

Survey and conservation status of five black rhino (*Diceros bicornis minor*) populations in the Selous Game Reserve, Tanzania, 1997–1999

Max Morgan-Davies

PO Box 24944, Karen 00502, Kenya
email: maxmd@swiftkenya.com

Abstract

The Selous Game Reserve in Tanzania has the most northerly population of the black rhino subspecies, *Diceros bicornis minor* in Africa. Over the past 50 years, numbers have decreased considerably from an estimated 2000 in the mid-1900s to a few small and scattered metapopulations identified in the late 1990s. This paper summarizes the results of a survey of five populations undertaken between 1997 and 1999 with the objective of determining the suitability of establishing one or more Intensive Protection Zones for the management of rhinos in the reserve. Four small, discrete, breeding populations were investigated: Kidai with 5–7 rhinos, Lukuliro with 10–15, Nahomba with 3–4, and Horogwe with 5–8. No rhinos were found in the Naluale area. There are possibly an additional 10–20 rhinos scattered about the reserve, making a total of 30–50. As the adjoining Lukuliro and Nahomba areas contain possibly the most viable of all presently known rhino populations in the reserve, it is recommended that these areas be managed jointly as the first Intensive Protection Zone for the Selous Game Reserve. This paper also details the conservation and management status of each population surveyed and gives some management recommendations. The constraints under which the Tanzania Wildlife Division is working are critical, and it urgently needs an infusion of funds and expertise if it is to save this last remaining metapopulation of *D. b. minor* in Tanzania.

Résumé

La Réserve de faune de Selous en Tanzanie contient la population la plus au nord pour l'Afrique de la sous-espèce de rhino noir *Diceros bicornis minor*. Au cours des 50 dernières années, leur nombre a diminué considérablement ; au milieu des années 1900, on estimait leur nombre à 2000 environ, et vers la fin des années 1990, on n'a plus identifié que quelques petites méta-populations éparpillées. Cet article résume les résultats d'une étude de cinq populations qui a été réalisée entre 1997 et 1999 dans le but de déterminer s'il était souhaitable de créer une ou plusieurs Zones de Protection Intensive pour la gestion des rhinos de la réserve. On a étudié quatre petites populations reproductrices discrètes : Kidai, qui compte 5–7 rhinos, Lukuliro, avec 10–15 rhinos, Nahomba, 3–4 rhinos et Horogwe, 5–8 rhinos (on n'en a trouvé aucun à Naluale). Il est possible qu'il y ait entre 10 et 20 rhinos supplémentaires dispersés dans la réserve, ce qui ferait un total compris entre 30 et 50. Comme les zones voisines de Lukuliro et de Nahomba abritent peut-être les plus viables de toutes les populations de rhinos connues aujourd'hui dans la réserve, on recommande de gérer ensemble ces deux zones comme étant la première zone de protection intensive dans la Réserve de faune de Selous. Cet article détaille aussi le statut de la conservation et de la gestion de chaque population surveillée et donne quelques recommandations en matière de gestion. Les contraintes avec lesquelles la Tanzania Wildlife Division doit travailler sont énormes et il y a un besoin urgent de fonds et d'expertise si l'on veut sauver la dernière méta-population de *D. b. minor* de Tanzanie.

Introduction

Tanzania has two subspecies of black rhino, *Diceros bicornis michaeli* and *D. b. minor*, the former occurring in the north, the latter in the south of the country (fig. 1). In the 1970s it was estimated that Tanzania had a total population of about 10,000 black rhinos and as a result of extensive and protracted poaching for horns, this number had been reduced to about 3800 by 1980 and 100 by 1992 (Tanzania 1993). By the late 1990s, few animals still existed in their former range, and their survival throughout the country now hangs in the balance. The viability of the few remain-

ing rhino populations in Ngorongoro Crater and Serengeti National Park is uncertain. It was estimated that there were perhaps 3000 rhinos in the Selous Game Reserve (SGR) in 1981 (Stephenson 1987). By the late 1990s, poaching had taken its toll and the population status of these animals was a matter of pure speculation. However, investigations during the early 1990s (Stronach 1991; Laurie 1991) identified four discrete breeding populations of *D. b. minor* remaining in the Selous Game Reserve.

