SADC Regional Programme for Rhino Conservation

REINTRODUCTION OF BLACK RHINO IN THE LUANGWA VALLEY, ZAMBIA

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Evaluation of areas for the reintroduction of rhinos to Zambia

Semester 4 Task 1.2-4.1

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- The IUCN African Rhino Specialist Group
- WWF-SARPO - (World Wide Fund for Nature - Southern Africa Regional Programme Office)
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The ***Programme goal*** is to contribute to maintain viable and well distributed metapopulations of Southern African rhino taxa as flagship species for biodiversity conservation within the SADC region.

The ***Programme objective*** is to implement a pragmatic regional rhino strategy within the SADC region following the acquisition of sound information on, firstly, the constraints and opportunities for rhino conservation within each range state and secondly, the constraints and opportunities for rhino metapopulation management at the regional level.

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Summary

- During the 1960s, the Luangwa Valley was recognised as the stronghold of the black rhino in Zambia. During the early 1970s, aerial surveys – designed to count elephants – suggested that the minimum density of rhinos in the valley was 0.1 km^{-2}. These surveys also provided maps of North Luangwa National Park and South Luangwa National Park showing whether rhinos were seen in each 10 x 10 km map square during each of five surveys. Rhinos were seen more frequently in the northern half of South Luangwa NP than in the southern half. Rhinos were also seen more frequently on the valley floor than above the Muchinga Escarpment.
- Road strip counts were conducted in the north-west quarter of South Luangwa NP during the early 1970s, at the same time as the air surveys. The former suggested that the mean density of rhinos in the miombo woodland above the escarpment was 0.08 km^{-2}. Sampling effort in the various vegetation types on the valley floor was probably too low to provide reliable estimates of rhino density in these.
- Intensive research in the 'core area' of South Luangwa NP during 1981-82 revealed that rhino density here was 0.39 km^{-2}. Analysis of rhino sighting records collected by antipoaching patrols during that same period revealed that rhinos were seen 1.5-2 times as frequently in North Luangwa NP as in the South Luangwa NP core area. Patrol reports from the years 1947-66 suggest that rhino density was greater in North Luangwa NP than in South Luangwa NP core area during that period also. These data imply that the overall mean density of black rhinos in North Luangwa NP used to be >0.39 km^{-2}.
- Extensive commercial poaching of black rhinos for trophies (rhino horns) commenced in the Luangwa Valley during the latter half of the 1970s and, by the mid 1980s, rhinos were very rare or locally extinct throughout the Valley. The rate of decline of black rhino density was greatest in those areas (e.g. North Luangwa NP) where antipoaching effort was least. But rhino numbers declined even in the area that received the highest density of antipoaching patrols.
- There have been infrequent reports, mainly by scouts, of sightings of rhinos, or their footprints, in South Luangwa NP as recently as 1999. There is no evidence that any rhinos remain in North Luangwa NP.
- The Frankfurt Zoological Society North Luangwa Conservation Project (FZS NLCP) provides technical expertise and long-term funding to support the Zambian Wildlife Authority (ZAWA) in the management and conservation of North Luangwa NP.
- There are very few available data on the diet of rhinos in the Luangwa Valley, or in similar vegetation types.
- A geographic information system was used to investigate the factors determining the spatial pattern of rhino sighting frequency in North Luangwa NP during the 1970s. Rhinos were seen more frequently in 100 km^2 map squares where a high proportion of the vegetation was thicket, or valley riverine vegetation. They were also seen more frequently in map squares that were close to sources of perennial water. The relative importance of these two factors was difficult to assess, because the proportion of thicket and riverine in a map square was correlated with the distance to perennial water.
- An attempt to use the Rhino Management Group model to predict carrying capacity in part of North Luangwa NP was unsuccessful, because the model assumed that rhino carrying capacity was positively related to the duration of the dry season, which in North Luangwa NP was greater than in any of the study areas where data were collected to construct the model.

- It is proposed that the figure of 0.1 rhinos km^{-2} be used as the stocking rate for a rhino reintroduction within North Luangwa NP. This low figure was chosen to eliminate any danger that rhinos placed in a fenced area might be over-stocked.
- The ZAWA/FZS NLCP draft plan to reintroduce the black rhino to North Luangwa NP is reviewed in the light of the IUCN/SSC Re-introduction Specialist Group guidelines for reintroductions, and the IUCN/SSC African Rhino Specialist Group/SADC RPRC draft guidelines for rhino reintroductions. The main concern arising from this review is the small number of rhinos to be freed and the absence of a time-table to release additional animals in order to provide an adequate number of founders.
- In collaboration with ZAWA and FZS NLCP, the reintroduction plan is revised, to provide for the release of a total of 20 rhinos into two, adjacent fenced areas and the later removal of the intervening fences to create a single fenced rhino sanctuary, large enough to accommodate 20 founders and their initial offspring.
- The capacity requirements in order for ZAWA to be able to protect, manage and monitor the rhinos are listed.
- Little or nothing is known about the attitudes of local people towards a rhino reintroduction and a preliminary assessment should be conducted through the ZAWA/FZS NLCP informer network. The potential benefits for the local people of a rhino reintroduction are few and the conservation education and community relations programmes of ZAWA/FZS NLCP will probably need to be expanded if the reintroduction programme is to receive support from the local people.
- Kapiri Kamfumu, westwards of Mfuwe Lodge, is proposed as the most suitable site for a future reintroduction of black rhino in South Luangwa National Park. This site was chosen because:
    1. Studies during the early 1980s revealed that rhinos lived there at a density of 0.39 km^{-2} and so the habitat is known to be suitable;
    2. It is within the small proportion of South Luangwa NP that is accessible by vehicle, even during the wet season (an important consideration for protecting the rhinos);
    3. Rhinos were reportedly seen there as recently as 1999;
    4. It is the area recommended by people with decades of experience in South Luangwa NP.

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Numbers and distribution of black rhinos in North Luangwa NP and South Luangwa NP during the 40 years

1960s

During the 1960s, the Luangwa Valley was the stronghold of the black rhino in Zambia (Ansell 1969). Ansell presented his colleagues' estimates of the numbers of rhinos in the North and South sections of the Luangwa Valley Game Reserve (as North Luangwa NP and South Luangwa NP were then known) (Table 1). The limitations of air survey as a method to estimate rhino numbers (Goddard 1967) were acknowledged by Ansell, who believed that Uys's estimate of 400 rhinos in Luangwa Valley (South) Game Reserve was plausible.

Additional information on the relative abundance of black rhinos in North Luangwa NP and South Luangwa NP during the 1960s was provided by Leader-Williams *et al*. (1990), who used patrol reports to calculate the mean number of rhinos seen during a 'standardised' patrol. These figures suggest that, during the period 1947-1966, rhino density was greater in North Luangwa NP than in South Luangwa NP, and was greater in the northern part of South Luangwa NP than in the southern part of South Luangwa NP (Table 2 & Figure 1).

1970s

During 1970-71, Caughley (1973) and his FAO colleagues conducted systematic aerial surveys across North Luangwa NP and South Luangwa NP, flying parallel flight lines 3 km apart. These surveys were designed to record the distribution of elephants, but any rhinos seen were also noted. The distribution maps presented by Caughley (Figures 2 & 3) record only the presence or absence of rhinos in each 10 x 10 km map square, not the actual number seen. The maps could reflect rhino density, or visibility from the air (the latter determined mainly by the density and aerial cover of trees and tall shrubs), or a combination of both factors. Rhinos were observed in all vegetation types and land systems (*sensu* Astle (1969)). The distribution map for South Luangwa NP also suggested that rhino density in southern South Luangwa NP was less than in northern South Luangwa NP (Figure 3).

Table 1. Estimates of the number of black rhinos in the present North Luangwa NP and South Luangwa NP during the 1960s (Ansell (1969). Densities calculated using the approximate areas given by Ansell and assuming that 1 km^2 = 0.386 square miles.

Protected Area	**Estimated number of rhinos (density, in rhinos km^{-2})**			
Ansell's source:	Uys	Allen & Berry	Patton	Dean
Survey method:	Flying over area & ground observation	Ground observation	Air survey	Air survey
Luangwa Valley (North) Game Reserve	150 (0.03)	-	55 (0.01)	41 (0.01)
Luangwa Valley (South) Game Reserve	400 (0.05)	-	70+ (0.01+)	170 (0.02)
Nsefu Game Reserve (now part of SLNP)	-	25 (0.12)	-	-

Figure 1. Map showing North Luangwa NP, South Luangwa NP and the sectors of South Luangwa NP referred to in Table 2 (Leader-Williams *et al*. 1990).

Table 2. The frequency of rhino sightings during patrols in North Luangwa NP and South Luangwa NP during the periods 1947-1966 and 1979-1981 (Leader-Williams *et al.* 1990). The number of sightings were standardised, to take account of the duration of the patrol, the number of people in the patrol, and the month of the year. The figures given by Leader-Williams were for 7-day patrols by 4 people during January.

Area	Frequency of rhino sightings	
	During 1947-1966 (sample size) [a]	During 1979-1982 [years] [b]
West bank of Luangwa River		
North Luangwa NP	10.5 (5)	9 [1980-1981]
South Luangwa NP – north	6.6 (8)	7 [1979]
South Luangwa NP – core	4.5 (7)	4 - 6 [1979-1980]
South Luangwa NP – south	0.7 (8)	2.5 [1980]
East bank of Luangwa River		
South Luangwa NP – Nsefu	-	4.5-6 [1981-1982]

[a] source: Leader-Williams *et al*. (1990, table 2)
[b] source: Leader-Williams *et al*. (1990, figure 5). Numbers are approximate, because they were estimated from this diagram. Years for which estimates apply vary, because poaching caused sighting frequency to decline in all areas during the earlier 1980s.

In surveys designed to count rhinos, 492 km were flown over three northern Game Management Areas (GMAs) in the Luangwa Valley during the early 1970s. The observed density of rhinos was 0.1 km^{-2} (Caughley 1973). Using a correction factor of 4 – obtained from Goddard (1967) – it was suggested that 0.4 rhinos km^{-2} was probably a reasonable approximation of density in the GMAs and could "safely be used as an estimate of density in the parks". Thus, Caughley (1973) estimated that there were around 2800 rhinos in South Luangwa NP. Using the same data, Ansell (1975), who acknowledged that the numbers which he presented earlier (Ansell 1969) were gross underestimates, now estimated that there were 12000 rhinos in the Luangwa Valley (which included North Luangwa NP and South Luangwa NP, as well as GMAs and other National Parks), with an absolute minimum of 4000 rhinos.

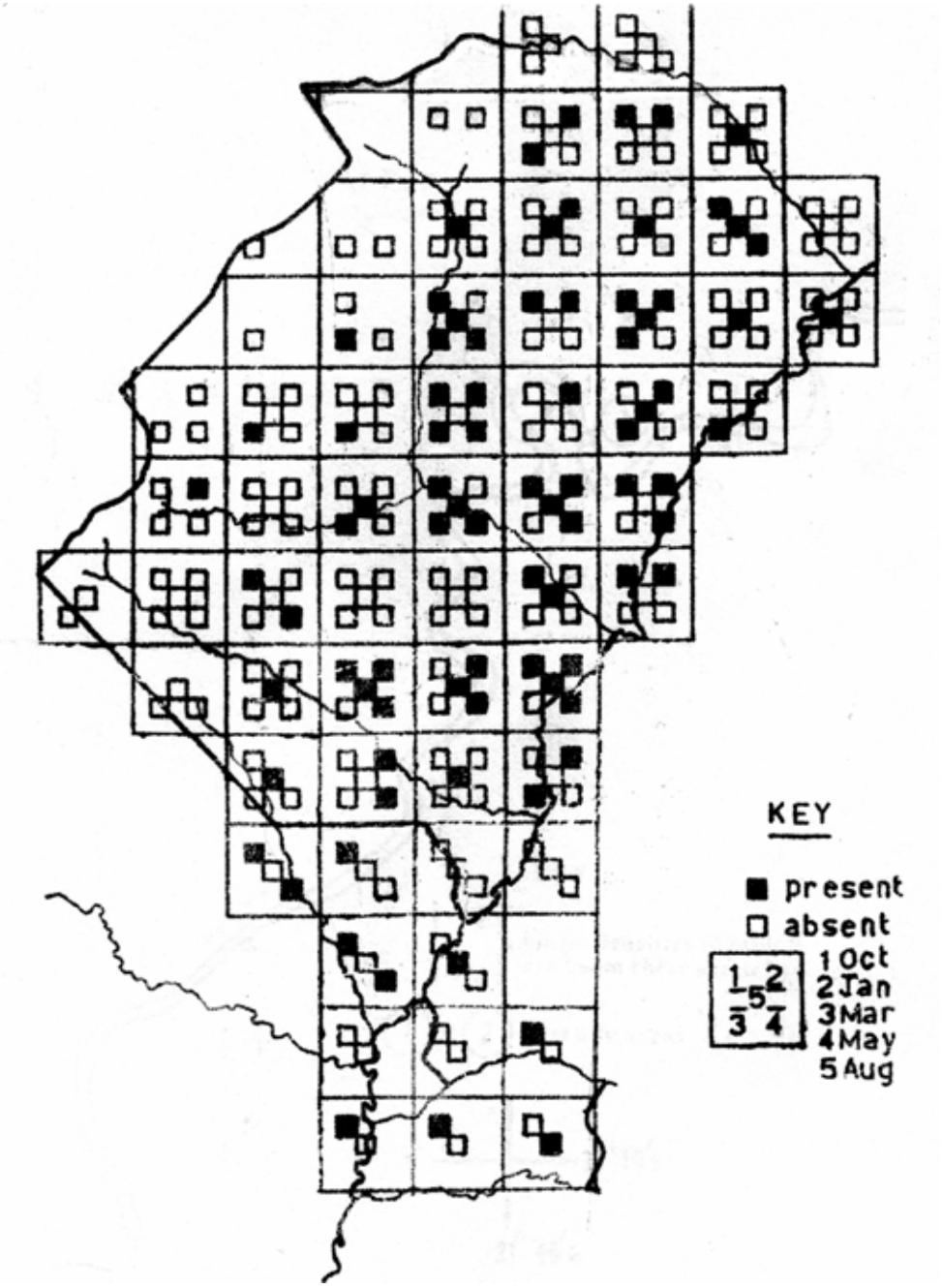

Figure 2. The frequency of sightings of rhinos in 10 x 10 km map squares covering North Luangwa NP during aerial surveys of elephants in 1970-71 (Caughley 1973).

