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Ecosystem studies on the former Mkwaja Ranch and the new Saadani National Park between 2001 and 2004

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Mkwaja Ranch
(Paddock)

Saadani Game Reserve
(Savanna landscape)

Deutsche Gesellschaft für Technische Zusammenarbeit
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FOREWORD

Between 1996 and 2003 the Federal Republic of Germany assisted the Government of Tanzania in rehabilitating and developing the Saadani Game Reserve, and eventually transforming it into a National Park.

This stretch of land along the coast of the Indian Ocean between Pangani and Bagamoyo is not an untouched wildness, but a landscape with a history of human settlement dating back a thousand years. However, very little is known about its existing biodiversity and its conservation value.

We therefore welcome the ongoing research of the Swiss Federal Institute of Technology/ETH Zuerich. I am thankful to Anna Treydte for providing a summary of some of the major features of her PhD dissertation, which was carried out as part of the research programme on Savannah dynamics undertaken by Prof. Dr. Kloetzli since the seventies.

Dr. Rolf D. Baldus

INTRODUCTION

Background. In recent decades African savannas have been increasingly used for ranching, and in Eastern and Southern Africa large cattle farms have been common, with the result that livestock biomass today exceeds that of indigenous ungulates (du Toit & Cumming 1999). The replacement of the natural and sustainable plant-herbivore interaction of various wildlife species by a single livestock species has usually had drastic effects on savanna ecosystem structure and function (Prins 1992, Walther 2002, Augustine 2003). While changes in vegetation structure and shifts in the nutritional quality of plants due to high densities of cattle grazing have often been observed, very little is understood about the nutrient redistribution through wildlife and the 'recolonization' process of native ungulate species entering such an altered landscape. Free ranging wildlife species can act as habitat restorers when they resettle in patches that are nutritionally and structurally attractive in an otherwise depleted rangeland.

Study objectives. This PhD study was carried out in a former cattle ranch (Mkwaja Ranch) which was in operation for almost 50 years and which now forms part of the Saadani National Park at the north-eastern coast of Tanzania. The project describes some of the vegetation changes caused by ranching and the first steps towards recolonization of the savanna ecosystem by wildlife. The work was carried out at various spatial scales. At a regional scale we investigated the presence and abundance of wild ungulate species on walking transects within the entire newly protected area. We then focussed upon patches of a particular type of habitat, the former cattle herding grounds or "paddocks", and used indirect observations based on tracks and signs to investigate the use of these areas by the common warthog (*Phacochoerus africanus*). Finally, a variety of analytical techniques were employed to gain information about the nutritional quality of plants and the diet of warthogs from their faeces.

History of Mkwaja Ranch. Mkwaja Ranch was started in 1954 by the Swiss company Amboni Ltd. in the Tanga /Pwani region, and cattle were mainly raised to supply the workers of sisal plantations with meat. The ranch increased significantly over the years, and up to 13,000 cattle grazed on the coastal savanna ground (Ford &

Blaser 1971, Fox 1990). The impact they had onto the vegetation was soon obvious: the bushy vegetation increased which resulted in decreasing grazing ground, higher tse-tse fly densities and higher efforts and maintenance costs to keep up with business (Klötzli 1995, Tobler et al. 2003). Part of the ranch, Mkwaja South, was already sold in 1996, and finally, the northern part of the ranch, Mkwaja North, was closed in the year 2000. One year after abandonment of the cattle raising business, the former ranching area was included into the new Saadani National Park (TANAPA 2002). Between 1996 and 2004, the rehabilitation of Mkwaja and Saadani Game reserve and the transition towards a National Park was supported by the Federal Republic of Germany through GTZ. Adjacent to the ranch in the south the Saadani Game Reserve was situated, an area protected since 1972 and densely populated by wild animals such as Hartebeest (*Alcelaphus buselaphus*), Waterbuck (*Kobus ellipsiprymnus*), Bohor Reedbuck (*Redunca redunca*), Giraffe (*Giraffa camelopardalis*), several Duiker species, Warthogs (*Phacochoerus africanus*) as well as predators such as the Lion (*Panthera leo*). Now the former ranch and the Game Reserve are combined and under protection by TANAPA and wildlife species are free to move within the entire area and its buffer zones (Baldus, Roettcher & Broska 2001).