In 1996, the World Wide Fund for Nature (WWF), in accordance with the 1993 National Rhino Policy and Management Plan, agreed to assist the Tanzania

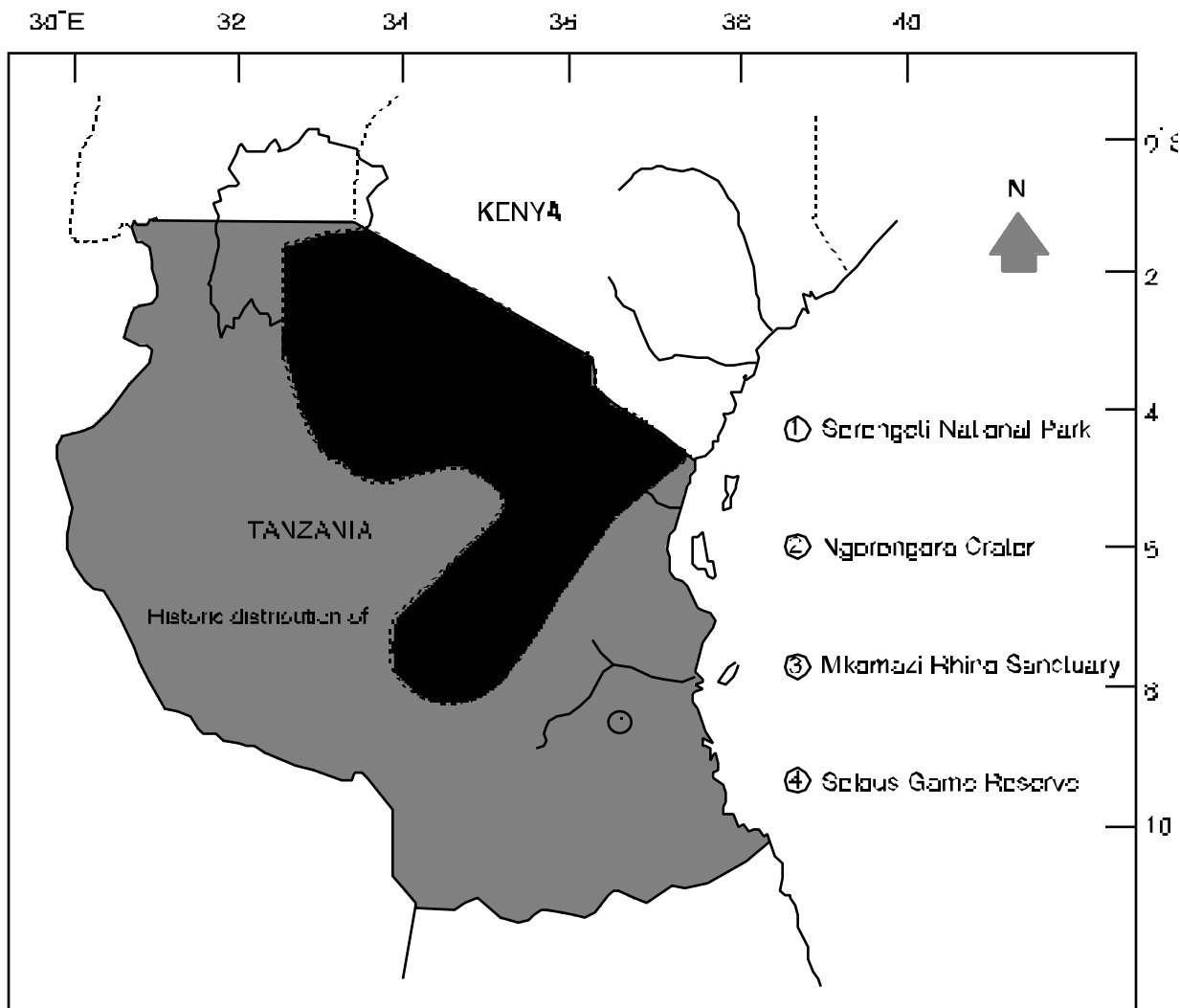


Figure 1. Historical and present distribution of the two taxonomic units of the black rhinoceros *Diceros bicornis michaeli* in the north and *D. b. minor* in the south of Tanzania (after Severre 1993).

Wildlife Division to update its information on the status of some of these Selous populations with a view to:

- providing current information that would assist the Wildlife Division to determine a future management strategy for the conservation of the SGR's remaining rhino population, and
- possibly establishing one or more of these areas as an Intensive Protection Zone (IPZ) for rhinos.

In 1997, I submitted an application to the US Fish and Wildlife Service for financial support under the Rhinoceros and Tiger Conservation Fund (Morgan-Davies 1997). The grant, approved in February 1997, covered field-staff training in rhino monitoring and the surveying of five black rhino populations in the SGR with a view to their future conservation through the establishment of IPZs.

Survey results

Based on observations by Stronach (1991) and Laurie (1991) and aerial surveys I made before the ground surveys, five rhino locations were selected and surveyed—Kidai, Lukuliro, Nahomba, Naluale and Horogwe—a total core area of about 1080 km².