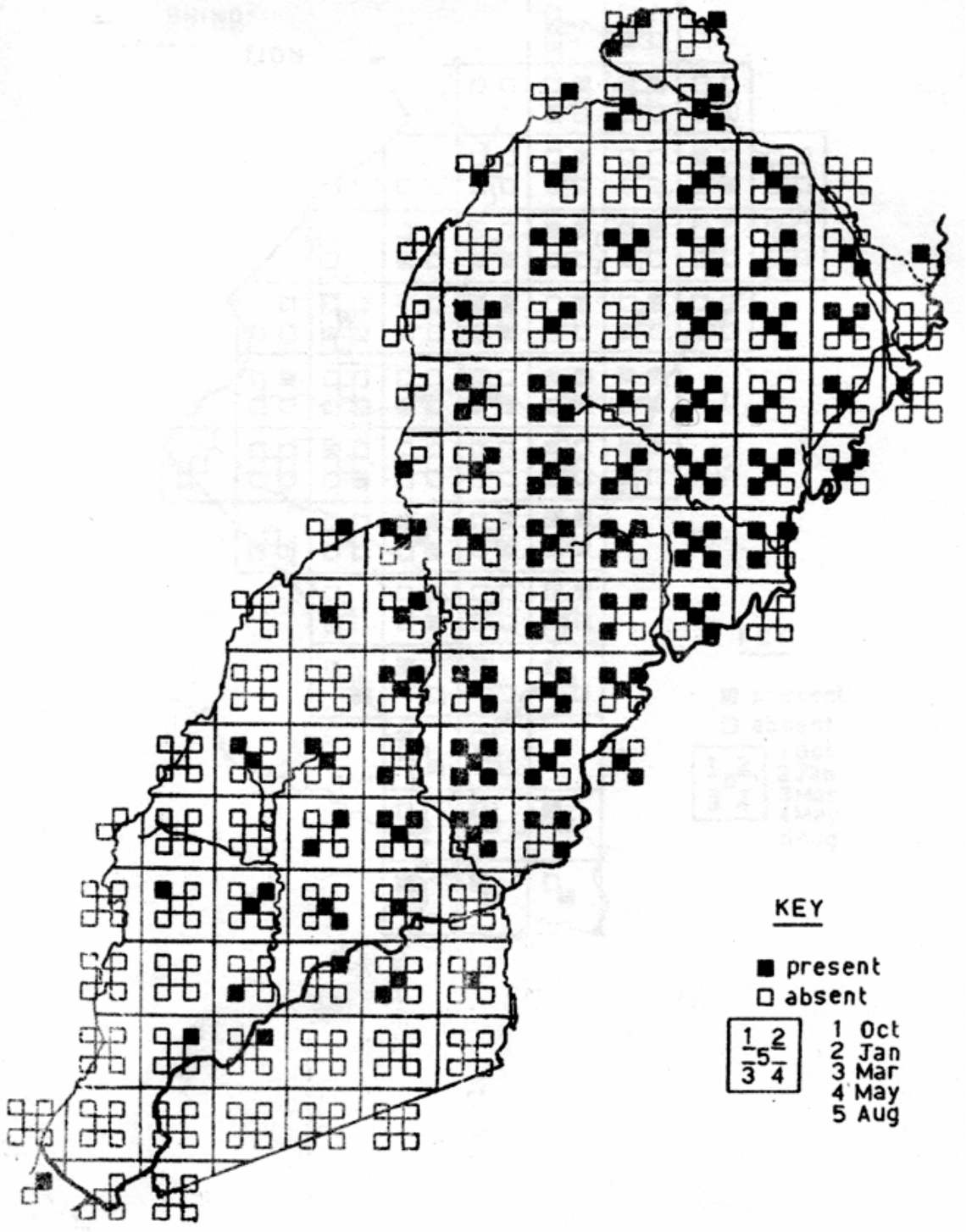

Figure 3. The frequency of sightings of rhinos in 10 x 10 km map squares covering South Luangwa NP during aerial surveys of elephants in 1970-71 (Caughley 1973).

Caughley (1973) also estimated the density of rhinos in seven small study areas that spanned the border between either North Luangwa NP or South Luangwa NP, and neighbouring GMAs. He found that rhino density was usually greater in North Luangwa NP and northern South Luangwa NP than in the adjacent GMAs (Table 3). The same data support the suggestion that rhino density was greater in northern South Luangwa NP than in southern South Luangwa NP.

Table 3. Comparison of rhino density in Luangwa Valley National Parks with the density in adjacent Game Management Areas. Study sites straddled NP/GMA boundaries. Data for early 1970s (Caughley 1973).

	Index of rhino density [a]							
Study site:	1 [b]	2 [b]	3 [c]	4 [c]	5 [c]	6 [d]	7 [d]	Mean
National Park	0	0.27	0.34	0.27	0.17	0	0	0.15
GMA	0	0	0	0	0.25	0	0	0.04

[a] number of rhinos seen on one side of the aircraft (flown at 177 km hour^{-1}, at 91 m above ground level) per 10 km of flight line
[b] National Park sector of study area was North Luangwa NP
[c] National Park sector of study area was northern South Luangwa NP
[d] National Park sector of study area was southern South Luangwa NP

During October 1975, Kuper (1975) used air survey to estimate the number of rhinos in the Luangwa Valley. On the basis of observed numbers, he estimated that there were: 445 (standard error 33 %) rhinos, at a mean density of 0.10 km^{-2}, in North Luangwa NP; and 870 rhinos, also at a mean density of 0.10 km^{-2}, in South Luangwa NP (excluding Nsefu sector). Kuper (1975) suggested that 2 was an appropriate correction factor and so estimated that there were 1740 rhinos in South Luangwa NP (plus a guess of 50 animals in Nsefu sector).

During October 1979, Douglas-Hamilton *et al*. (1979) conducted an aerial census to estimate the numbers of elephants, rhinos and other wildlife in the Luangwa Valley. They flew west-east, parallel flight lines, 10 km apart, counting animals within a 300 m wide strip. The survey area covered 20000 km^2, including North Luangwa NP and South Luangwa NP. On the basis of the rhinos that they counted, they estimated that there were 867 rhinos (with a 95 % confidence interval of 515) in the survey area, at a mean density of 0.043 km^{-2}. But rhinos were not evenly distributed across the survey area. Few rhinos were seen in North Luangwa NP, instead they were found mostly in South Luangwa NP towards the Luangwa River, with the highest density in Nsefu sector. Nsefu sector was subjected to an additional, high-intensity count and, from these data, it was estimated that there were 66 rhinos in this 212 km^2 sector, at a mean density of 0.31 km^{-2}.

Using a correction factor of 2 to account for animals missed by the observers, Douglas-Hamilton *et al*. (1979) then estimated that there were 0.09 rhinos km^{-2}, or 1734 in total, in their 20000 km^2 survey area. They guessed that mean rhino density in the remainder of the Luangwa Valley was 0.01 km^{-2} and then estimated that there were 1250 rhinos in this area. They suggested that the "whole valley could thus contain between 2500 and 3500 rhinos, possibly considerably more". Their estimate was much less than the earlier estimate of 4000-12000.

1980s

During the early 1980s, Leader-Williams *et al*. (1990) used sightings of rhinos by scout patrols to provide indices of rhino densities in various protected areas within the Luangwa Valley (Table 2). These figures are remarkably similar to those for 1947-1966, despite the fact that rhino poaching was common by 1979, when 78 % of rhino skulls found in the Luangwa Valley National Parks were from animals killed by poachers (Leader-Williams 1985a). These data contradicted the claim of Douglas-Hamilton *et al*. (1979) that rhino density was greater in South Luangwa NP than in North Luangwa NP and instead suggested the reverse.

Leader-Williams (1985a, 1988) also used individual recognition (the most accurate method of counting rhinos) to determine that there were 66 adults and 11 calves in a 200 km^2 study area during 1982, at a mean density of 0.39 km^{-2}. This study area was within the South Luangwa NP 'core' area (Figure 1). A less-intensive study in Nsefu sector during the same year estimated that there were at least 37 rhinos there, at a minimum density of 0.17 km^{-2} (Leader-Williams

1985a). Leader-Williams also used the numbers of middens, dungpiles, tracks and scrapes seen per kilometer walked by scout patrols in seven areas of South Luangwa NP as indices of rhino density. These data also suggested that rhino density was greater in northern South Luangwa NP than in southern South Luangwa NP.

Past attempts at rhino conservation in North Luangwa National Park and South Luangwa National Park

After the 1979 aerial survey, Douglas-Hamilton *et al*. (1979) suggested that poaching was probably responsible for the apparent decline in the number of rhinos in the Luangwa Valley since the earlier survey (Caughley 1973). Later, Leader-Williams showed that 78 % of rhino skulls found in the Luangwa Valley during 1979 had signs that showed that the horns had been chopped off, indicating that these animals had not died naturally, but were killed illegally and their horns removed. The percentage of animals killed by poachers may have been greater than this, because animals that were merely wounded by poachers may have died later from their wounds and not had their horns chopped off. Horn removal indicated that the poaching was for commercial trophies, not meat (Jachmann 1998).

In response to this poaching, the then National Parks and Wildlife Service (NPWS) and the World Wildlife Fund established the Save the Rhino Trust (SRT) (Leader-Williams 1985a). SRT established two antipoaching units (APU) during 1979 and 1980: APU 1 was responsible for patrolling in the Luangwa Valley and APU 2 patrolled in the Zambezi Valley (Leader-Williams *et al*. 1990). APU 3 and APU 4 were formed during 1984 and APU 3 was based close to North Luangwa NP and APU 4 was based near the western boundary of South Luangwa NP. The areas patrolled included North Luangwa NP, northern South Luangwa NP, southern South Luangwa NP, South Luangwa NP core area and the Nsefu sector of South Luangwa NP (Figure 1). Leader-Williams *et al*. (1990) monitored the effectiveness of the antipoaching efforts.

Accurate determination of rhino density is difficult and Leader-Williams *et al*. (1990) used the number of rhinos seen by scout patrols as an index of density. The number seen was influenced by the duration of the patrol, the number of scouts and the season, and so the numbers of sightings were standardised, as if they had been made by 4 scouts on a 7-day patrol during January. The instantaneous rate of decline of rhino sightings varied from –0.99 in North Luangwa NP to –0.24 in the South Luangwa NP core area (Figure 4). The rate of decline was greatest in the area with the least patrol effort, and least in the area with the greatest patrol effort (Leader-Williams 1990). This observation, combined with the fact that 67 % of all rhinos found dead in the Luangwa Valley during 1979-1985 had axe marks on the skull (Leader-Williams 1988) provided strong evidence that illegal hunting was the cause of the decline in rhino numbers in the Luangwa Valley during the early 1980s.

As early as 1982, Leader-Williams (1985a) recognised the need either to increase greatly SRT funding, so that patrol effort could be increased across the Luangwa Valley, or, if extra funding was not available, to concentrate antipoaching efforts in relatively small areas with a high density of rhinos. SRT followed this advice and greatly increased patrol effort in the South Luangwa NP core area, but even this increased effort was insufficient to stop this subpopulation declining. Further analysis suggested that poaching could have been prevented in the 400 km^2 South Luangwa NP core area if it had been permanently patrolled by all five APUs, instead of the one or two that were actually there (Leader-Williams 1990).

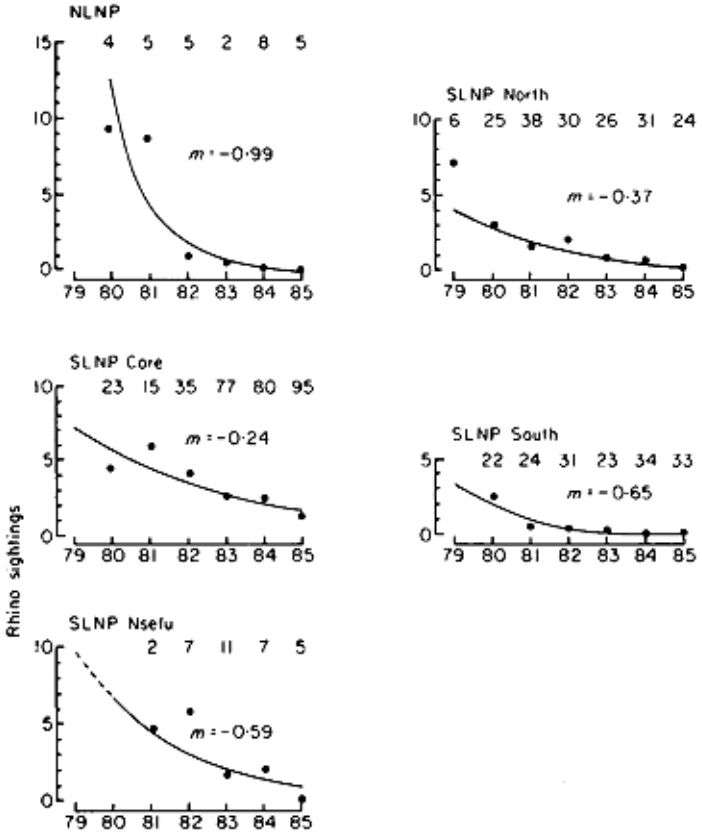

Figure 4. The differing rates of decline of rhino sightings in North Luangwa NP and four sections of South Luangwa NP during 1979-1985 (Leader-Williams *et al*. 1990). Data for 1979 and 1980 were not shown if there were just one or two patrols in an area during these years. The number of sightings were standardised to take account of number of scouts, patrol duration, and season. *m* = instantaneous rate of decline. In all cases, the decline in rhino sightings was due to poaching.

Gangs of poachers in North Luangwa NP and South Luangwa NP comprised about 7-9 men and were armed with automatic weapons, rifles or muzzle-loading guns (Leader-Williams *et al*. 1990). Almost all the poachers caught were Zambians. Most poachers captured in North Luangwa NP were from Chief Chikwanda's area, near Mpika town, to the west of the park, while most poachers caught in South Luangwa NP were from the areas of Chiefs Mpumba, Mailo and Serenje, near the town of Serenje. The towns of Mpika and Serenje are situated on the Great North Road, which runs south-west to north-east, above the Muchinga Escarpment, to the west of the national parks (Figure 5). The 98 people arrested by APU vehicle patrols for the illegal possession of rhino horn or ivory included three game scouts. This suggests that NPWS staff played a minor role in the poaching of rhinos in the Luangwa Valley, a view supported by Phil Berry (pers. comm.).

