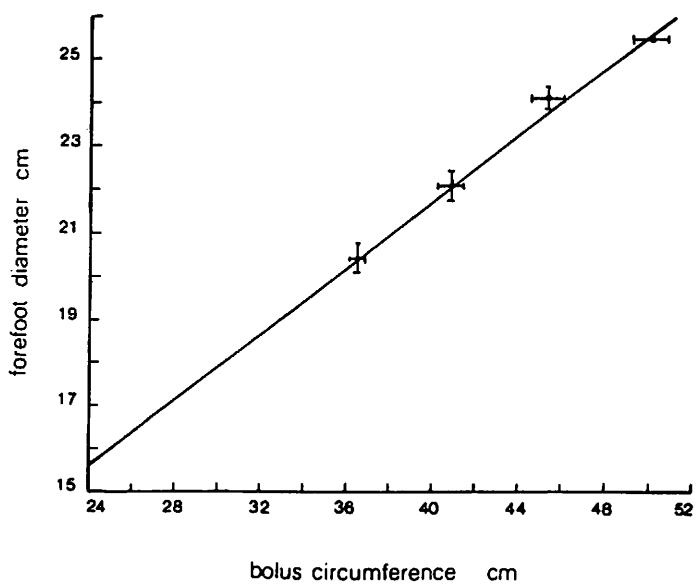

Fig. 6. Plot of mean bolus circumference against mean fore-foot diameter for rhinos 1-4.

HOME RANGES AND RHINO DENSITY

Home ranges

The footprint and droppings method were not suitable for accurately determining the home ranges of the individual animals, firstly because no footprints could be found in areas with a rocky soil texture and, secondly because not enough boli of the various animals were found of which the circumference could be measured. Fig. 7 shows the locations of footprints or boli of a particular animal. The year-round home ranges of rhinos 1 to 3 can be roughly estimated as being 23 to 28 km², while rhino 4 has a home range of approximately 15 to 17 km². Of rhino 5, not enough information is available to even give a rough approximation. From the data we may conclude that home ranges of the Mwabvi rhino overlap considerably and are relatively large compared with 1.0 km² in the Lerai Forest, 6.0 km² in Ngorongoro, 11.7 km² in Olduvai Gorge, Tanzania (Goddard, 1967) and 5.6 to 22.7 km² in Masai Mara (Mukinya, 1973). Home ranges of rhino occupying the short grasslands of the Serengeti plains are obviously larger with 43 to 133 km² (Frame, 1980). As mentioned by Goddard (1967) and Mukinya (1973), in different areas with a similar vegetation structure, but with differences in water availability, home ranges of rhino were significantly larger in areas where water supplies were widely scattered and sparse.

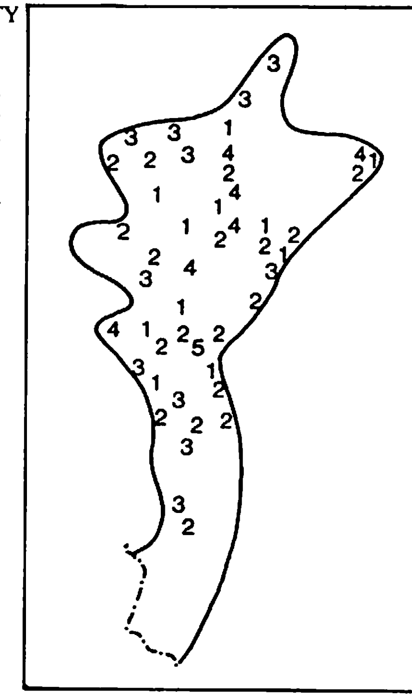

Fig. 7. Approximate locations of footprints and boli of rhinos 1-5.

Rhino density

The 6 or 7 rhino occupy an area of 52 km², giving a density of 0.12 to 0.14/km². This compares with 0.32/km² in Ngorongoro, 0.16/km² in Olduvai Gorge, Tanzania (Goddard, 1967), 0.32/km² in Tsavo National Park, Kenya (Goddard, 1969), 0.41/km² in Luangwa valley, Zambia (Caughley, 1973), 0.14/km² in Masai Mara, Kenya (Mukinya, 1973) and 0.05/km² on the Serengeti plains in Tanzania (Frame, 1980). On account of differences in the vegetation structure, none of these areas are directly comparable. The rhino density in Masai Mara is similar to that of Mwabvi. However, the vegetation of Masai Mara consists of short grasslands, interrupted by stretches of riverine vegetation, generally containing low densities of the browsing black rhino. Olduvai Gorge also has a similar rhino density as Mwabvi. The vegetation is mainly *Acacia* and *Commiphora*, thornbush, roughly corresponding with the thicket vegetation in Mwabvi. The water supply is identical to that of Mwabvi, widely distributed and sparse during the dry season. As noted earlier, it is most likely that the water availability in Mwabvi is one of the main factors contributing to large home ranges, hence low rhino densities.