Kidai

LOCATION

The Kidai rhino area is located in the northern sector of the reserve immediately north of the Rufiji River and within the only area of the SGR designated for tourist game viewing and not for hunting. It encloses a core area of about 300 km².

Within this area are three tourist camp concessions: Beho Beho, Sand River and Stiegler's Gorge. Sand River Camp plays an important part in helping the Wildlife Division to maintain ranger morale and efficiency and thus provides security for this last remaining, northernmost population of *D. b. minor* along the banks of the Rufiji River.

VEGETATION

Unlike the vast area of predominantly *Brachystegia* woodland that extends southwards from the Rufiji, the northern area of the reserve is primarily light *Acacia-Combretum* wooded grassland with numerous lakes, swamps and areas of dense *Hyphaene* palms along sec-

tions of the Rufiji River. The banks of the Rufiji, Ruaha and Sumbadsi have relatively small areas of riparian forest of varying density. The 120-m high, east-facing, rocky escarpment between Kipalala and Mtundusi Hills is covered with a dense stand of stunted *Julbernardia-Brachystegia* woodland. Elsewhere, small isolated patches of thicket and forest occur.

WATER

More than adequate water is available for rhinos throughout the year from the Ruaha and Rufiji Rivers. The Sumbadsi, Beho Beho and other minor streams almost invariably dry up during the dry season from July to November. Despite there being water in the Ruaha and Rufiji Rivers, however, available evidence indicates that rhinos seldom use them. The disturbance of tourist motorboats originating from Sand River Camp, the presence of poachers operating along these two rivers, and fear of the large population of Nile crocodiles perhaps compels these animals to drink elsewhere. During much of the year rhinos drink from the smaller streams and temporary pools of surface water. During the dry season they concentrate around the few perennial springs located below the Kipalala escarpment and the remaining pools of water along the lower reaches of the Sumbadsi River.

RHINO NUMBERS AND DISTRIBUTION

Rhino signs indicate a possible small breeding population of 5–7 animals. A fresh track of one calf was recorded. Its track details:

Date: 23 August 1997

Track width: 16.5 cm

Accompanied by one adult

Provided there are no losses from poaching or natural causes, the population should slowly increase. However, the question of long-term viability of a very small, isolated population is pertinent. It has not yet been possible to determine the demographics of this population, although it should become evident within the next 2–3 years, as the local ranger force is now better trained and equipped. Unlike elsewhere in the SGR, where rhinos are very rarely seen, rangers and visitors do occasionally see a rhino in the Kidai area. About mid-1950, a visitor to the Sand River Camp area for the first time successfully photographed what appeared to be a subadult male (Elizabeth Theobald,

pers. comm. 1997). Doubtless, additional photographs of these particular animals will be taken in time. Infrared beam-operated cameras have been procured for the Kidai area and results are awaited.

SECURITY

Poachers travelling up and down the Rufiji River from Maloka and its neighbouring villages along the banks of the river, just outside the north-eastern boundary of the reserve, are a constant threat to Kidai. Although poaching for fish and snaring animals may be their primary objective, the presence of a rhino is undoubtedly a great temptation. Heavy poaching also occurs along the Ruaha River. This was graphically re-confirmed recently (Richard Barnwell, pers. comm. 1999) when nearly 50 poacher camps and considerable poaching activity were recorded along an approximately 30-km stretch of the northern bank of this river.

The Kidai rhinos are the only population of this species in the SGR that have had a permanent force of rangers dedicated to their security for the past few years. This is made possible through the financial support of the directors of Sand River Camp. However, the enthusiasm and competence of the rangers is limited, and they are in need of good leadership in the field. The constant provision of suitable field equipment and clothing by their mentors does not automatically ensure their efficiency. A dedicated officer is needed who will provide daily motivation and leadership, and additional practical training in rhino tracking. It is important that rangers spend more time covering the whole rhino area on foot and camping out more frequently while on patrol, rather than focusing their activities on the immediate area of their permanent camp.

Lukuliro

LOCATION

The Lukuliro rhino population is located immediately north of the Lukuliro River

headwaters within the eastern sector of the reserve. The area surveyed is about 370 km² in extent and probably represents the core area of this population. The Lukuliro, Kitope and Kinjekenje Rivers more or less form the boundary of the area. It is a favoured area for licensed trophy hunters looking for elephant and buffalo.