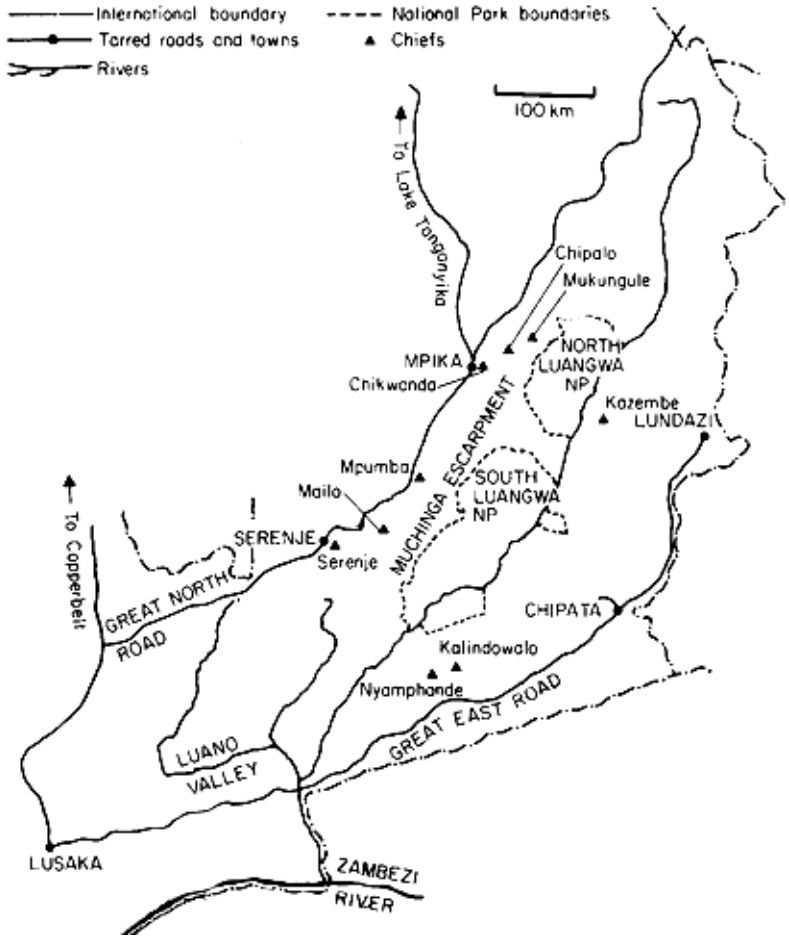

Figure 5. Most poachers caught during the 1980s came from areas near the towns of Mpika and Serenje, along the Great North Road (Leader-Williams *et al*. 1990)

Rhinos appear to have been extinct in North Luangwa NP by 1986, when the North Luangwa NP Conservation Project started. During 1990, it was reported that “no signs whatever of rhinos have been recorded during 3½ years of operation in North Luangwa NP by project personnel” (NLNPCP 1990).

In contrast, a few rhinos appear to have survived in South Luangwa NP into the 1990s. Kimura (2001) compiled game scout recollections of rhino sightings during the 1990s and reported 6 sightings during 1991-1996, most in the vicinity of Kapiri Kamfumu in the area between the Mushilashi and Katete Rivers (Table 4, Figure 6). There was also a report from Fundukutu, in the GMA to the south-east of the Manzi-Luangwa River confluence. Additional to these reports, the scout who accompanied us in the field during our visit to South Luangwa NP reported seeing three rhinos in the Kapiri Kamfumu area during 1999, and a second scout reported seeing the footprints of an adult and youngster (together) between the Mushilashi and Libi Rivers during 1998. This second area is immediately northwards of the Kapiri Kamfumu area. Phil Berry (pers. comm.) believes that some rhinos may still survive in the rugged hill country of the Chisomo GMA, West Petauke GMA and Petauke GMA, to the south-west of South Luangwa NP, and in the Nchindi Hills, some 20 km southwards of Mfuwe.

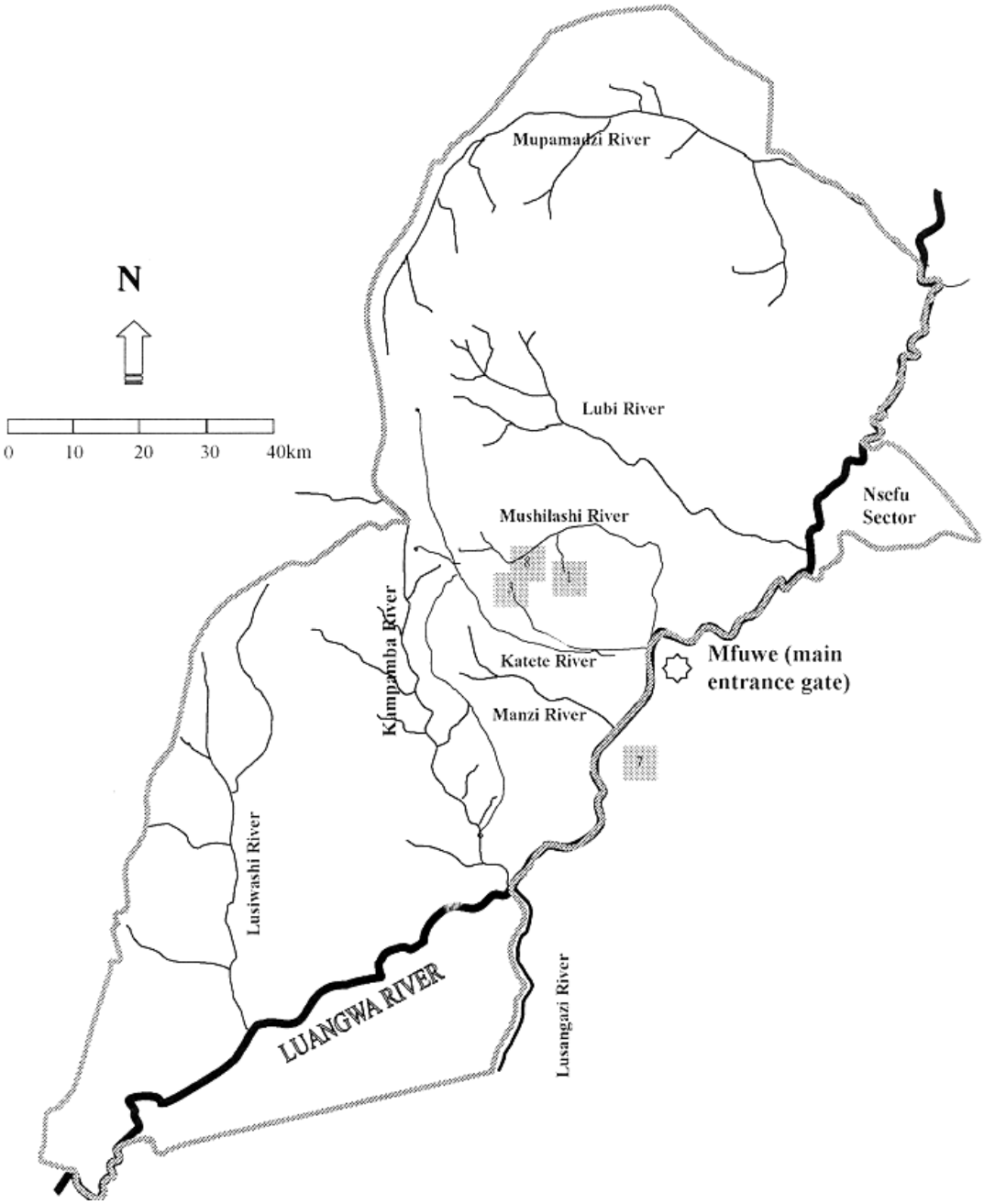

Figure 6. Locations of sightings of rhinos or their tracks by scouts in South Luangwa NP since 1990 (Kimura 2001)

Table 4. Records of rhinos or their tracks reported since 1990 by scouts in South Luangwa NP (Kimura 2001)

Year	Season	Sighting	Location	Location on map
1991	Dry	Animal	Kapiri Kamfumu	1
1991	Dry	Animal	Fundukutu	7
1991	Wet	Tracks	Battle field	3
1992	Dry	Animal	Kapiri Kamfumu	1
1993	Dry	Tracks	Fundukutu	7
1996	Dry	Animal	Mushilashi	8

The North Luangwa Conservation Project

The North Luangwa Conservation Project (NLCP) advises and indirectly assists ZAWA staff in antipoaching work. It provides the scouts with training, uniforms, patrol equipment and patrol rations. It helps to maintain ZAWA staff houses, provides water wells at staff camps and builds schools for the children of staff. NLCP has installed a radio communications system that covers most of North Luangwa NP and assists ZAWA to operate an incentive scheme, which pays financial bonuses to scouts for the capture and conviction of poachers. ZAWA and the NLCP also operate an informer network. As the AfRSG (1999) points out, the operation of intelligence networks is an economical method of preventing poaching and catching poachers.

ZAWA scouts, who are based on the periphery of North Luangwa NP, patrol in the park and the surrounding GMAs. 132 scouts are responsible for patrolling a total area of about 10000 km^2, including North Luangwa NP (4636 km^2). During 2000 and the first half of 2001, the number of patrols per month in North Luangwa NP averaged 9 (range 4 – 13). In these 18 months, only eight elephants were found poached in the park and these represented just 0.4 % of the minimum number of elephants in the park during March 2000 (NLCP 2000). The 38 other animals known to have been poached were killed for meat and included 15 duiker. More than 33 % of the animals known to have been poached in the park were killed during August 2000, when there was a nation-wide upsurge in poaching that coincided with the restructuring of ZAWA. Only five elephants are known to have been killed in the GMAs during the past 18 months, all during 2000. As in the park, most poaching in the GMAs was for meat rather than trophies, with duikers forming 44 % of the 141 animals known to have been killed. Most of the poaching within North Luangwa NP occurred close to the boundaries of the park (Figure 7).

NLCP undertakes small community projects to provide assistance to villages around North Luangwa NP. For example, patrol rations are purchased locally, if possible. During 2000, NLCP initiated visits to North Luangwa NP by children from local schools.

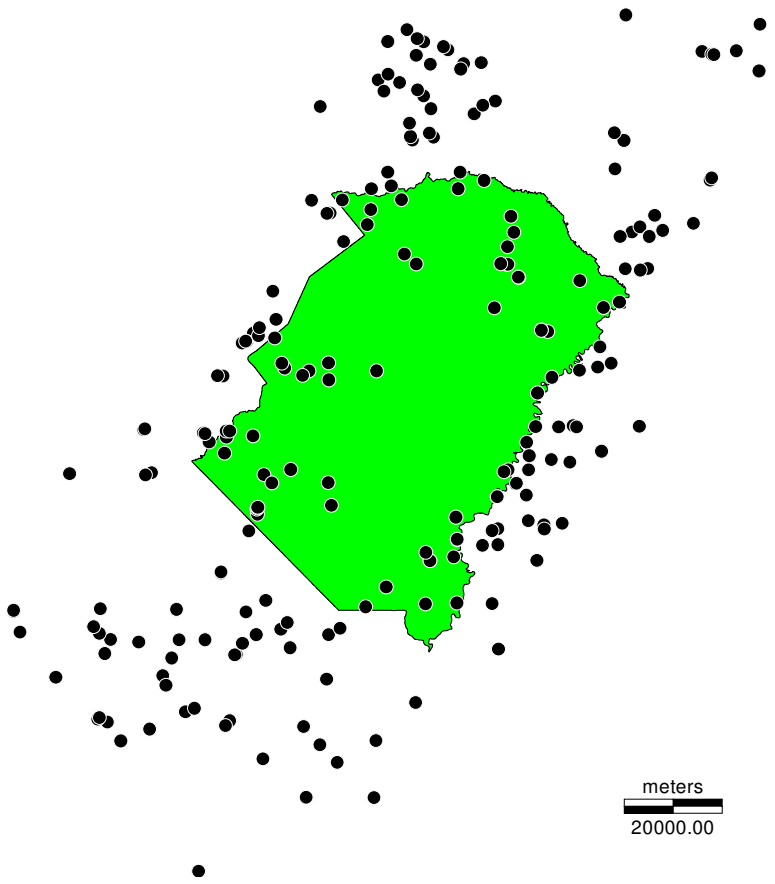

Figure 7. Most poaching incidents detected by scouts patrolling in and around North Luangwa NP occurred in the GMAs or, if in the park, close to the park boundary.

Habitat, food and carrying capacity of rhinos in the Luangwa Valley

Habitat preferences of black rhinos in the Luangwa Valley

During the early 1970s, Liberg (1973) used road strip counts to study the distribution of rhinos and other species in relation to vegetation type in the 'back country' of South Luangwa NP (Table 5). The 'back country' was the region north and west of Mfuwe and was, in essence, the north-west quarter of South Luangwa NP. Liberg noted that "A special habitat preference of the rhino, although not clearly indicated by [the] figures, is the ecotonal zone between *Combretum-Terminalia* and miombo. Almost all the well-known rhino localities which tourists are recommended to see rhino …. are also in that transition zone. The highest density of rhino in this study was found on the road …. that goes through 'lowland miombo', which is an ecotone from miombo to *Combretum-Terminalia*."

Leader-Williams (1985b) radiocollared rhinos in the Kapiri Kamfumu region of South Luangwa NP to determine their home ranges. He noted that the core area of each female's home range included a feature that contained water during October (the end of the dry season) and an area of thicket (riverine, backplains or *Combretum-Terminalia*), while the less-used areas encompassed scrub (mopane, miombo or *Combretum-Terminalia*). Liberg's (1973) data on the density of rhino dung in various vegetation types also illustrated the importance of thickets to rhinos (Table 6).

Diet of black rhinos in the Luangwa Valley

In southern Africa, the plant genera that rank high in the diet of black rhinos are *Acacia*, *Aloe*, *Bauhinia*, *Commiphora*, *Croton*, *Diospyros*, *Diplorhynchus*, *Disperma*, *Euphorbia*, *Vitex*, and the fruits of *Kigelia africana* (Smithers 1983). Genera that are eaten in Namibia, East Africa and Zimbabwe include *Acacia*, *Bauhinia*, *Combretum*, *Cordia*, *Euphorbia* and *Grewia*.

Formal studies of the diet and food preferences of black rhinos in the Luangwa Valley, conducted during the early 1980s in South Luangwa NP, have not been published or reported on (N. Leader-Williams, pers. comm.). A list of some of the plants that rhinos have been observed to eat in the Luangwa Valley was compiled by a former NPWS ranger (P. Berry, pers. comm. to E. van der Westhuizen) (Table 7). As elsewhere in their range, black rhinos in the Luangwa Valley were browsers, eating both forbs and woody plants. Many of the plants on Berry's list are found in the valley riverine vegetation type (Smith 1997).