Parker (1967) estimated that one would expect Mwabvi Reserve (351 km²) to contain 140 rhino, based on comparison with densities of rhino in the Luangwa valley, Zambia (Caughley, 1973). This is most unlikely, firstly because one year before Parker surveyed the Reserve, the extension area was still occupied by a large number of people, reducing the available rhino area to the size of the original Reserve (131 km²). Secondly, poaching has always limited the available area for rhino within the orginal Reserve (game scouts and local hunters, pers. comm.; pers.obs.), which may be the main reason that rhino spend most of their time in the thicket vegetation. Thirdly, during the latter part of the dry season, the food availability for rhino is limited to mainly woody browse (pers.obs.), imposing a nutritional constraint, upon their expansion. Parker (1967) suggested that the early burning policy is responsible for a possible nutritional constraint. However, the thicket vegetation does not burn at all, while most of the mopane woodland hardly burns because the shallow rooting system of the trees results in a low grass biomass. Fourthly, as mentioned before, the scarcity of water during most of the dry season may well be another factor contributing to low densities of rhino.

DISCUSSION AND CONCLUSION

Mwabvi Game Reserve contains 6 or 7 black rhino, occupying an area of 52 km², covering 37 km² of the original Reserve and 15 km² of the extensions area. By itself the rhino cannot be considered a viable population, although numbers must have been low for a period of more than 60 years. The extension area of Mwabvi Game Reserve borders on a vast wilderness area in Mozambique, which is part of the Zambezi ecosystem. According to Smithers & Tello (1976), in Mozambique rhino still occur in the area between the Zambezi river and Nsanje district in Malaŵi, while local hunters informed us that rhino occupied patches of thicket vegetation from the international border to the Zambezi river. In addition, the Mwabvi rhino are by no means restricted to Malaŵi, as Parker (1976) found a large male rhino south of Nyantoko thickets, right on the international border. Therefore, I suggest that the Mwabvi rhino is part of a larger population, mainly occupying eastern Tete District in Mozambique. It is most likely that several rhino occupying eastern Tete District have home ranges overlapping the international border into Malaŵi. During the dry season, these rhino may be restricted to their range in Mozambique, as the closest available water from the international border is at Mwabvi camp. If one of the rhino occupying Mwabvi or eastern Tete District, with home ranges overlapping Mwabvi area, is killed by poachers, immigration of rhino from Zambezi area follows. Hence, the Mwabvi rhino has been kept a viable subpopulation through exchange of genetical material with the metapopulation in Mozambique. First priority is that Mwabvi becomes politically stable and that the administrative status of the extension area becomes clear to all parties involved. If the extension area is not administered by the Department of National Parks and Wildlife, in order to secure survival of the few remaining black rhino in Malaŵi, the boundary of the original Reserve will have to be altered in those places where the rhino occupance area overlaps the extension (approximately 22 km²). Fig. 8 shows the proposed new extension of the original Reserve (shaded), the recently cultivated areas (black) and the relevant areas with high human habitation (dotted). This corridor will enable rhino to move across the international border. Before the people were removed from the old extension area in 1975, this corridor was frequently hunted for rhino, which has probably continued at a low scale (during this survey, a four-year-old female was found killed by poachers south of Nyantoko hill, while another older skeleton (2 to 3 years) was found west of Nyantoko hill, presumably more skeletons can be found in this region).

Parker (1976) found it rather strange that no rhino bones were ever discovered in the Reserve. However, a simple calculation will show that intensive patrolling is needed to discover the remains of a rhino that died a natural death in a population of only 7 animals with a lifespan of 30 years. This means that every 4.3 years one rhino dies a natural death, of which the bones remain for perhaps a couple of years. Thus every other two years the remains of only one rhino — that most likely died in the thicker vegetation — can be discovered. The remains of some rhino that died a natural death and of those that were killed by poachers have only recently been discovered, firstly because the thickets are never patrolled and secondly because the patrols that are carried out always follow the same tracks.