VEGETATION

The predominant vegetation of the eastern sector of the reserve is the almost ubiquitous *Brachystegia*



Max Morgan-Davies

The Lukuliro River looking upstream to its source in the Liwande Hills.

woodland. However, it is the vast dry, sand areas of coastal thicket, dominated by a mixture of evergreen *Canthium* and deciduous *Margaritaria* spp. that make this area of the reserve so important. Its relative inaccessibility because of the dense impenetrable nature of the vegetation makes these thickets an ideal refuge for rhinos. Although the area surveyed is only about 350 km², the Lukuliro thicket area extends at least an additional 500 km² to the north. An aerial survey to the north of the Kinjekenjeke River during the dry season revealed neither obvious signs nor actual presence of rhinos, so it was not included in the subsequent ground survey of Lukuliro.

WATER

During the wet season, from November to January and from March to June, adequate water is readily available in the major rivers and in shallow pans and

mud wallows. However, by the height of the dry season in September–October all major streams, including the Lukuliro River, have dried up and uncontrolled bush fires are prevalent. Even the vast and relatively luxuriant thicket area is devoid of water for much of the year. At this time the only water to be found is in holes dug by elephants in the dry bed of the Lukuliro River, and in a few small springs, also maintained by elephants, along the dry watercourses that lead into the headwaters of the Lukuliro. It is these few vital perennial springs that the Lukuliro rhinos depend upon for their dry-season water. The majority of these perennial waterholes are located in relatively open *Brachystegia* woodland just outside the major thicket area. This makes the rhinos extremely vulnerable to poachers.

Although up to three rhinos have occasionally been seen around these springs during daylight hours, most

Max Morgan-Davies



The ubiquitous *Brachystegia* woodlands dominate the Selous Game Reserve vegetation southwards from the Rufiji River.



A relatively large thicket waterhole at the onset of the dry season.

return to cover shortly before daylight. In this way they reduce the risk of being ambushed by poachers.

RHINO NUMBERS AND DISTRIBUTION

The Lukuliro area appears to have the largest number of rhinos of the five areas so far surveyed in the SGR. It is estimated that there is a breeding

population of 10–15 animals. This could include up to four accompanied calves and five unaccompanied sub-adult animals (table 1).

Dry-season waterhole in one of the watercourses that flow into the Lukuliro River headwaters.

activity is at night (Hassan Ndauka, pers. comm. 1997). Emerging from the thickets shortly after nightfall, the rhinos make for the springs and normally

Table 1. Track details of rhino calves and subadults recorded in the Lukuliro area.

Date (1997)	Track width (cm)	Notes
20 Sep	17.0	accompanied by 1 adult
23 Sep	17.5	single animal
23 Sep	18.0	single animal
23 Sep	17.0	single animal
16 Oct	17.5	accompanied by 2 adults
20 Oct	17.0	accompanied by 2 adults
23 Oct	15.5	accompanied by 2 adults

Although so far there is no information on the demographics of these animals, it does appear to be a viable population with a healthy proportion of calves and subadult animals. It is certainly the largest single metapopulation of rhino so far recorded in the SGR and, together with the Nahomba area, Lukuliro should be considered for IPZ status.

During the dry season when rivers, streams and most pools are dry, the Lukuliro rhino population appears to be concentrated within a core area of about 150 km². However, unlike the Kidai rhinos that do not seem to move any great distance from their core area around

Mtundusi and Kipalala, the Lukuliro wet-season dispersal area may extend for an additional 500 km² or more to the west and north. The heavy cover of intervening wooded grasslands between thicket areas during the verdant wet season provides greater concealment for rhinos and may enable them to move from one metapopulation to another during this time of the year—a possibility that warrants urgent investigation in the interest of breeding and the long-term viability of these scattered rhino populations.

SECURITY

Despite rhinos having been documented as occurring in the Lukuliro area for the past decade, the only protection these animals received before 1997 was occasional foot patrols by Wildlife Division rangers stationed at Kingupira, about 100 km to the east. In the main these patrols kept to the few well-marked vehicle tracks maintained by professional hunting concessionaires, and to the still clearly visible seismic survey lines that criss-cross a large part of the reserve. Most of the rangers are poorly trained, equipped, armed and motivated, and until this survey there were

Max Morgan-Davies



Aerial view of one of the many seismic cut lines.

no written records available of rhino incidence other than those recalled from memory by members of the staff. Although this important rhino population is located relatively deep within the SGR, it is not beyond the reach of the numerous elephant poachers who live in and around the Maloka complex of villages and who are such an irritant to the Kidai area. It is highly likely that the old seismic survey lines are still being used by elephant and rhino poachers to infiltrate deep into the reserve.