Table 5. Rhino density in different vegetation types of the north-west quarter of South Luangwa NP during the early and late dry seasons of the early 1970s (Liberg 1973). Density was estimated using road strip counts. Distance is the distance driven within each vegetation type. The area searched stretched for 60 m either side of the road and was calculated as the distance multiplied by 0.12

Liberg's vegetation association	May-June		July-October	
	Distance (km)	Rhino density (km^{-2})	Distance (km)	Rhino density (km^{-2})
Kigelia-Combretum	56.3	0	77.2	0.10
Thicket	90.1	0	93.4	0.09
Combretum-Terminalia & mopane	152.9	0.05	241.1	0.10
Lowland miombo	-	-	334.2	0.22
High ground miombo	424.8	0.08	555.1	0.07
Burned miombo	-	-	424.7	0.08

Table 6. Density of rhino dung in different vegetation types within the north-west of South Luangwa NP during the early 1970s (Liberg 1973)

Vegetation association	Dung density (groups per hectare)
Combretum-Terminalia woodland	5.8
Combretum-Terminalia open woodland	0
Mopane woodland	0
Mopane scrub	0
Open thicket	11.1
Dense thicket	19.0
Miombo woodland	3.2
Miombo intermediate	0
Miombo scrub	2.5
Dambo	0
Drainage line	0
Burned miombo scrub	0
Burned drainage line	0

Table 7. List of some plant species that black rhinos were observed to eat in the Luangwa Valley. List compiled by P. Berry. Vegetation type data from Smith (1997).

Species	Plant part	Vegetation types in which found	Comment
Kigelia africana	Fallen mature fruits	Valley riverine	Often eaten
Combretum fragrans	Leaves	Valley riverine, Miombo, *Combretum-Terminalia*	
Combretum imberbe	Leaves & stems of small saplings	Valley riverine	
Sennia obtusifolia		Valley riverine	
Xeroderris stuhlmannii		Valley riverine	
Baphia obovata		Mixed alluvial thicket, *Combretum-Terminalia* woodland	
Markhamia obtusifolia		Valley & Escarpment riverine, Escarpment miombo, Mixed alluvial thicket, *Combretum* thicket	
Markhamia zanzibarica		Valley riverine, Mixed alluvial thicket, *Combretum* thicket	
Colophospermum mopane	young seedlings	Most	
Feretia aeruginescens	twigs	Termite mounds	
Terminalia sericea	leaves from small bush	Valley riverine, Miombo, *Combretum-Terminalia*	
Diospyros senensis		Valley riverine	
Flueggea virosa		Valley riverine	
Lonchocarpus capassa		Valley riverine	
Polygonum sp.		Valley grasslands	Aquatic plants on surface of lagoons. Eaten extensively.
Chrozophora plicata		?	Perennial herb on clays
Diplorhynchus condylocarpon		Miombo, *Combretum-Terminalia*	

Although the diet of rhinos in East Africa has been studied in detail (e.g. Goddard 1968, 1970), there have been few studies in areas ecologically similar to the Luangwa Valley. In Matusadona NP, in the Zambezi Valley, a plant-based study revealed that *Karromia tettensis*, *Combretum zeyheri*, *C. celastroides*, *Diospyros quiloensis*, *Baphia massaiensis*, *Carphalea pubescens*, *Diplorhynchus condylocarpon*, *Acacia nigrescens*, *Grewia bicolor* and *Colophospermum mopane* were the ten principal species in the rhino diet towards the end of the wet season (T. Woodfine, pers. comm.). At the end of the dry season, the list of the ten principal foods was similar, except that *Catunaregam spinosa* and *Croton gratissimus* replaced *D. condylocarpon* and *G. bicolor*.

M. Coates-Palgrave (unpubl.) visited the midlands area of Zimbabwe and noted the woody plants which reintroduced rhinos ate there. The region has areas of miombo woodland, interspersed with *Combretum-Acacia* woodland, wooded grassland and mopane woodland. The structure of *Combretum apiculatum*, *C. molle*, *C. hereroense* and *Terminalia prunioides* plants had been modified by rhinos bending and breaking branches. Four species of *Acacia*, including *A. gerrardii*, were eaten, as were members of the Euphorbiaceae, including *Flueggea virosa* and *Pseudolachnostylis maprouneifolia*.

Factors influencing rhino distribution in North Luangwa National Park

Smith (1998) compiled a vegetation map of North Luangwa NP (Figure 8), but no map of soil types has been prepared, although Smith does mention the soil types under each vegetation type. The only spatial data available for rhinos in North Luangwa NP is the map of Caughley (1973) who recorded whether or not rhinos were seen in 10x10 km map squares during each of five elephant surveys in 1970-71 (Figure 2). The numbers of rhinos seen in each map square during each survey were not given.

Not all map squares within the park were included in all surveys and those not covered during all five surveys have been eliminated from the analysis that follows. Those map squares which fall predominately outside the park were also eliminated, because no environmental data were available for these squares. The frequency with which one or more rhinos were seen in any map square is likely to reflect both rhino density within that square and the ease with which rhinos could be seen from the air within the vegetation types in that square. All other aspects being equal, rhinos would be easier to see in more open vegetation types.

The spatial distribution of dry season water sources (see Figure 11) was used to calculate, for each 1 x 1 km map square, the distance to the nearest water source. This was undertaken using the routine DISTANCE within the IDRISI GIS (Eastman 2000). Next, the mean distance from dry season water was calculated, for each 10 x 10 km square, as the mean value for the one hundred 1 km^2 squares that fell within it. The frequency of rhino sightings in each 100 km^2 square was negatively correlated with the mean distance from water (Figure 9). In other words, rhinos were seen more often close to permanent water sources, than in places more distant from such water. The greater frequency of rhino sightings, and presumably therefore a greater density of rhinos, close to permanent water sources, probably reflects two factors. Firstly, the importance of water sources as supplies of drinking water and wallows and, secondly, the greater productivity of plants, particularly during the dry season, in areas close to perennial water sources. During the dry season, rhinos prefer to eat plants growing along drainage lines (Emslie & Adcock 1994).

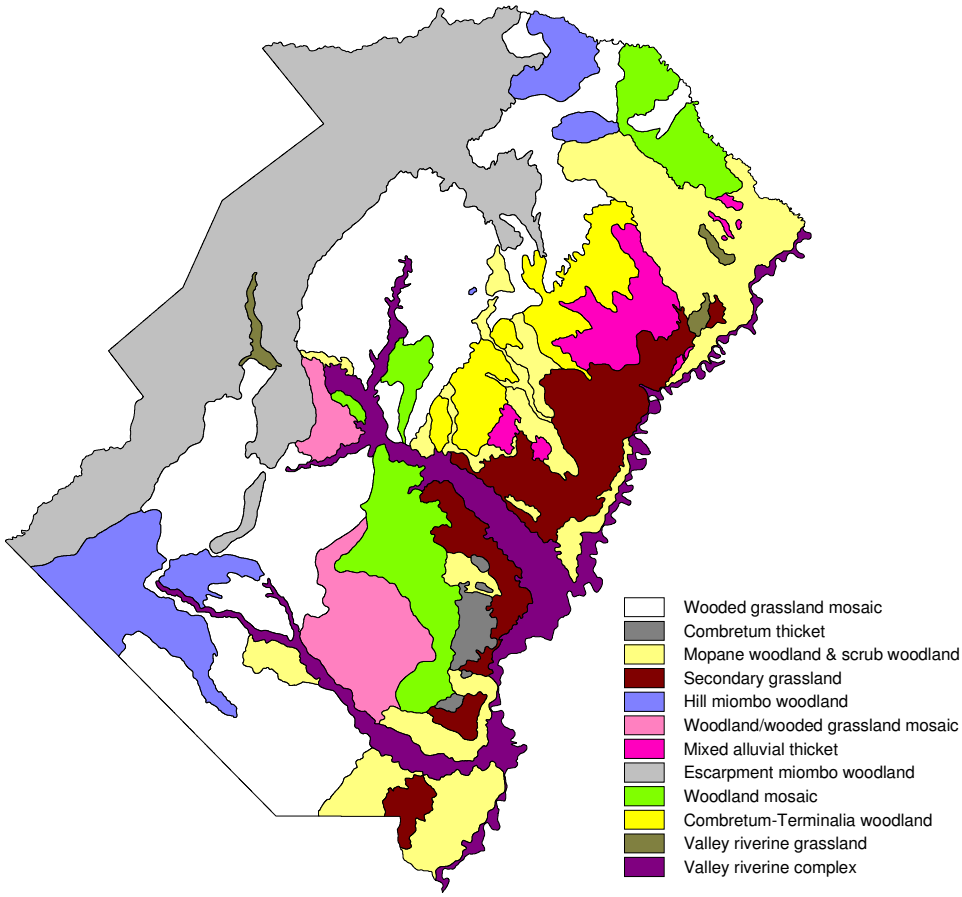

Figure 8. Vegetation of North Luangwa NP (from Smith 1998, provided by E. van der Westhuizen).

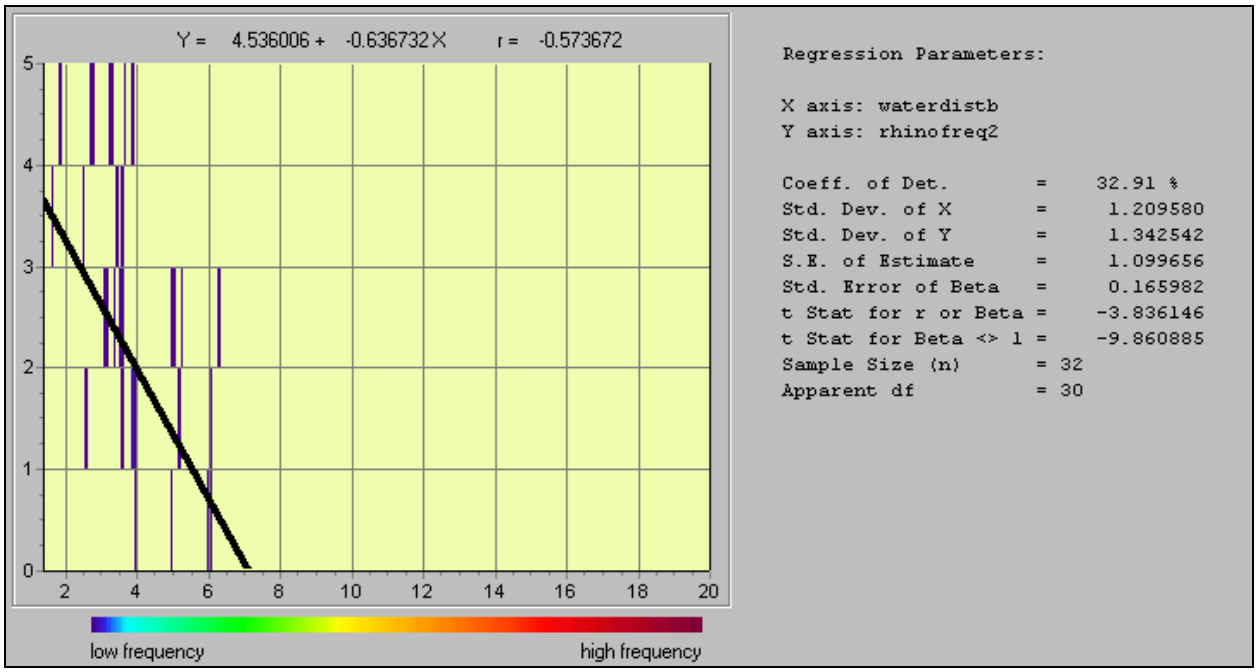

Figure 9. The negative correlation between rhino sighting frequency (*y* axis) and mean distance to dry season water (*x* axis): *r* = - 0.573, n = 32, *P* < 0.01).

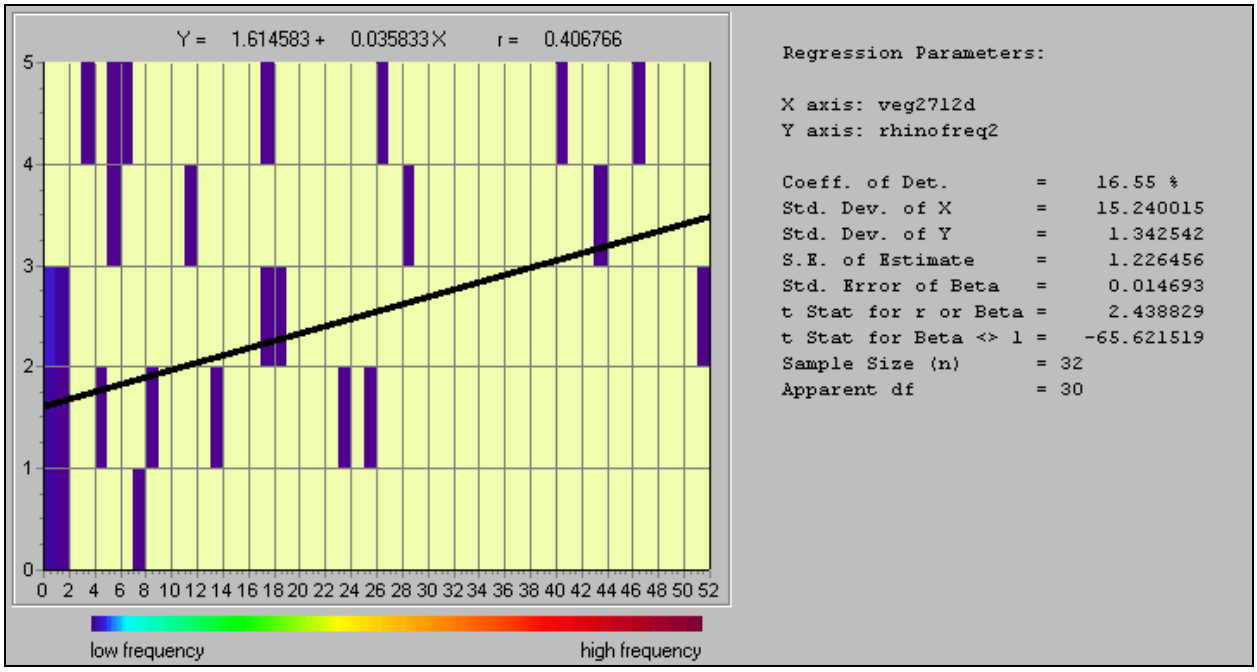

Figure 10. The positive correlation between rhino sighting frequency (*y* axis) and percentage of each 100 km^2 square covered by mixed alluvial thicket, *Combretum* thicket and valley riverine complex (*x* axis): *r* = 0.406, n = 32, *P* < 0.05).