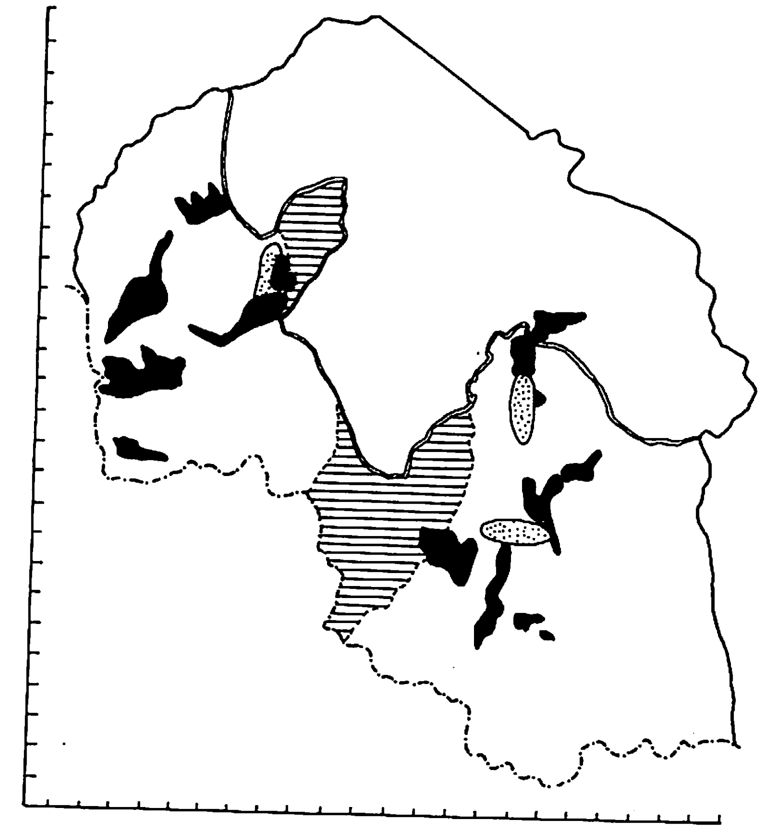

Fig. 8. Proposed new extension of the old Reserve (shaded), recently cultivated areas (black) and relevant areas with high human habitation (dotted).

Summarizing, we can state that the Mwabvi rhino have been kept low in number because:

1. Human disturbance in the form of illegal hunting and trespassing. Both act through decreasing the habitat available, compressing the rhino in the dense cover of the thicket vegetation and reducing numbers by direct killing of animals. During Parker's survey (1976). I estimate that there were presumably at least 10 rhino in Mwabvi. This means that the aerial survey result was low by at least a factor of 2.5.

2. Water availability during most of the dry season is restricted to a small number of permanent waterholes of which those that are easily available are situated in an area of about 1 km² (1,2,3,4 and 6 in Fig. 1).

3. Food availability during the latter part of the dry season is restricted to mainly woody browse. In addition, early dry season burning may even further reduce food availability for rhino during this time of year.

4. Possible predation of young rhino by lions.

Illegal activity is the main factor why animal numbers in general have been kept low in the Reserve. Numerous bush-fence traps were found around Nyantoko hill, in Ntaya Thumba thicket and along the Mwabvi and Thangadzi rivers. Within 15 minutes, 10 bush-fences including snares were removed around Dayelo waterhole. Gunshots of muzzle-loaders and shotguns were heard frequently, while the remains of two rhino, killed by poachers were found around Nyantoko hill. It is obvious that the patrol activity of the game scouts is low, while during the patrols that are carried out they seem to almost completely fail to enforce the law. Their poor morale can be understood from the following factors:

1) Mwabvi's unstable political climate, ii) persistent doubt on how to handle law breakers in the extension area, iii) poor discipline due to lack of supervision, iv) unpopularity among the local people who seem to frighten them and, v) time spent on collecting food outside the Reserve.

If the goal is to protect the few remaining black rhino in Malaŵi and to give the area more tourist appeal, then obviously the management of the area must undergo significant changes. As it stands, animal numbers are too low, whereas densities of the tse-tse fly are too high. The roads are the worst in Malaŵi and the place has little to offer the common tourist.