The dangers of poaching are particularly high during the wet season when ill-equipped Wildlife Division patrols are even less frequent than during the dry season. The area is presently covered by adequate patrol roads, and making any additional tracks, like the track passing the important water points along the upper reaches of the Nahomba River, would be counter-productive. In general, the most effective anti-poaching is done not by vehicle but by conscientious and continuous foot patrols throughout the year.

The present rhino base camp on the northern banks of the Lukuliro River is strategically located to cover both the Lukuliro and the Nahomba rhino areas. For security and administrative purposes, it is important that the old Lukuliro airstrip be made serviceable once

again, and that a new all-weather road from Kingupira to the Lukuliro base camp be completed as soon as possible.

Nahomba

LOCATION

The Nahomba rhino area is located in the eastern sector of the SGR around the headwaters of the Nahomba River and about 10 km south-west of the Lukuliro River rhino base camp. Laurie (1991) separated the Nahomba from the Lukuliro area, possibly for reasons associated with the methodology of his survey. Although the Nahomba rhino area is about 400 km² in total, time constraints allowed for only about 60 km² of it to be surveyed.

VEGETATION

Compared with the adjacent Lukuliro area, the Nahomba vegetation is primarily *Brachystegia* and *Pterocarpus* woodland with relatively small patches of coastal thicket. Some thicket patches appear to be decreasing in area as a result of fire damage. This observation is purely subjective but the subject de-

Max Morgan-Davies



Many of the smaller patches of thicket appear to be decreasing in area as a result of annual dry-season fire damage.



A shallow dry-season waterhole in the bed of the Nahomba River near its headwaters.

serves further investigation in light of the importance of these thickets for rhinos.

WATER

Although the Nahomba River normally flows during the height of the wet season, only five residual waterholes (maintained by elephants) supply water to this area during much of the rest of the year.

RHINO NUMBERS AND DISTRIBUTION

Within the approximately 60 km² of area surveyed, the tracks of three to four individual rhinos were identified. All were recorded within a few kilometres of the Nahomba headwaters. It is not possible to estimate the extent of movement of these few animals, although it is likely that they move between Nahomba and Lukuliro, and possibly even further westward.

SECURITY

Many years ago the Wildlife Division permitted the construction of a vehicle track that runs for a distance of 9

km parallel to the upper reaches of the Nahomba River. The track is less than 100 m from the river and has full view of four of the five waterholes. At one waterhole there was a much-used and annually refurbished tree hide. Such hides should be forbidden in areas where there are rhinos. The temptation for poachers to use such gratuitous constructions from which to shoot at, or follow up, a drinking rhino or elephant is obvious. At one waterhole the survey team found a dead elephant. The body was too putrefied to ascertain the cause of death. Anti-poaching patrols in the Nahomba area are as infrequent as in the Lukuliro area.

Naluale

LOCATION

The Naluale rhino area is located in the southern sector of the SGR along its southern boundary. The area straddles a number of small perennial streams that make up the headwaters of the Naluale River. Approximately one-third of the area lies in the Udendeule Forest Reserve, which is outside the Selous Game Reserve, and the remaining two-thirds within the reserve—a total area of about 100 km².

VEGETATION

Compared with much of the SGR, the more steeply undulating countryside around the Naluale River headwaters has a relatively thin cover of open *Brachystegia* wooded grasslands and eroded ridgetops. There are scattered patches of light riverine forest.

WATER

Water is relatively easily found throughout the year in many of the smaller streams that run into the Naluale River.

RHINO NUMBERS AND DISTRIBUTION

This area was investigated by Laurie (1991) and evidence of a small number of rhinos was recorded. However, the present survey disclosed no signs of rhinos. From field investigations and discussions with the local rangers, it now seems unlikely that rhinos exist in any viable numbers east of the Ligombe and Naluale headwaters. This is not, however, the situation around the headwaters of the Horogwe River, about 25 km to the west.



Max Morgan-Davies

Carcass of an elephant found by the survey team at the head of the Nahomba River.

SECURITY

Foot patrols in the Naluale area are infrequent and no special effort is made by Wildlife Division field staff stationed at Likuyu Sekamaganga to investigate and monitor the occurrence of rhinos in this southern extremity of the SGR. The area immediately outside the southern boundary of the reserve (where rhinos

are alleged to occur) is designated a wildlife management area in which villagers have rights to use wildlife on a sustainable basis. The only wildlife seen by the survey team while working in the Naluale and Horogwe areas was a single genet cat and a lone buffalo. Animal tracks of any sort were a rarity. It is debatable if the reduction of rhinos between Laurie's 1991 survey and this 1998 survey seven years later is due to human disturbance or to a natural movement of these animals within a greater home range.