I used the REGRESSION routine in IDRISI also to seek relationships between rhino distribution, as recorded by Caughley (1973), and the vegetation types mapped by Smith (1998). I created a raster image of Smith's vegetation map, using a pixel size of 1 km^2 and then, for each 100 km^2 map square, calculated the area of each vegetation type within that map square. There was a positive correlation (r = 0.365, n = 32) between the number of surveys during which rhinos were seen in a square and the area of thicket (defined here as mixed alluvial thicket or *Combretum* thicket) in that square. This is in line with the observation of Leader-Williams (1985b) of the importance of thicket in the home range of individual rhinos. It also suggests that Caughley's (1973) map (Figure 2) reflected mainly the density distribution of rhinos, and not principally their visibility during air surveys (because the visibility of rhinos would be expected to be lowest in squares with a high proportion of thicket). There was an even stronger correlation between rhino sighting frequency and the combined area of mixed alluvial thicket, *Combretum* thicket and valley riverine complex (Figure 10). The latter vegetation type includes riverine thicket (Smith 1998). The combined area of mixed alluvial thicket, *Combretum* thicket and valley riverine complex in each square was also negatively correlated with the mean distance to permanent water (r = - 0.373, n = 32). In other words, there was more thicket and riverine in squares close to permanent water. Because of this latter correlation, including both distance to water and the area of thicket and riverine in a multiple regression to predict rhino sighting frequency did not increase the proportion of the variance explained, compared with the area of thicket and riverine alone (for area of thicket and riverine, R^2_{adj} = 0.165; for area of thicket and riverine, and distance to permanent water, R^2_{adj} = 0.167).

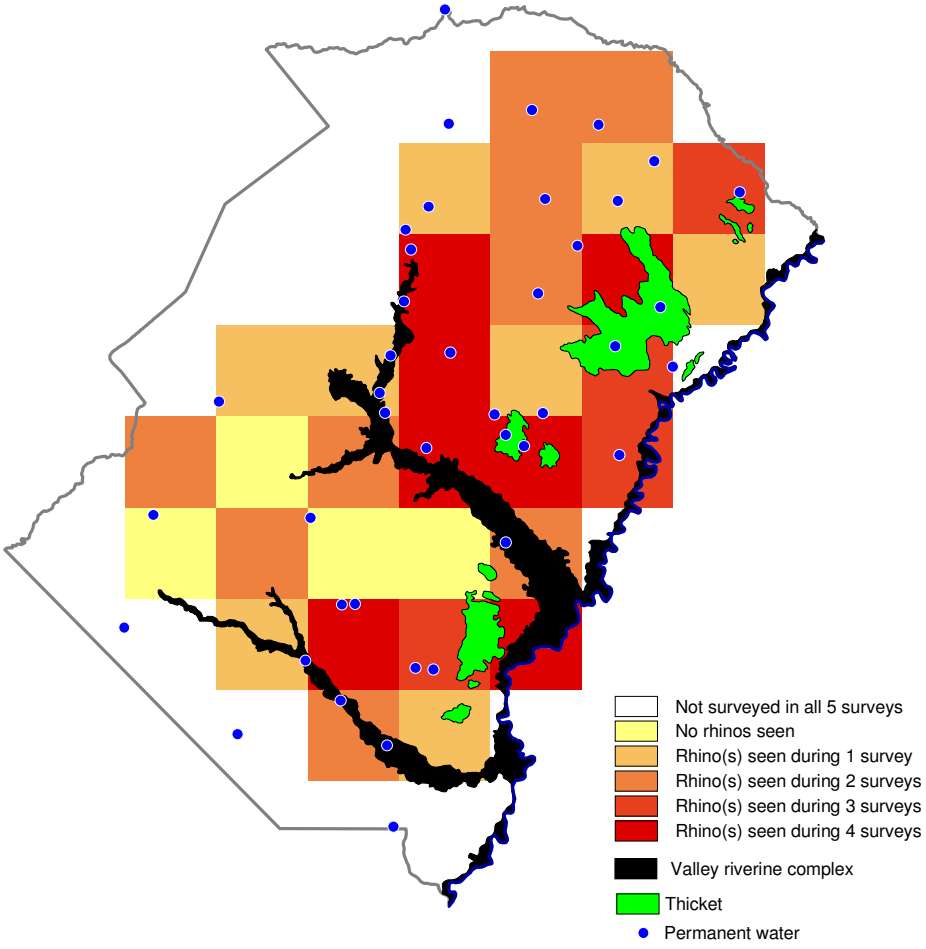

Figure 11. Frequency with which one or more rhinos were seen in 10x10 km map squares in North Luangwa NP during elephant surveys in 1970-71 (Caughley 1973) in relation to mixed alluvial and *Combretum* thickets, valley riverine vegetation and permanent water sources during 2000 (blue dots and Luangwa River). Locations of permanent water sources provided by H. & E. van der Westhuizen.

Carrying capacity

RMG carrying capacity model

With the assistance of NLCP and ZAWA staff, I attempted to calculate the rhino carrying capacity for a small area in North Luangwa NP using the RMG black rhino carrying capacity model (Adcock 2001). This was done knowing that North Luangwa NP falls outside the region (South Africa and Namibia) which was used to provide the data with which that model was constructed. A day was spent conducting vegetation assessments in the area proposed, in the ZAWA/FZS NLCP rhino reintroduction plan (ZAWA/FZS NLCP 2001), as a fenced rhino sanctuary. The areas of the different vegetation types within the proposed sanctuary were calculated with reasonable accuracy, using a digitised version of Smith's (1998) vegetation map and a GIS. Soil data also came from Smith (1998), with soil fertility assumed to be negatively related to the proportion of sand in the topsoil. Five years of rainfall data were available for North Luangwa NP, but no temperature data were available.

When these data, or conservative 'guesstimates' when data were unavailable, were entered into the model, the model predicted a unbelievably high carrying capacity (>4 rhinos km^{-2} for the

proposed sanctuary). In the model, the predicted carrying capacity is the mean of four values, each derived from a different multiple regression equation. The predictions of the four equations varied widely (from about 1 to >8 km^{-2}). A sensitivity analysis then revealed that 'rainfall concentration' (a measure of the variability of mean monthly rainfall during the year and positively related to the duration of the dry season) was having a major impact on the predicted carrying capacity. Rainfall concentration in North Luangwa NP (0.38) was greater than that at any of the 15 sites where data were collected to construct the model. Some of the regression equations gave much greater weight to rainfall concentration than other equations, hence the wide range of values for predicted carrying capacity from the four equations. But all four equations predicted that carrying capacity would rise with an increase in rainfall concentration, which is contrary to the relationship that would be expected between carrying capacity and the duration of the dry season.

At this point, it was concluded that:

1. the model would not be useful for predicting the carrying capacity of black rhinos in North Luangwa NP, or any part of it;
2. the inclusion of rainfall concentration in the multiple regression equations used by this model to predict carrying capacity was not justified biologically (at least so long as the regression coefficient for rainfall concentration was positive), nor scientifically (*P* values for inclusion of rainfall concentration in the four equations varied from 0.09 to 0.5 (Adcock 2001)).

Rhino densities in North Luangwa NP before poaching

The incidence of rhino poaching in the Luangwa Valley increased rapidly during the 1970s (Douglas-Hamilton *et al*. 1979). Prior to the mid-1970s, poaching probably had little effect on the density of rhinos in North Luangwa NP. During 1975, Kuper (1975) observed 0.10 rhinos km^{-2} in North Luangwa NP during an aerial survey. But aerial survey is a very inefficient method of counting rhinos (Goddard 1967) and so 0.1 rhinos km^{-2} should be regarded as the minimum density. The only other pre-poaching density estimates available for North Luangwa NP are for two small areas just inside the park boundary (Table 3, study sites 1 and 2), where Caughley (1973) derived, from air survey, estimates of 0 and 0.27 rhinos km^{-2}. Overlooking the sample size of only 2, the mean density (0.13 km^{-2}) was very similar to Kuper's (1975) estimate.

No other density estimates are available for North Luangwa NP, but density indices are available in the form of the number of rhinos seen by patrols in North Luangwa NP and various sections of South Luangwa NP (Table 2). Data for 1947-1966 and 1979-80 are remarkably consistent in their predictions of the relative density of rhinos in the different areas and suggest that the density of rhinos in North Luangwa NP was 1.5-2 times greater than in the core area or Nsefu section of South Luangwa NP. During 1981-82, rhino density was 0.39 km^{-2} in the core area and at least 0.17 km^{-2} in Nsefu (Leader-Williams 1985a). During 1979, after an intensive aerial survey of the Nsefu area, Douglas Hamilton *et al*. (1979) estimated the mean density there as 0.3 km^{-2}. It seems likely that the mean density of rhinos in North Luangwa NP before extensive poaching occurred was >0.3 km^{-2}.

Little is known about the distribution of rhinos within North Luangwa NP, but Caughley's (1973) study suggested that rhinos were relatively uncommon in the escarpment miombo woodlands, in the west of the park above the Muchinga Escarpment. This is in agreement with observations on the frequency of rhino sightings and dung in various habitats, including 'high ground' miombo woodland, in the north-west of South Luangwa NP (Liberg 1973), and with air survey observations in the miombo woodlands of the Zambezi escarpment in Zimbabwe (pers. obs.). Liberg's (1973) mean estimate of rhino density in the escarpment miombo (0.077 km^{-2}, based on road strip counts with a narrow strip width and driving 1404 km (Table 5)), is probably close to the real density. Liberg's observations suggested that rhino density in escarpment miombo woodland did not vary between the early dry season and the late dry season, nor was it influenced by the vegetation being burnt.

Liberg's (1973) estimates of rhino density in other vegetation types were based on much shorter stretches of road and may be less reliable. Liberg specially mentioned the high density of rhinos in the ecotonal zone between *Combretum-Terminalia* and miombo. In North Luangwa NP, the areas that Smith (1998) mapped as 'woodland mosaic' (Figure 8) are mosaics of hill miombo (lowland miombo in Liberg's terminology) and *Combretum-Terminalia* woodland. Species found in the hill miombo that rhinos would be expected to eat include *Diplorhynchus condylocarpon* (found on 83 % of transects; mean density 238 plants ha^{-1}), *Pseudolachnostylis maprouneifolia* (34 % of transects; 103 plants ha^{-1}), *Bauhinia petersiana*, *Bridelia cathartica*, *Ximenia caffra* and *Ziziphus mauritania* (data of P. Smith, supplied by H. & E. van der Westhuizen). *Combretum-Terminalia* woodland includes *Pseudolachnostylis maprouneifolia* (76 % of transects; 139 plants ha^{-1}), *Diplorhynchus condylocarpon* (36 % of transects), *Antidesma venosum*, *Bauhinia petersiana*, *Bridelia cathartica* and *Euphorbia matabelensis*. Plants of the family Euphorbiaceae are often favoured by black rhinos (Emslie & Adcock 1994) and of the 43 species of this family that occur in North Luangwa NP, 15 occur in either the hill miombo, or the *Combretum-Terminalia* woodland, or both (Smith 1998).

A well-developed grass layer is present in both hill miombo and *Combretum-Terminalia* woodland. Grass fires during the dry season are common if ignition sources, e.g. poachers or park managers, are present. Grass fires often kill the above-ground parts of small woody plants, prompting these plants to grow new shoots from ground-level. But even before this new growth appears, rhinos often eat burnt plants (Emslie & Adcock 1994). Sometimes, tall grass may reduce habitat suitability for rhinos (Emslie & Adcock 1994) and one advantage of fires is that they temporarily remove the grass layer. Regular fires prevent small woody plants growing taller than the reach of a rhino. The elimination of grass fires for a significant period can allow short woody plants, favoured by rhinos, to grow tall and beyond their reach. This is believed to be the reason for a decline in rhino numbers in Hluhluwe Game Reserve, South Africa (Emslie & Adcock 1994).

No attempt is made here to estimate the carrying capacity of the differing vegetation types within North Luangwa NP, because it is not likely that the carrying capacity within a large area is simply the sum of the carrying capacity for individual patches of vegetation. Leader-Williams (1985b) pointed out that female rhinos in his study area had home ranges that included thicket (presumably as places to shelter and keep cool during the heat of the day (Emslie & Adcock 1994)) and a permanent water source. Thus, the carrying capacity of an area for rhinos is likely to be determined not simply by the proportion of the area that is covered by waterholes, thickets and vegetation types that contain preferred foods, but also by the spatial distribution pattern of these resources. In a similar vein, Adcock (2001) has emphasised the importance that the spatial distribution of permanent water sources has on the carrying capacity of dominant male rhinos.

Both elephants and giraffe, despite their height, often feed on low woody plants and are potential competitors with rhinos, but giraffe are very rarely seen in North Luangwa NP and the number of elephants in the park has declined markedly since the 1970s, as a result of poaching. Thus, neither elephants nor giraffes are likely to endanger a reintroduction of black rhinos by competing with the rhinos for food.

Frost can have a major impact on food availability for browsers (by killing small woody stems over large areas, thereby reducing the browsers' food supply until the plants have had time to grow new stems), but frost is absent from the Luangwa Valley.

Vegetation in the rhino sanctuary proposed in the ZAWA/FZS NLCP reintroduction plan

The vegetation within the rhino sanctuary proposed in the ZAWA/FZS NLCP reintroduction plan (2001) was assessed, in co-operation with NLCP and ZAWA staff, following the guidelines of Adcock (2001). At 15 sites, the availability of browse <2 m tall was noted, together with the approximate species composition of this browse (Tables 8 & 9). In both wooded grassland and the riverine areas, browse availability was generally low, but suitability was high.

Table 8. List of plants encountered during vegetation assessment in the area of the sanctuary proposed in the ZAWA/FZS NLCP reintroduction plan, and their division into species regarded as suitable and unsuitable as rhino food (on the basis of feeding studies or reviews by Emslie & Adcock (1994), Smithers (1983), T. Woodfine (pers. comm.) and Coates-Palgrave (unpubl.).