View over Mkwaja Ranch

STUDIES

Our study in the new Saadani National Park was aimed at the entire ecosystem of this coastal savanna landscape, and we investigated both vegetation and wildlife. We described and quantified the vegetation changes that occurred due to the 50-year long life-stock grazing. We also counted and observed wildlife species (direct and indirect observations) to understand how native animal species can use this impacted area now after the cattle are withdrawn from the ranch. In this article, we focus on the

recolonization process and the preferred habitat of native ungulate species in an environment modified by domestic livestock use. Habitat use and feeding preferences of native ungulate species might reflect an adaptation to the altered ecosystem conditions on the former rangeland. We present three main scientific questions and results of the entire study, which was conducted between 2001 and 2004.

1) QUESTION: What animal species are present on the abandoned ranch?

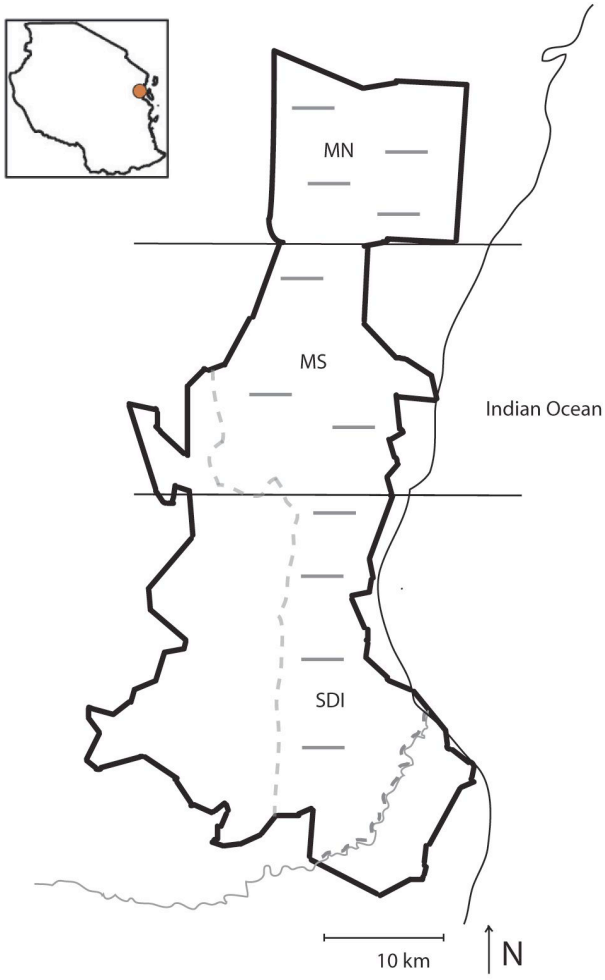
We wanted to assess the number of the major wild animal species, mainly herbivorous ungulates, present in the new Saadani National Park. In particular, we wanted to test whether there was a difference in wildlife abundance and species composition between Mkwaja Ranch and the former Saadani Game Reserve. On Mkwaja, many animals had been chased away during ranch operation because they were carrier of diseases harmful to cows (Amboni Ltd. 1954-1999, Fox 1990), and poaching activity was high directly after the ranch closed (pers. obs.). Therefore, we expected a low number of animals on the former rangeland, mainly composed of animals that could cope with the high bush density, animals that had not been directly in food competition with cattle and that could avoid livestock and humans during ranching times. Additionally, based on previous survey data of the Tanzanian Wildlife Conservation Monitoring program (TWCM) and on our surveys, we investigated the overall trend of population dynamics between 1991 and 2003 in the entire Saadani ecosystem.

Methods:

We established eleven ground transects of 4 km length each within the entire study area of about 680 km^2 in 2001 (Figure 1). Within 2001 and 2003, we walked along these transects together with game scouts of the former Saadani Game Reserve and recorded the number of individuals of all wildlife species, together with the habitat and position they were encountered in. These surveys were conducted early in the morning and in the evening during the main activity hours of the animals. To analyse the data, we used DISTANCE sampling, a technique and software program that takes

different detection probabilities due to a varying habitat into account (Buckland et al. 2001). In a particularly patchy mosaic of habitat such as Mkwaja Ranch, this technique helps to adjust population estimates for animals that could have been missed during the survey. We calculated estimates of population sizes based on the number of individuals encountered. We also used old reports of surveys conducted between 1991 and 2001 in the Saadani ecosystem by the Tanzanian Wildlife Conservation Monitoring (TWCM) to detect trends in population densities over time.