Horogwe

LOCATION

The area was chosen for survey as a result of an earlier aerial investigation and discussions held with the Wildlife Division staff stationed at Likuyu Sekamaganga. The area is located around the headwaters of the Horogwe River between the Luwegu and Ligombe Rivers in the southern sector of the SGR. Like the Naluale area, the southern boundary of the reserve passes through the Horogwe survey area from south-east to north-west.

Max Morgan-Davies



One of the many eroded ridgetops in the Naluale area.

Although the area surveyed was only about 250 km² in extent, this could have been increased with advantage. Regrettably, the whole survey team succumbed to severe food poisoning and had to be evacuated to Likuyu Sekamaganga for urgent medical treatment.

VEGETATION

In keeping with the majority of the SGR, the vegetation of Horogwe is dry *Brachystegia* woodland that covers the middle and upper slopes of a closely undulating but occasionally steep landscape of ridges and valleys. Nearly all valleys are lined with close canopy, evergreen forests, a verdant undergrowth mosaic and small intermittent patches of perennial swamp or seasonally flooded tall grasslands.

WATER

Unlike the Lukuliro area in the eastern Selous, where water is scarce and restricted to a few small waterholes in the dry season, the whole area of probably more than 1000 km² to the north of Nahomba, between the Luwegu

and Mbarangandu Rivers, is covered with a vast network of perennial springs, streams and a small number of miniature lakes. A rhino in search of water at any time of the year would not have to travel more than 1–1.5 km almost anywhere in this region. Maintaining vehicle tracks throughout most of this area, even during the dry season, necessitates the constant felling of small trees to place across the numerous streams. Without these temporary wooden crossings, which are regularly washed away during the wet season, even 4 x 4 vehicles can get stuck in the coarse sand that lies below the crystal clear water found in the majority of these streams.

RHINO NUMBERS AND DISTRIBUTION

After only one short visit to the area it was not possible to determine if the Horogwe rhinos are resident within the area throughout the year. It is equally possible that they move around during the wet season, as do the Kidai animals, and possibly also the Lukuliro population. With coarse, dry sandy soils on ridgetops and slopes, it was not possible to ascertain much in terms of possible rhino numbers from their tracks. However, the records of two

Max Morgan-Davies



Temporary bridge built with young *Brachystegia* trees across one of the many streams in the Horogwe area.

fresh tracks, 16 dung piles and 17 scrapes indicate that 5–8 animals could be in the area. Two important findings were 1) the identification of a confirmed third breeding population, and 2) the vast area of prime rhino habitat between the headwaters of the Luwegu and Mbarangandu Rivers that still needs to be investigated.

Track details of rhino calf and adult recorded in the Horogwe area:

Date: 20 June 1998

Track width: 16.0 cm

Indistinct track of single calf plus adult

SECURITY

The security of rhinos resident immediately within and along the southern boundary of the SGR is of concern. Rangers and infrastructure at Lukuyu Sekamaganga Wildlife Division headquarters are inadequate, foot patrols are infrequent, and roads and river passes receive little attention. Encroachment by hunters from the Community Wildlife Management Area into the neighbouring Udendeule Forest Reserve and the SGR itself has been recorded and may be the cause of the evident lack of wildlife in the area. It is almost impossible to obtain a true assessment of the extent of human encroachment and poaching as information elicited depends on who is interviewed. The remoteness of the area and the inadequate ranger force does not, under present circumstances, make it a secure location for the long-term survival of rhinos. A further and more extensive ground survey needs to be undertaken as soon as possible in the potentially excellent rhino area between the Luwegu and Mbarangandu Rivers.

Intensive Protection Zone status for the Lukuliro–Nahomba area

The Policy and Management Plan for the Black Rhinoceros in Tanzania (Tanzania 1993) calls for ‘establishment of intensive protection zones (IPZs) in suitable rhino areas to ensure the recovery of this species’.

The Selous Game Reserve General Management Plan (Tanzania 1995) states one of its objectives is ‘to provide adequate protection of rhinos by establishing IPZs in areas where they are known to still occur, and that these areas will be patrolled very frequently by motivated patrol teams’.

The 1998 draft Policy and Management Plan for the Black Rhinoceros, *Diceros bicornis*, in Tanzania

(Tanzania 1998) continues to support the establishment of IPZs in Rhino Protected Areas wherever possible.

The Wildlife Division is therefore eager that the important Lukuliro area (ideally together with the Nahomba area) be approved as an IPZ in recognition of the division’s efforts in protecting this unique metapopulation of the southern subspecies of the black rhino. However, AfRSG specifies that a prerequisite for IPZ status is that law-enforcement staff be deployed in the field at moderate to high density specifically to protect the rhino population, at a recommended level of one ranger per 10 km² but not less than one ranger per 30 km². Additionally, AfRSG will support the development of an IPZ only if there is long-term sustainable funding to support it (Richard Emslie, pers. comm. 2001).