Species regarded as 'good' food	Species regarded as 'poor' food
Diplorhynchus condylocarpon	*Combretum obovatum*
Pseudolachnostylis maprouneifolia	*Brachystegia* spp.
Combretum fragrans	*Colophospermum mopane*
Combretum zeyheri	
Combretum imberbe	
Combretum apiculatum	
Dichrostachys cinerea	*Terminalia* spp.
Commiphora sp.	*Ozoroa* sp.
Diospyros kirkii	*Hyphaene* sp.
Diospyros senensis	
Bauhinia sp.	
Acacia hockii	
Acacia gerrardii	
Acacia sieberiana	
Indigofera sp.	
Grewia spp.	
Catunaregam spinosa	
Ziziphus sp.	
Baphia sp.	
Lonchocarpus capassa	
Kigelia africana	
Trichilia emetica	
Flueggea virosa	
Xeroderris stuhlmannii	
'Forbs'	

Table 9. Estimates of browse availability and suitability as food for black rhinos in the area of the sanctuary proposed in the ZAWA/FZS NLCP reintroduction plan

Vegetation type	Percentage of proposed sanctuary covered by vegetation type	Number of sites	Mean browse availability (% aerial cover of browse <2 m tall)	Mean browse suitability (%)
Wooded grassland	31.4	6	27	79
Woodland mosaic	51.4	4	49	39
Valley riverine complex	17.2	5	28	72

Vegetation monitoring in proposed rhino sanctuaries

Black rhinos at densities between 1.3 and 5.2 km^{-2} in Addo NP, South Africa, transformed dense shrub thicket into open dwarf shrubs (Hall-Martin *et al*. 1982, cited by Owen-Smith 1988). But generally, the density of black rhinos is too low for them to impact vegetation as severely as other megaherbivore species, which often live at greater densities (Owen-Smith 1988).

Euphorbia spp. plants are favoured by rhinos and reintroduced populations of rhinos can have a dramatic effect on populations of *Euphorbia* trees. In Sebakwe Recreational Park, Zimbabwe, reintroduced black rhinos pushed over *Euphorbia* trees, killing many plants (pers. obs.) and later the same thing happened after rhinos were released in Liwonde NP, Malawi (Bhima & Dudley 1996). No *Euphorbia* trees are included in the North Luangwa NP plant checklist (Smith 1997), but the planned enclosure includes a large *Euphorbia* species that is probably *Euphorbia candelabrum*, which occurs in South Luangwa NP (Astle *et al*. 1997). Some individuals of this tree *Euphorbia* were relatively small (about 2 m tall and 10-15 cm diameter at chest height) and one could speculate that these are young individuals that have had a chance to grow into the intermediate height classes since rhinos were eliminated from North Luangwa NP.

Although rhinos may have a dramatic effect on *Euphorbia* trees in the proposed sanctuary, tree Euphorbias and black rhinos did coexist in North Luangwa NP until about 20 years ago and so presumably could coexist there after rhinos were reintroduced to the park. Vegetation monitoring in the sanctuary should perhaps concentrate on using plant-based methods to record the rhino diet, and the effects of rhinos on vulnerable species, such as the tree Euphorbias. Emslie & Adcock (1994) suggested that if regular monitoring revealed that normally "unpalatable" species were forming an increasing proportion of the rhino diet during the wet season, this might be a sign that the sanctuary was overstocked.

The effects of fire, or the absence of fire, on the availability of browse for rhinos should also be monitored.

Evaluation of the current plan by ZAWA and FZS NLCP to reintroduce a small population of black rhinos to a defined area of North Luangwa National Park

The current plan (ZAWA/FZS NLCP 2001) – which is in draft form - is evaluated using established criteria for reintroductions generally (IUCN 1998) and rhino reintroductions in particular (AfRSG/SADC RPRC 2001). The IUCN guidelines considered here are those for Pre-Project Activities, and the Planning, Preparation and Release Stages. Those for Post-release Activities are not considered in detail at this early stage in the programme.

Pre-project activities: Biological

1. Feasibility study and background research

IUCN guideline: Individuals to be released should preferably be of the same subspecies as those that were extirpated.

AfRSG/SADC guideline: Founders to be from more than one source population of the same subspecies

Comment: The current plan proposes the release of black rhinos of the subspecies *Diceros bicornis bicornis*. The subspecies that used to occur in North Luangwa NP was *D. b. minor*, the south-central black rhino (Emslie & Brooks 1999). However, the reference in the plan to *D. b. bicornis* was an error and there was no intention to release any

animals other than those belonging to the subspecies that used to occur in the Luangwa Valley (H. & E. van der Westhuizen, pers. comm.).

IUCN guideline: Detailed studies should be made of the status and biology of wild populations to determine the species' critical needs.

Comment: The results of such studies are summarised by Emslie & Brooks (1999). No additional studies are proposed in the plan and none are needed before reintroducing black rhinos to North Luangwa NP.

IUCN guideline: The species, if any, that has filled the void created by the loss of the species concerned should be determined: an understanding of the effect the reintroduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population.

Comment: It appears that no species has filled the void created by elimination of the black rhino from North Luangwa NP. Both elephant and giraffe may compete for food with black rhinos, but the number of elephants in North Luangwa NP has declined greatly, as a result of poaching, since rhinos were eliminated, and giraffe are very rare in North Luangwa NP (H. & E. van der Westhuizen, pers. comm.). If elephants and rhinos do compete for food, then the reduction in the elephant number will be beneficial to rhinos.

IUCN guideline: The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the number of years necessary to promote establishment of a viable population.

AfRSG/SADC guideline: Each population should be established with 20 or more effective founders and the sex ratio of the founder group should be as close to parity as possible. Where there are plans to release just a few animals initially, there should be a clear plan to introduce the additional founders, up to the target of 20 or more.

Comment: The plan proposes the initial release of two individuals, but provides no definite plan to release additional animals, nor the time scale for this. The absence of a timetable leading to the release of sufficient founders to create a viable population is the plan's major fault. There is no mention in the plan of the sex ratio of the founder population, although the first two animals to be released would be a male and a female. The suggestion by IUCN that the released population should be modelled is probably superseded by the AfRSG/SADC guidelines, which are based on extensive experience of rhino reintroductions.

IUCN guideline: A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term management.

AfRSG/SADC guidelines: Each population should be established with 20 or more effective founders. For purposes of genetic management, there should be periodic exchange of effective breeders between populations of the same subspecies. Rapid rates of population growth should be maintained.

Comment: Long-term management of the reintroduced population is not addressed by the plan, other than from the aspect of security of the rhinos.

2. Previous reintroductions

IUCN guideline: Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing the re-introduction protocol.

Comment: One of the two FZS Technical Advisors in North Luangwa NP has experience of the black rhino reintroduction in Malawi (H. van der Westhuizen, pers. comm.). Furthermore, although the plan does not refer to any experts, the FZS NLCP has been in contact with, for example, a veterinarian with rhino experience and the SADC RPRC co-ordinator (H. & E. van der Westhuizen, pers. comm.).

3. Choice of release site and type

IUCN guideline: The reintroduction site should be within the historic range of the species. For a reintroduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. A re-introduction may have to be made into an area which is fenced , but it should be within the species' former natural habitat and range.

Comment: North Luangwa NP is within the historic range of the black rhino (Ansell 1969) and, as far as is known, does not contain any remnant population (NLNPCP 1990, H. & E. van der Westhuizen, pers. comm.). The plan proposes the release of rhinos into a fenced area that is within the species' former habitat and range (Caughley 1973).

IUCN guideline: The reintroduction area should have assured, long-term protection.

Comment: The proposed reintroduction site is in North Luangwa NP which, by virtue of its legal status as a National Park, will remain, for the foreseeable future, a place where conservation is the major form of land-use.

4. Evaluation of reintroduction site

IUCN guideline: Re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the foreseeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/political or cultural environment since the species' extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.

AfRSG/SADC guidelines: Each population should be established in an area with a carrying capacity of at least 100 rhinos.

Comment: The site chosen for a rhino sanctuary within North Luangwa NP (i.e. south of Marula Puku Camp) appears to meet the habitat and landscape requirements of rhinos (principally food, drinking water and cover). Although surface flow along the Lubonga River, which runs through the proposed sanctuary, ceases during the late dry season, pools of water remain in the river bed and will provide drinking water. Rhinos were seen here frequently during air surveys in the early 1970s (Caughley 1973) and the analysis presented in this report suggests that sighting frequency reflected primarily rhino density and not simply visibility to aerial observers.

There is no evidence of habitat change within North Luangwa NP since rhinos were extirpated. Some areas that were mopane woodland during 1965 are now grassland (Smith 1998), but these changes probably occurred when elephant numbers were high and before rhinos were eliminated. Elephants can be a major cause of habitat change in African wildlife areas, but the number of elephants in the Luangwa Valley has declined dramatically during the past 20 years (Jachmann 1998). Fire, or its absence, is another factor that can cause significant habitat change. A recent

decline in the incidence of fires within North Luangwa NP (as a result of more efficient law-enforcement) could have important consequences for rhino conservation, if fire removal allows woody plants, previously kept short and within the reach of rhinos by regular fires, to grow tall, with most or all of their foliage beyond rhino reach.

Changes in the legal/political/cultural environment have not been fully explored, but the apparent reduction in poaching pressure on rhino populations elsewhere in the SADC region during the late 1990s probably reflects one such change. The administrative transformation of the department responsible for Zambian national parks from the NPWS into ZAWA is another such change, but it is probably still too early to judge the consequences of this.

The best evidence that North Luangwa NP has a carrying capacity of >100 rhinos comes from the October 1975 air survey (Kuper 1975). On the basis of the observed rhinos, Kuper estimated that there were 445 rhinos in North Luangwa NP, at an average density of 0.10 km^{-2}. Given the difficulty of counting rhinos from the air (Goddard 1967), it is likely that the actual number of rhinos in North Luangwa NP – at a time before numbers were severely depleted by poaching – was several times this estimate.

The sanctuary proposed in the plan is about 50 km^2 and is probably too small to support a founder population and their offspring over the next decade.

IUCN guideline: Identification and elimination, or reduction to a sufficient level, of previous causes of decline.

Comment: Illegal hunting for commercial trophies was the cause of the elimination of black rhinos from the North Luangwa NP (Leader-Williams *et al*. 1990). Both rhinos and elephants were poached. Since rhinos were eliminated, law-enforcement efforts have intensified and the number of elephants poached annually has declined. Just eight elephants are known to have been poached in North Luangwa NP and the surrounding GMAs during 2000. Most poached animals were killed for meat. The plan proposes that a special unit of ZAWA staff will be trained and equipped by FZS NLCP to provide security for the reintroduced rhinos. The sanctuary is in the centre of North Luangwa NP, furthest away from potential poachers crossing the park boundary, will be accessible by vehicle year-round and close to NLCP headquarters.

5. Availability of suitable release stock

IUCN guideline: It is desirable that source animals come from wild populations, which ideally should be closely related genetically to the original native stock and show similar ecological characteristics.

Comment: The two potential founders that are already available are wild individuals.

IUCN guideline: Removal of individuals for reintroduction must not endanger the wild source stock. Stock availability must be guaranteed to meet the project protocol. Individuals should be removed from a wild population only after the effects of translocation on the donor population has been assessed and it is guaranteed that these effects will not be negative.

Comment: Only two founders have been identified for this reintroduction so far. The reintroduction will not proceed if source stocks are threatened by the removal of some of their animals for transfer to North Luangwa NP.

IUCN guidelines: Prospective release stock must be subjected to a thorough veterinary screening process before shipment from original source. Animals infected with or positive for non-

endemic or contagious pathogens with a potential impact on population levels should not be shipped. The uninfected, negative remainder to be quarantined and retested before shipment. Stock must meet health regulations prescribed by the veterinary authorities of the recipient country. Adequate provision for quarantine if necessary. Minimise risk of infection during shipment.

Comment: All rhinos intended for shipment to North Luangwa NP would be placed in quarantine bomas at their capture site for at least three weeks, in order to meet Zambian veterinary regulations. The animals would be tested for contagious pathogens while they were in these bomas. They would be flown to North Luangwa NP and would be out of contact with other livestock during this relatively brief journey. Thus, the risk of infection during shipment would be minimised.

Pre-project activities: Socio-economic and legal requirements

IUCN guideline: Reintroductions are generally long-term projects that require the commitment of long-term financial and political support.

Comment: The reintroduction has the support of the Zambian Wildlife Authority and therefore the political support of the Government of Zambia. During 1998, Frankfurt Zoological Society (FZS) signed an agreement with the government, whereby FZS pledged their support for the conservation and management of North Luangwa NP and the surrounding GMAs for a further decade. Two Technical Advisors employed by FZS are based full-time in North Luangwa NP. During 2000, FZS's financial support for the NLCP totalled DM 591 637 (about US$ 264 000 at current exchange rates). This support from an overseas NGO helped cushion the ZAWA staff in North Luangwa NP from some of the effects of the reorganisation of NPWS and the formation of ZAWA. But ZAWA staff had not been paid for about three months prior to my visit.

IUCN guideline: Socio-economic studies should be made to assess impacts, costs and benefits of the reintroduction to local people.

Comment: No such studies have been carried out, but the release of rhinos into a fenced sanctuary near the centre of North Luangwa NP is very unlikely to have any negative impact on the nearest people, who are those living in the GMAs that surround North Luangwa NP. There is a very slight chance that a rhino that escaped from the sanctuary might move as far as the park boundary, into the GMA and injure people or damage crops there. The benefits to the local people from a reintroduction of black rhino would probably be limited, but increased tourism in North Luangwa NP and possibly therefore increased job opportunities for local people may result.

IUCN guideline: A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long-term protection of the reintroduced population, especially if the species' decline was due to human factors. The programme should be fully understood, accepted and supported by local communities.

Comment: No assessment has been carried out. Some local people were involved in the illegal commercial trophy hunting of rhinos and elephants during the 1980s and even today some are involved in illegal meat hunting. Recently, there has been very little trophy hunting of elephants, presumably a reflection of a greatly-reduced international demand for ivory. Elsewhere, in neighbouring SADC countries, the poaching pressure experienced in protected areas that contain rhinos is much less that the poaching pressure that they experienced during the 1980s. Presumably, this also reflects a reduction in international demand, for rhino horn.

NLCP has initiated a number of community projects in the GMAs around North Luangwa NP, in order to generate goodwill and to ensure that wildlife conservation provides financial benefits to the local people.

IUCN guideline: Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the reintroduction area. If these measures are inadequate, the reintroduction should be abandoned or alternative release sites sought.