Finally I would like to make some comments in relation to the footprint/droppings method, used during this survey, which can only be applied in areas with low rhino numbers. With higher rhino numbers, an alternative method may be applied.

The procedure is as follows:

1. The area is sampled for footprint diameters and boli circumferences, using the transect method described in this paper, whereby the size of the actual grid (width between transects) and the width of the actual transect determine the accuracy of the result.

2. Only those footprints should be used, where the difference between fore - and hind-feet can be determined and Δf calculated.

3. The data should be fed into a five-dimensional array of which the parameters are: latitude of datum (I), longitude of datum (II), forefoot diameter (III), Δf (IV) and bolus circumference (V).

4. The result is a number of five-dimensional clusters, equal to the number of rhino present in the area, where the cluster-size equals the approximate size of the home range. Cluster analysis can be executed with the BIOPAT computer program (Program system for BIOlogical PATtern analysis, developed by P. Hogeweg and B. Hesper: Bioinformatics group, R.U. Utrecht, The Netherlands).

MANAGEMENT RECOMMENDATIONS

Mwabvi is an important conservation area, firstly because it contains some of the last Malaŵi rhino, secondly because it contains the rare Nyala and Sable antelope, thirdly because it forms part of the extensive home ranges of several packs of African wild hunting dog and fourthly because it is a major water-catchment area. Most of the Reserve is not suitable for cultivation, while the presence of the tse-tse fly and the water shortage during the dry season also restrict human habitation. The following management recommendations should be considered:

1. The game scouts should be transferred to other conservation areas in Malaŵi and the Reserve re-staffed.

2. A game ranger should be based at Mwabvi camp. He should be provided with housing.

3. The number of game scouts should be increased by at least one per camp. In this way one scout can be off to collect food, while the other two are on patrol. if possible, more scouts should be based at Mwabvi camp as it is situated in the centre of the rhino area.

4. The scouts should be provided with sturdy bicycles.

5. Patrols should not be carried out following fixed routes, and should include the thicket areas. Patrols should be made daily.

6. Carriers working for the Department of National Parks and Wildlife and living in the villages of the extension area should be discharged, as all law enforcement activities are directly passed on to the hunters in these communities.

7. The Department should organise food transport into the Reserve every fortnight or at least once a month at pay-day.

8. If the extension area is not administered by the Department of National Parks and Wildlife, the original Reserve should be increased by 22 km², altering the boundary in those places where the rhino distribution overlaps the old extension (Fig. 8). The present pattern of human habitation can thus, be maintained.

9. Depending under whose administrative responsibility the extension area comes, a firewood cutting scheme should be proposed to prevent excessive tree clearing. This would reduce the erosion of the lower elevations of the valley.

10. The Department should immediately look into development of fuel supplies for the rapidly expanding population of the Lower Shire valley. The possibility of using the indigenous woodlands of both the extension area of Lengwe and Mwabvi should be considered.

11. The Department should carry out research as to the effect of early burning on the food availability for rhino and other browsers in the Reserve. Of particular interest would be a study of food competition between Nyala and rhino.

12. The infrastructure of the Reserve should be developed to provide access for tourists and law enforcement activities.

13. Translocation of the Mwabvi rhino should never be considered. Firstly because the operation would be too costly, giving the density of the vegetation and shyness of the animals, secondly, because numbers of rhino are too low to start a viable new population and thirdly, because at the same expense and with similar veterinary difficulties fresh stock could be introduced somewhere else in Malaŵi from areas like the Luangwa valley in Zambia.

ACKNOWLEDGEMENTS

I would like to thank Mr. S. Phiri, Mr. Matewe and Mr. Nkhonje for assisting during the survey and the Malaŵi Government for allowing the research to take place in their conservation area. I sincerely enjoyed the hospitality I received from Janet and John Hough, Jeane and Willem Ankersmit and Kathy and Richard Bell.

Prof. Dr. G.P. Baerends kindly read the report. Further thanks are due to Jane and Peter Bannister for their assistance during the initial period of the project. The work was funded by the Netherlands Foundation for the Advancement of Tropical Research (WOTRO) and the van Tienhoven Foundation.

Further I would like to express my gratitude to Mrs. H. Lochorn-Hulsebos and Mr. D. Visser for respectively typing the report and matters concerning the lay-out.