The core rhino area of Lukuliro is about 250 km² and that of Nahomba 400 km², making a total of about 650 km². Complying with AfRSG guidelines, the two combined areas would therefore require between 22 and 65 rangers. However, appreciating existing financial and staff constraints, a more practical figure of 40 dedicated rangers should be able to provide adequate surveillance and security for this area.

Infrared beam-operated cameras

During the course of these surveys, active TrailMaster infrared beam-operated cameras were used wherever and whenever possible. A number of inherent, ongoing practical problems were experienced in the field—not least being vandalism by baboons and total destruction of equipment by hyenas. When these problems did not occur, night photographs of elephants and buffaloes were relatively easy to obtain. A night photograph of a rhino has yet to be obtained. Two major drawbacks inhibited the successful use of this equipment during these surveys:

- The relative complexity of the infrared ‘receiver’ element excluded the equipment from being effectively operated by any of the rangers.
- The initial setting-up of 6–10 cameras and constant servicing of them every 2–3 days proved more time consuming and disruptive of the survey work than had been anticipated.

With the surveys now completed, and most of the cameras still intact, it is hoped that an effort will be made to pursue an infrared camera monitoring programme in the Lukuliro–Nahomba and Kidai areas.



One of the many elephant images taken with an infrared beam-operated camera. A rhino photograph has yet to be obtained with one of these cameras.

Despite not obtaining infrared beam-operated photographs of rhinos during the survey period, with more time available for camera work by a small and dedicated team (particularly if undertaken on a full-time basis with no distractions), valuable results should be obtained (Griffiths 1993).

Rhino faecal DNA

As part of the survey it was proposed that DNA extracted from rhino dung be used to identify individual animals based on unique patterns of different polymorphic loci. The sex of individual rhinos was also to be determined from their dung by using sex-specific primers. In this manner it was expected that

- the minimum number and sex of the rhinos within each surveyed area would be ascertained
- by the use of the Bayesian Mark–Recapture RHINO software, an accurate population estimate could be made, which would help estimate the carrying capacity of each of the surveyed areas—particularly that of Lukuliro–Nahomba (Emslie 1993)

In March 1997, the faecal DNA research proposal was accepted by Dr Colleen O’Ryan, Department of Biochemistry, University of Cape Town. A total of 50 faecal samples from three locations were collected and sent for analysis (table 2).

Table 2. Details of 50 rhino faecal samples collected for DNA analysis

Date sent for analysis	Number of samples
<i>Kidai area</i>	
September 1998	2
March 1998	5
December 1998	11
Total	18
<i>Lukuliro area</i>	
September 1997	7
December 1997	15
April 1998	3
Total	25
<i>Horogwe area</i>	
August 1998	7

In this pilot study, total genomic DNA was extracted from these dung samples and polymorphic microsatellite DNA loci were amplified using the polymerase chain reaction. Although very low amounts of DNA were extracted, and inhibitors of plant origin were co-extracted with the rhino DNA, positive amplification products were obtained from 60% of the dung samples collected from the Lukuliro area. Nine genotypes were observed using a polymorphic microsatellite locus specific for the black rhino. Preliminary data suggest that eight of the nine genotypes are unique and to date represent the minimum number of individuals present in this particular Selous metapopulation; it is possible that more will be identified when the remaining 40% of the Lukuliro samples have been analysed.

The success of a DNA-based procedure to estimate the minimum number of individual rhinos in a population from their dung will have profound consequences, not only in the SGR but in similar locations throughout Africa and Asia where access to elusive rhino or other endangered wildlife populations cannot be reliably had by any other means.

Discussion and recommendations

Although the number of *D. b. minor* in Tanzania has been considerably reduced over the past 20 years, the present investigation, together with those of Stronach (1991) and Laurie (1991), confirms that the species continues to exist, albeit in relatively small numbers scattered about the SGR. However, the threat to rhinos and elephants from poaching in the reserve is still present. Although no rhino carcasses have apparently been found in recent years (Benson Kibonde, SGR project manager, pers. comm. 1996), the large areas of dense evergreen thicket and riparian forest, and the inadequate ranger force dedicated to daily monitoring of most rhino populations makes the detection of carcasses on foot or from the air very difficult—particularly in the wet season. This could give the false impression that there is no poaching and that the population is stable when, in fact, it is in covert decline as rhinos become fewer and increasingly isolated from each other because of poaching or human disturbance, and breeding finally ceases.