Comment: Extra ZAWA staff will be permanently deployed in and around the sanctuary, with the specific task of monitoring and protecting the rhinos. The rhino sanctuary would be surrounded by an electrified fence with two or three live wires at rhino nose height. The fence would be designed to keep rhinos in the sanctuary, but to facilitate the passage of other large mammals under, over or through the fence, with minimum damage being inflicted on the fence. Daily patrols by scouts would check the integrity of the fence and search for signs of intruders. The purpose of confining the rhinos to a relatively small area of the park is to make it easier to monitor and protect them.

IUCN guidelines: The policy of the country to reintroductions and to the species concerned should be assessed. Reintroduction should take place with the full permission and involvement of all relevant government agencies of the recipient country.

Comment: The Government of Zambia, acting through the Zambian Wildlife Authority, is supportive of introductions/reintroductions, as evidenced by the introduction of the white rhino to Mosi-oa-Tunya NP at Livingstone. ZAWA supports the proposed reintroduction of black rhinos in North Luangwa NP and is a co-sponsor of the reintroduction plan.

IUCN guideline: If the species poses potential risk to life or property, these risks should be minimised and adequate provision made for compensation where necessary.

Comment: The rhinos pose little risk to life or property. In the short and medium-term, the only people likely to be at risk from the rhinos (and, if care is taken, not a great risk at that) will be the ZAWA and NLCP staff who have chosen to work with the rhinos, and tourists who may pay for the opportunity to see rhinos. There is a very slight chance that a rhino may escape from the park early during the reintroduction programme and, in the long-term, a successful reintroduction will probably lead to the dispersal of rhinos from the park and into the GMAs. But even if either of these events happen, the risk of injury to people or property from a rhino must be regarded as slight, certainly by comparison with the risk posed by other wild animals, such as elephants and lions, that are already resident in the GMAs.

Planning, preparation and release stages

IUCN guideline: Approval of relevant government agencies and land owners, and co-ordination with national and international organisations.

Comment: The Government of Zambia, acting through the Zambian Wildlife Authority, has approved the plan to reintroduce black rhinos to North Luangwa NP. The SADC RPRC is sponsoring this feasibility study.

IUCN guideline: Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.

Comment: The NLCP technical advisors are employed by FZS, which has contacts with people with relevant expertise. They and ZAWA are also in contact the SADC RPRC, which has extensive contacts with numerous people with relevant experience.

IUCN guideline: Identification of short-term and long-term success indicators and prediction of programme duration, in the context of agreed aims and objectives.

AfRSG/SADC guidelines: An annual population growth rate of 5 % is a minimum target. The average intercalving interval of adult females can be monitored and should be no more than 3 years (ideally, nearer 2 years), while the average age at which each female has her first calf should not exceed 8 years (ideally, nearer 6 years). Rhinos are relatively slowly-breeding animals and therefore their management during a re-introduction programme must be proactive (potential breeding constraints must be avoided before they arise), rather than reactive (simply responding to problems once they become apparent).

Comments: Short-term success indicators would include a post-release survival rate of >90 % (for South African and Namibian translocations during 1986-95, it was 91.6 % (Adcock *et al*. 1998)). Long-term success indicators would include a mean intercalving interval of <3 years, a mean age for females at first calving of <8 years, and a mean exponential rate of increase for the population number of >0.05.

IUCN guideline: Secure adequate funding for all programme phases.

Comment: FZS has indicated its willingness to provide or acquire funds to pay for aspects of the reintroduction that are beyond ZAWA's budget.

IUCN guidelines: Design of pre- and post-release monitoring programme: monitoring the health and survival of individuals is important.

Comment: Five or six scouts will be trained in rhino monitoring. Released rhinos will be fitted with radiotransmitters to permit regular monitoring of their location, physical condition, survival and breeding. The age of a female when she produces her first calf and the interval between consecutive births are both useful measures of a population's wellbeing, once the immediate post-release phase is over. NLCP and ZAWA will establish and maintain a database of the information collected by the monitoring staff.

IUCN guidelines: Appropriate health and genetic screening of release stock. If release stock is wild-caught, check that: stock is free of infectious or contagious pathogens before shipment; and will not be exposed to vectors of disease agents that may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.

Comments: Only rhino populations of the subspecies *D. b. minor* will be considered as potential source stocks. Release stock will spend at least three weeks in quarantine at their capture site and be screened for infectious or contagious pathogens before shipment. Tsetse flies *Glossina* spp., which are the vector for *Trypanosoma* spp. (the parasites that cause trypanosomiasis) are present in North Luangwa NP, but absent from those areas that might possibly provide source stock for the reintroduction. It is likely that rhinos moved to North Luangwa NP will become infected by *Trypanosoma* spp. and occasionally rhinos have died under similar circumstances (Taylor 1986, Mihok *et al*. 1992). A detailed veterinary review of the potential problem and how to avoid it is needed, but it is likely to include measures such as positioning traps for tsetse flies around the pre-release pens in North Luangwa NP, and ensuring that only animals in good condition are moved to North Luangwa NP. Anthrax epidemics occur in the Luangwa Valley (Turnbull *et al*. 1991, H. & E. van der Westhuizen, pers. comm.), but the animals principally affected are

hippos. Anthrax outbreaks occur mainly during the dry season, when the hippos are resident in the Luangwa River, some 20 km away from the proposed rhino sanctuary. In Kruger NP, South Africa, where anthrax outbreaks occur regularly, black rhinos are regarded as not behaviourally-susceptible to the disease, even though they can catch it (R. Bengis, Kruger NP, pers. comm.).

IUCN guidelines: If vaccinations are required prior to release, allow sufficient time for the development of acquired immunity. Appropriate veterinary measures as required throughout the programme, including adequate quarantine arrangements, especially where founder stock crosses international borders. Development of transport plans, with special emphasis on ways to minimise stress on the individuals during transport.

Comments: A veterinarian with rhino experience has offered to assist with all veterinary aspects of the reintroduction. These would include capture of individuals at the source location, screening of the animals while they were in quarantine at their capture site, care during their transport to North Luangwa NP and health monitoring while they were in the pre-release pens at North Luangwa NP. The veterinarian would work with a ZAWA veterinarian to provide the latter with increased experience of working with rhinos.

IUCN guideline: Determination of the release strategy.

Comment: The rhinos will be held in bomas in North Luangwa NP before release into the rhino sanctuary soon after the onset of the rainy season.

IUCN guideline: Establishment of policy on interventions.

Comment: Such a policy still has to be developed, but it is recommended here that, if the health or wellbeing of any rhinos is threatened, management should immediately intervene to remedy the problem.

IUCN guideline: Development of conservation education for long-term support; professional training of individuals; public relations through mass media and local community; involvement where possible of local people.

Comment: Every opportunity will be taken to train ZAWA staff in the skills needed for rhino protection, monitoring, research and veterinary medicine (see following sections). The importance of conservation education is fully recognised and during 2000 NLCP initiated a programme of school visits to North Luangwa NP. Staff at ZAWA HQ are well placed to promote public relations through the national media.

IUCN guideline: Welfare of animals for release is of paramount concern through all stages.

Comment: The reintroduction plan would fully comply with this guideline.

Revised reintroduction plan

Estimated carrying capacity

The rhino sanctuary proposed in the ZAWA/FZS NLCP reintroduction plan covered 54 km^2 in an area where rhinos were seen frequently during the 1970s aerial surveys (Caughley 1973). But the density of rhinos that used to live in this area is unknown. Furthermore, our attempt to calculate a carrying capacity for this area was not satisfactory. Therefore it was decided that the initial stocking density of the sanctuary should be 0.1 rhinos km^{-2}, even though it is possible that the previous density was several times greater than this value. Selection of such a low and conservative density should remove any danger that the rhinos would be overstocked at the start of the reintroduction and would allow rhino numbers in the sanctuary to increase by births without overstocking in the early stages.

If the reintroduction is a success, the sanctuary will become overstocked eventually. The simplest solution to this problem will be to remove part or all of the fence and permit some or all of the rhinos to disperse into unfenced areas of North Luangwa NP. When rhinos were still present in North Luangwa NP, they were often seen along the Mwaleshi River, just to the south of the first fenced area (P. Berry, pers. comm.). Caughley's (1973) air survey data support this observation, with rhinos frequently seen in the areas both south and south-east of the proposed sanctuary. Thus, although it is not possible to estimate the rhino carrying capacity of the area around the proposed sanctuary, it is possible to be certain that previously this area did support an above-average (for North Luangwa NP) density of rhinos.

Minimum size of fenced area

If 0.1 rhinos km^{-2} is the initial stocking density, then the sanctuary proposed in the ZAWA/FZS NLCP plan would be too small for a founder population of 20 individuals. And building a larger sanctuary and simply adding additional rhinos after the first release of animals is not acceptable. If more than one batch of rhinos is released into the same area, often there are fights between established individuals from the first release and individuals from subsequent releases and frequently such fights result in deaths (Brett 1998). Therefore, it is proposed that during the early stages of the reintroduction programme there would be two sanctuaries, close together, and that a first batch of rhinos would be released into the one and a subsequent batch released into the second a year or two later.

Sequence of developments

1. The first fenced area would be similar to that referred to in the original plan, but bigger. There would be extensions to the west to include more riverine vegetation, particularly thicket, and to the south-east to include an additional perennial water-point that would serve as a source of drinking water and as a wallow. This fenced area would be 84 km^2 (perimeter 37.5 km) and therefore large enough to accommodate eight founders.
2. There would be a second fenced area to the north of the first one (Figure 12), also in an area where rhinos were seen frequently during the aerial surveys of the early 1970s. The area contains perennial water sources and was mapped mainly as valley riverine complex and wooded grassland mosaic by Smith (1998). The demarcated area also contains a small patch of hill miombo and some mopane woodland. But the area needs more extensive examination than was possible during this brief study, before the exact location of the perimeter fence is finalised. But this fenced area would be about 130 km^2 (perimeter 45 km) and thus large enough for about 12 founders at a stocking rate of 0.1 rhinos km^{-2}. The extensive examination should also determine whether the two fenced areas might share a common boundary, prior to stage 3 below.
3. Once monitoring has revealed that individuals in the second fenced area have established home ranges, or in the case of adult males, territories, the fence between the two sanctuaries would be removed to create a single rhino sanctuary of about 200 km^2.

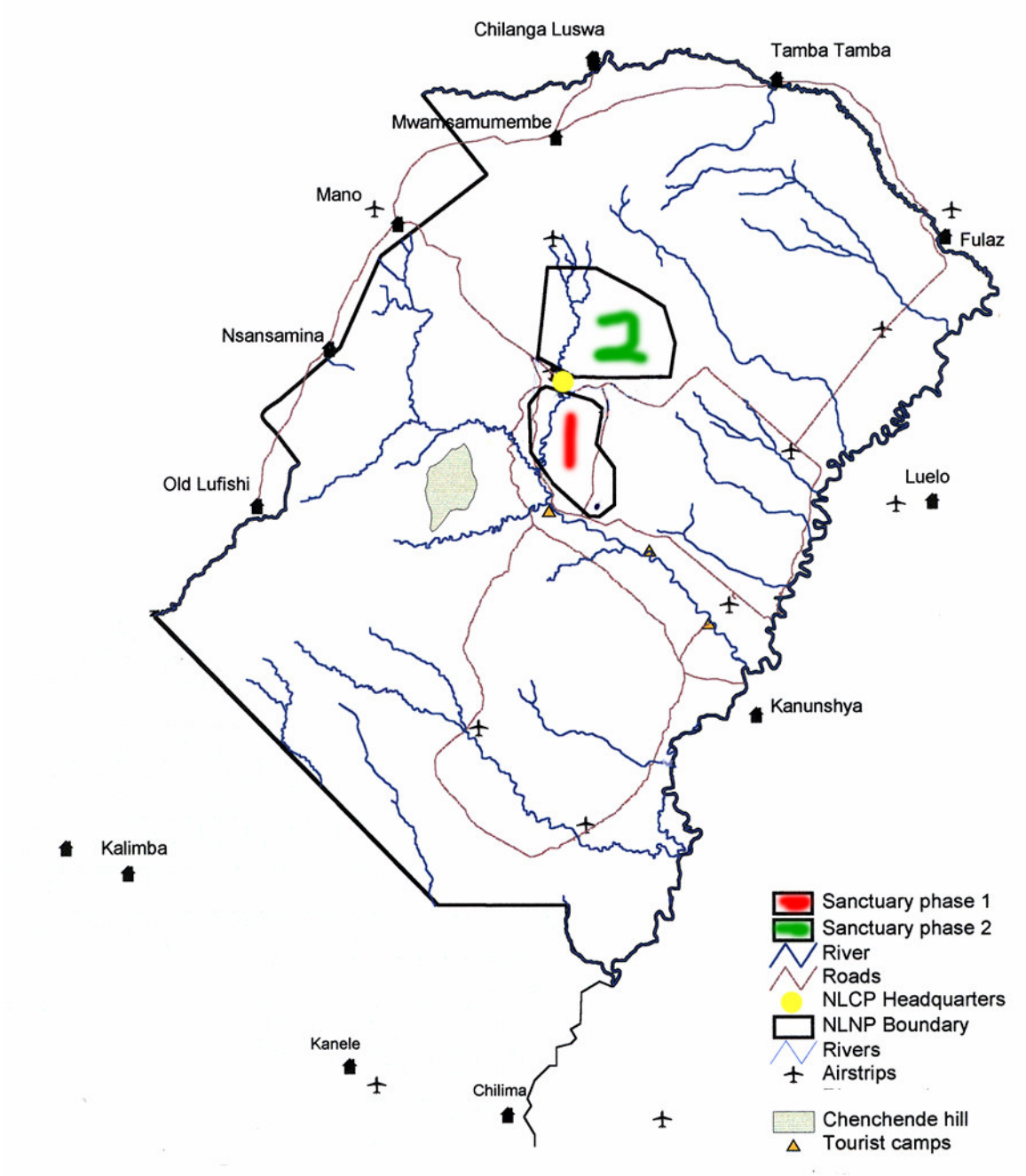

Figure 12. The location of the two fenced areas, sanctuary phases 1 and 2, for the reintroduction of black rhinos to North Luangwa NP.

Necessary conditions to develop a viable rhino population

ZAWA The branch of government responsible for wildlife in Zambia recently underwent extensive re-organisation, as well as a change of name from NPWS to ZAWA. Part of the re-organisation included transformation from a civil service department, totally dependent on government funding, to a self-financing organisation. But this change has been accompanied by significant problems, not least of them financial: at the time of my visit, ZAWA staff had been unpaid for about three months. In North Luangwa NP, the adverse effects of this had been cushioned by the NLCP, but a speedy resolution of ZAWA's problems is a prerequisite for persuading owners and managers of potential source populations that a rhino reintroduction in North Luangwa NP has a high probability of success.