REFERENCES

Caughley, G. (1973) *Game management.* In FAO report DP/ZAM/68/510

Frame, G.W. (1980) Black rhinoceros *(Diceros bicornis L.)* sub-population on the Serengeti plains, Tanzania. *Afr. J. Ecol.* 18: 155-166

Gordad, J. (1967) Home range, behaviour and recruitment rates of two black rhinoceros populations. *E.Afr.Wildl. J.* 5: 133-150

——— (1969) Aerial census of black rhinoceros using stratified random sampling. *E.Afr.Wildl.J.* 7: 105-114

Jachmann, H. (1984) *The ecology of the elephants in the Kasungu National Park, Malaŵi.* Ph.D. thesis, Univ. of Groningen.

——— and R.H.V. Bell (in press) The use of droppings in assessing numbers, occupance and age-structure of elephant populations; a refinement of the method. *Afr.J.Ecol.*

Mukinya, J.G. (1973) Density, distribution, population structure and social organisation of the black rhinoceros in Masai Mara Game Reserve. *E.Af.Wildl.J.* 11: 385-400

Parker, I.S.C. (1976) *Black rhinoceros and other large mammals in the Mwabvi Game Reserve.* Report to the Malaŵi Government. Duplicated, 44pp.

Riding, C. (1975) *Mwabvi Game Reserve.* Report to the Malaŵi Government. Duplicated, 40pp.

Smithers, R.H.N. and J.L.P. Tello (1976) Checklist and Atlas of the Mammals of Mozamique. *Museum Memoirs No. 8.*

Manuscript received 12 March 1984

Nyala 10(2): 91-98, 1984.

ADDITIONS TO THE VERTEBRATE FAUNA OF LIWONDE NATIONAL PARK, MALAŴI

A. M. MORGAN-DAVIES,[1]
Liwonde National Park,
P.O. Box 41,
Liwonde, Malaŵi.

C.O. DUDLEY[2] and H.M. MEREDITH,
Chancellor College
P.O. Box 280,
Zomba, Malaŵi

INTRODUCTION

The most authoritative account of the birds of the Liwonde National Park is that of Stead (1979) who records a total of 284 confirmed species of as occurring within the park. Stead and Dudley (1977) records 40 species of mammals, and although Sweeney (1961) records a total of 48 species of snakes as occurring in Malaŵi, Dudley and Stead (1976) confirms a mere 3 species for the Liwonde National Park and refer to no specific amphibians.

The observations by A.M. Morgan-Davies (M-D) were made mainly between June 1982 and March 1983 and between September and October 1983 while he was stationed at Liwonde National Park. C.O. Dudley (CD) and H. Meredith's (HM) records principally occurred between June 1976 and October 1977 during the course of a vegetation survey within the park although there is a small number of earlier and later records. Doubtless a few additional species of birds remain to be added in time (see Addendum at end of this paper) but the records of the other vertebrates are very incomplete, in particular the rodents, bats, reptiles and amphibia. Based on published distributional records and habitat preference we would expect at least 30 more species of small mammals, 30 more reptiles (15 of them lizards) and 15 more species of amphibia.

In the list of species that follows; the numbers in the left hand margin refers to Benson and Benson (1977), in respect to birds, to Sweeney (1971) in respect to snakes and to Sweeney (1959) in respect to mammals. The amphibians and other reptiles are unnumbered. Nomenclature follows that of Benson and Benson (1977), Stevens (1974) and Stewart (1967).

FAUNAL LIST

MAMMALS

87. Nyasa Red Squirrel, *Paraxenus p. palliatus* (Peters).

On the 20th September 1983 a pair of Nyasa Red Squirrels were observed for nearly twenty minutes as they ate the flowers of the Wild Mango, *Cordyla africana,* along the Likwenu River. Sweeney (1959) gives montane forests as the habitat of this species in the South and Central Provinces of Malaŵi, and the two animals seen along this lowland riverine forest may probably have been vagrants from the nearby Mongolwe/Chikala Hills. (M-D, CD).

BIRDS

44. African Pygmy Goose, *Nettapus auritus* (Boddaert).

51. Southern Pochard, *Netta erythrophthalma* (Wied).

53. White-backed Duck, *Thalassornis leuconotus* Eyton.

[1] Present address: C/o Mr. R. Stretch, P.O. Box 324, Kokstad 4700, R.S.A.
[2] Present address: Museums of Malaŵi (Top Mandala), P.O. Box 30360, Chichiri, Blantyre 3, Malaŵi.