To prevent such a situation and to build up existing rhino numbers in the SGR, the following measures are recommended for priority consideration:

- The joint Lukuliro–Nahomba area is immediately

accorded IPZ status as specified by AfRSG.

- A specially trained and dedicated force of rhino rangers, under committed field leadership, must be assigned to this and any other IPZ in the SGR throughout the year exclusively for the surveillance, monitoring and security of these areas. These rangers should not be periodically diverted, as at present, to such duties as road building or boundary demarcation or to accompany licensed sport hunters.
- Additional favourable rhino areas that have not yet been investigated should be surveyed, for example, between the Luwegu and Mbarangandu Rivers, the thickets at the headwaters of the Luwimbi River, and the area of the Nyanga Pan.
- Work with the TrailMaster infrared beam-operated cameras should continue, particularly within the Lukuliro–Nahomba and Kidai areas.
- The rhino faecal DNA work so far undertaken by Dr Colleen O’Ryan to obtain information on minimum numbers and sexes of individual rhinos within each sub-population should continue.
- All rhino rangers should receive additional specialized training in practical rhino tracking and field craft. This training could be provided through the courtesy of one or another of the numerous wildlife management agencies in southern Africa or Kenya.
- Rangers should be instructed to specifically investigate, particularly during the wet season, any movements of rhinos between one sub-population and another. A suitably trained and experienced senior officer should be permanently stationed at Kingupira to administer all matters pertaining to the surveillance, monitoring and security of rhinos throughout the SGR, under the direction of the national rhino coordinator.

Acknowledgements

I am grateful to the Tanzania Wildlife Division for authorizing these rhino surveys in the Selous Game Reserve; the US Fish and Wildlife Service and the World Wide Fund for Nature for co-funding the project; the African Rhino Specialist Group for their technical input; and the Department of Biochemistry, University of Cape Town, for their microsatellite DNA work.

I am particularly appreciative of the assistance I received from Keryn Adcock, Richard Barnwell, Jessica Cunningham, Holly Dublin, Raoul Du Toit, Richard

Emslie, Charles Fraser, Kassim Kayoyo, Benson Kibonde, Andrew Laurie, Musa Lyimo, Esmond Martin, Bakari Mbanjo, Simon Milledge, Willingness Minja, Frumnes Mngara, Herman Mwageni, Hassan Ndauka, Kate Newman, Colleen O'Ryan, Paul Siegel, Peter Stephenson, Bimb Theobald, the late Lizzy Theobald, and all the Wildlife Division rangers and staff who accompanied me during these surveys.

References

- Emslie, R.H. 1993. RHINO version 1.2/1.21. A population estimation package designed for black rhinoceros in particular, but applicable to other species. In collaboration with L.G. Underhill, H.J. Van Hensbergen, K. Adcock, N. Pendock and W. Zucchini. Ecoscot Consultancy Services. Set of three software manuals. 285 p.
- Griffiths, M. 1993. *The Javan rhino of Ujong Kulon: an investigation of its population and ecology through camera trapping*. PHPA/WWF, Jakarta.
- Laurie, A. 1991. Survey report and recommendations. In: *Tanzania Rhino Conservation Project report*. Frankfurt Zoological Society, Frankfurt. 19 p. Unpublished.
- Morgan-Davies, A.M. 1997. Proposal to the US Fish and Wildlife Service for financial support under the Rhinoceros and Tiger Conservation Fund for staff training and the survey of four black rhino, *Diceros bicornis minor*, populations in the Selous Game Reserve, Tanzania, with a view to their conservation through the establishment of Intensive Protection Zones. World Wide Fund for Nature and Tanzania Wildlife Division. 23 p. Unpublished.
- Severre, E. 1993. Taxonomy of Tanzania's rhinos. Paper presented to the Tanzania Rhino Workshop, Arusha, 3–5 May 1993. 7 p. Unpublished.
- Stephenson, J.G. 1987. Rehabilitation of the Selous Game Reserve. Final report by the Frankfurt Zoological Society on behalf of the Wildlife Department, Ministry of Natural Resources and Tourism, United Republic of Tanzania. Unpublished.
- Stronach, N. 1991. Selous Game Reserve: Elephant and rhino conservation report. World Wide Fund for Nature. 6 p. Unpublished.
- Tanzania. Department of Wildlife. 1993. Policy and management plan for the black rhinoceros in Tanzania. 11 p. Unpublished.
- . 1995. Selous Game Reserve general management plan. 145 p. Unpublished.
- . 1998. Policy and management plan for the black rhinoceros, *Diceros bicornis*, in Tanzania. Draft document to Minister for Natural Resources and Tourism, Tanzania. 34 p. Unpublished.