The release of up to eight rhinos in the first fenced area must be preceded by the provision, by ZAWA, of 20 extra staff who will be responsible for rhino monitoring and security. ZAWA must provide firearms and ammunition for these staff. NLCP is willing to assist by providing capital items, other items of equipment and training, and renovating accommodation. A further 12 or 13 staff will be needed before the second batch of 12 animals is released into the second fenced area.

Local attitudes The absence of any assessment of the attitude of the local people towards a reintroduction of black rhino is worrying. It is likely that most local people will be indifferent to any reintroduction, because it will have little or no impact on their lives. A preliminary assessment of local attitudes should be conducted, easily and inexpensively, via the ZAWA/NLCP informer network. Only if this suggests that local attitudes towards a reintroduction are negative might it be necessary to undertake more extensive research.

Existing informers should also be able to state whether the persons who purchased rhino horn from poachers during the late 1970s and early 1980s are still resident in the area, and whether there is likely to be any market for poached rhino horns. The absence of any attempts to poach the white rhinos in Mosi-oa-Tunya game park encourages the view that the Zambian market for rhino horns in greatly reduced, or has disappeared.

Capacity requirements

Rhino protection

- Protection of the rhinos is estimated to require an additional 26 scouts and one ranger (H. van der Westhuizen, pers. comm.).

These staff would be dedicated towards rhino protection and their number would be over and above the current staff complement. Their home base would be Mano, which is just outside the north-west side of North Luangwa NP, and from there they would operate into the park. Mano already has surplus housing (following last year's restructuring of ZAWA) and FZS had indicated its willingness to renovate these houses and, as part of their ongoing house-building programme, to build some new houses if necessary.

- FZS and NLCP are willing to arrange and fund the training of scouts.
- ZAWA's Acting Assistant Director (Research) has indicated that he believes that ZAWA would be willing to provide these extra staff and to equip them with firearms.
- Because the black rhino is probably extinct in Zambia, the ranger will not have had any experience of this species prior to his appointment to the new post. It is recommended that the ranger visit other protected areas, including black rhino reintroduction sites, within the SADC region in order to gain some experience of this species and its protection.

Rhino monitoring

- Monitoring of the rhinos is estimated to require an additional five or six scouts (H. van der Westhuizen, pers. comm.).
- Again, ZAWA's Acting Assistant Director (Research) has indicated that he believes that ZAWA would be willing to provide these extra staff.
- These staff would need to attend a training course in rhino monitoring and FZS has indicated its willingness to fund their attendance at such a course.
- A FZS technical advisor will train the scouts in the use of radiotracking equipment.

- Monitoring scouts would be responsible to a ZAWA ecologist. ZAWA already has ecologist posts, with one based at Mpika, to the west of North Luangwa NP. Furthermore, North Luangwa NP will be a priority area for the Mpika-based ecologist.
- However, because the black rhino is probably extinct in Zambia, the ecologist will not have had any experience of this species. It is recommended that the ranger visit other protected areas, including black rhino reintroduction sites, within the SADC region in order to gain some experience of this species and monitoring it.
- The ecologist will require training in the establishment and maintenance of a rhino database. A FZS technical advisor is willing to be trained in the use of the database and then to teach the biologist, and other ZAWA staff, how to use it.

Rhino management

The ZAWA establishment at their Head Office includes a veterinarian, but he has had little experience of rhinos. It is recommended that:

- a ZAWA vet attend the Zimbabwean course entitled *Chemical and physical restraint of wild animals*;
- a ZAWA vet 'shadow' an experienced rhino vet throughout all stages of the translocation, including the capture of the rhinos at the site of the source population, their confinement in quarantine pens and testing them for pathogens, their transport to North Luangwa NP, their placement in pre-release pens there and their health monitoring.

Strategies for possible future involvement of communities in rhino conservation at North Luangwa NP

The proposed reintroduction will take place close to the centre of North Luangwa NP, remote from the local communities on the periphery of the park. Therefore the potential benefits – and costs – to local communities of this reintroduction are not great.

Tourism and jobs

If this reintroduction goes ahead, the rhinos in North Luangwa NP will be the only black rhinos known to be in Zambia. One consequence of this is likely to be an increase in the number of tourists visiting North Luangwa NP, especially if tourists are provided with opportunities to see rhinos, in ways that are not detrimental to the wellbeing of the rhinos, at an early stage in the reintroduction programme. An increase in the number of tourists should lead to a small increase in employment opportunities for local people.

There will be temporary jobs available to local people during the building of bomas and sanctuary fences.

Community education

During the early years of the reintroduction, the opportunities for most local people to see the rhinos during the normal course of their lives will be negligible. People will only get a chance to see the rhinos (and no local child is likely to have ever seen one because rhinos appear to have disappeared from North Luangwa NP more than 15 years ago) if plans are made to transport groups of people into the park and show them the animals. If enough people, and particularly local dignitaries and children, are given this opportunity, it may be possible to encourage local

people to 'adopt' the rhinos as 'their rhinos', something that is missing from the rest of Zambia. NLCP has already initiated a scheme to take parties of schoolchildren on visits to North Luangwa NP.

National pride

During the reintroduction, ZAWA should take every opportunity to ensure that the programme is reported by the national newspapers, radio and television. The aim would be to encourage the wider Zambian public to identify with the project and take pride in it.

Site in South Luangwa National Park for the future reintroduction of black rhino

It is proposed that the vicinity of Kapiri Kamfumu, westwards of Mfuwe Lodge, is the most suitable site for a future reintroduction of black rhinos in South Luangwa NP (Figure 13).

Four factors have influenced the choice of this area:

- **Security**. Good security requires that a site is readily and quickly accessible by vehicle all year round. Most of South Luangwa NP is inaccessible to vehicles during the rainy season. All-weather access is restricted to the roads to the west and south-west of Mfuwe Lodge (i.e. the roads shown as solid red lines on the map in Figure 13).
- **Habitat**. Kapiri Kamfumu is within the study area of Leader-Williams (1985a, 1988), an area which supported 0.39 rhinos km^{-2} during 1981/82. At least four or five rhinos were poached in the South Luangwa NP core area (which included this study area) from 1979 to 1982 (Leader-Williams *et al*. 1990), which suggests that the pre-poaching density of rhinos in the core area may have been greater than 0.39 km^{-2}. There is no indication that there has been any major change in the habitat since Leader-Williams' study and so this area should still support about 0.4 rhinos km^{-2}, once released individuals have settled into their new environment. The area includes permanent sources of drinking water such as Kamundi Lagoon, which is where our guide reported seeing rhinos during 1999. Astle (1999) identified the main vegetation types in the area between the Mushilashi and Katete Rivers as shrubland complex, alluvial complex, miombo woodland on flat interfluves, miombo woodland on ridges, drainage head and shrubland *Julbernardia*. Leader-Williams (1985b) radiocollared rhinos in the Kapiri Kamfumu region to determine their home ranges. He noted that the core area of each female's home range included a feature that contained water during October (the end of the dry season) and an area of thicket, while the less used areas encompassed scrub (mopane, miombo or *Combretum-Terminalia*).
- **Rhino sightings during 1990s**. It is the area of South Luangwa NP where rhinos were last seen by scouts (Figure 6).
- **Expert recommendation**. It is the area recommended for this purpose by people with long experience of the Luangwa Valley and its rhinos (Phil Berry, pers. comm.).

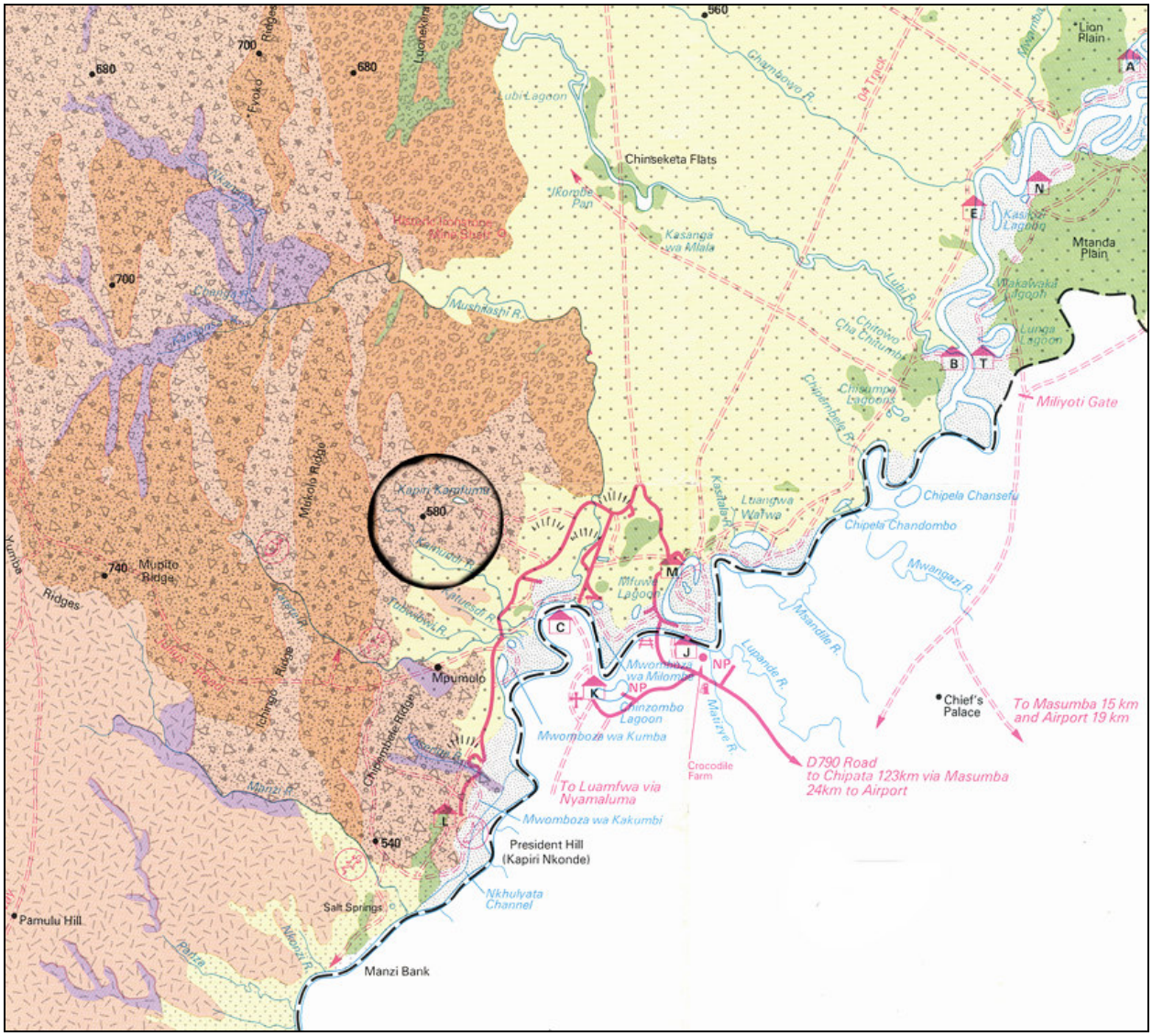

Figure 13. Kapiri Kamfumu (ringed), the site proposed for any future reintroduction of black rhino in South Luangwa NP. Map scale 1: 215 000.

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Appendix - Terms of Reference

Contracted for 18 days to make an evaluation of specific areas in Zambia for rhino conservation

- **Evaluation of feasibility and reintroduction options for black rhinos in North Luangwa NP (with South Luangwa NP as an alternative/future reintroduction site).**

1. Review all available historical information and documented evidence on the past numbers and distribution of black rhinos in North and South Luangwa NP. This review should include any surveys or past information on rhino densities and local distribution within the present protected areas.
2. Briefly review past activities, successes and failures in rhino conservation in North and South Luangwa NP, including the main reasons for decline and extinction from the Valley, and any recorded persistence of remnant animals in the late 1980's. Identify peripheral areas of greatest threat to rhino security, including areas of the NPs that have had highest levels of internal and external poaching in the past, and relate that to past and present successes (e.g. by NLCP) in monitoring and protecting hunted species.
3. In collaboration with the ZAWA project executant (G Kampamba), and with input from the FZS NLCP, examine past habitat preferences of black rhinos in the Luangwa Valley, and through linkage to available habitat, soil and vegetation maps (and GIS data), and information/studies on food preferences, make preliminary estimates of ecological carrying capacity (in terms of density) for black rhinos in North Luangwa NP, both on a broad scale for the protected area(s) and for representative constituent habitat types. This should include consideration of a full range of habitat requirements for rhinos including food, water, cover and potential competition and interaction with other species, and suggestions for vegetation monitoring for any area fenced for containment of rhinos.
4. On the basis of the above reviews, available information, site visits and interviews make a critical evaluation of the current plans by ZAWA and the FZS NLCP to reintroduce a small population of black rhinos to a defined area of North Luangwa NP. Use established criteria for reintroduction (IUCN/SSC Reintroduction Specialist Group and AfRSG/SADC RPRC) to assess each of the key biological and management-related aspects of the reintroduction plan. This should include consideration of the minimum size, development options and estimated carrying capacity of the planned fenced area (including the necessary surrounding zone of security (IPZ)), and identification of necessary conditions and sequence of phased developments (e.g. fence extension or removal) and other inputs to develop a viable rhino population of at least 20 animals in NLNP.
5. Identify capacity needs for rhino protection, monitoring and management at North Luangwa NP, including minimum staffing by ZAWA (and/or NGO/private sector) and training requirements. Identify strategies for any possible future community involvement in rhino conservation at North Luangwa NP, including any potential benefits linked to reintroduction of rhinos to the park.
6. On the basis of site visits, reviews and historical information identify one area in South Luangwa NP with the best attributes for reintroduction of black rhinos to a future/alternative site, with emphasis on developing a second viable rhino population in the Luangwa valley.
7. At the conclusion of country visit, brief a meeting of senior and participating ZAWA senior staff and FZS representatives, on the outline conclusions of the evaluation and recommendations for redeveloping conservation of black rhinos in the Luangwa Valley PA system in the short term.
8. In co-ordination with ZAWA project executant, FZS staff and SADC RPRC, produce consolidated evaluation report containing potential elements for a ZAWA reintroduction plan for rhinos and/or an integrated management plan for North Luangwa NP.

- **Evaluation of white rhino management at Mosi-oa-Tunya NP**
  (See separate report)