Figure 1



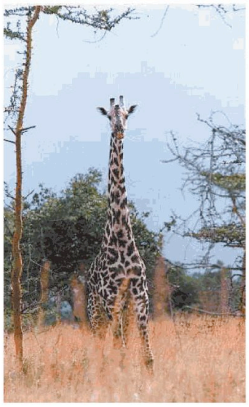
Results and discussion:

Within the entire study area we found animal species rather typical for savanna landscapes in East Africa (Robinson 1999; some examples see Figure 2). Previous survey data combined with our survey showed that there had been an increase in species richness and in population densities within the entire Mkwaja / Saadani ecosystem from 1991 to 2001. Yet, very few animals lived in Mkwaja North, the former ranch area that was abandoned in 2000. Here we found animals that belonged mainly to the browser / mixed feeder guild such as Red Duiker *(Cephalophus Harveyi)* and Grey Duiker *(Sylvicarpa grimmia),* Bushbuck *(Tragelaphus scriptus)*, Giraffe *(Giraffa camelopardalis)*, etc. Some of the large grazer species that usually live in large herds, such as Wildebeest (*Connochaetes taurinus*), Common Zebra (*Equus quagga*), or Hartebeest (*Alcelaphus buselaphus*) only occurred in the more open

habitat of the former Game Reserve and Mkwaja South but never in the bush-increased terrain of Mkwaja North. We found large populations of most species in the former Saadani Game Reserve, and several of these populations might even be close to carrying capacity. Hence, we would have expected a larger proportion of wildlife species moving northwards into the newly opened former rangeland. However, the wildlife survey showed that between 2001 and 2003, immediately after the ranch closed and the entire area became a National Park, few native ungulates were present in former ranch areas. Figure 2

A few browser species dominated in the bush-thicket / savanna mosaic of the former ranch, while in the adjacent Saadani game reserve species richness of both browsers and grazers was high. We therefore conclude that the recovery of vegetation and recolonization through wild ungulates will take place gradually, with pioneer species facilitating the entry of more demanding animal species by opening up the vegetation and improving the quality of forage. One of the most abundant animal species on Mkwaja Ranch was the warthog. Therefore, we used this grazer species as an example in our further studies on how wildlife will be able to use this newly developed rangeland habitat (Treydte 2004).

Bohor Reedbuck
Redunca redunca



Giraffe
Giraffa camelopardalis

Wildebeest
Connochaetes taurinus

Waterbuck
Kobus ellipsiprymnus

Hartebeest
Alcelaphus buselaphus

Warthog
Phacochoerus africanus

2) QUESTION: How can recolonising wildlife species use the former ranch habitat?

We investigated the habitat preferences of a native grazer, the common warthog (*Phacochoerus africanus*), and how it utilized the abandoned rangeland. Our sampling scheme was centred on the former cattle herding grounds, the so called paddocks. Cattle were fenced there over night while they were walked to grazing areas and water reservoirs during the day. Therefore, the impact of trampling, grazing and defecating decreased with increasing distance away from the paddock centre, and a characteristic vegetation structure and species composition has developed. We expected wildlife to be attracted to the paddocks because of their habitat structure and the presence of good quality fodder plants on nutrient-enriched soil. Hence, we recorded vegetation and habitat structure on the paddocks and their surrounding savanna landscape. We also calculated indices of warthog presence and activity based on different signs and we tried to identify the factors that seemed to be important for the habitat choice of the warthog.

Warthog family on a paddock

Methods:

During ranching times there were about 14 paddock areas distributed on Mkwaja North. We conducted vegetation and habitat analyses on seven different paddock systems, i.e. in the paddock centre and centrifugally spreading out away from the centre into the surrounding savanna landscape (Figure 3). We recorded the grass species present, the vegetation cover of the grass, forb, bush and canopy layers, the distance to the next open water source, the average vegetation height, etc. We delineated several sample transects of 300 m^2 in four different vegetation zones that could be discriminated in and around paddocks due to their different grazing history and their distance from the paddock centres (Figure 4). We used the indirect

observation technique and recorded signs such as footprints, dung pellet groups and digging tracks of the warthog. We visited the plots repeatedly on seven different occasions between May 2002 and February 2003 and recorded vegetation structure and signs of warthog activity, some of which are shown in Figure 5. With this technique, we wanted to test whether warthogs showed a regional or seasonal preference in using the paddock sites preferably over savanna habitat.

Figure 3

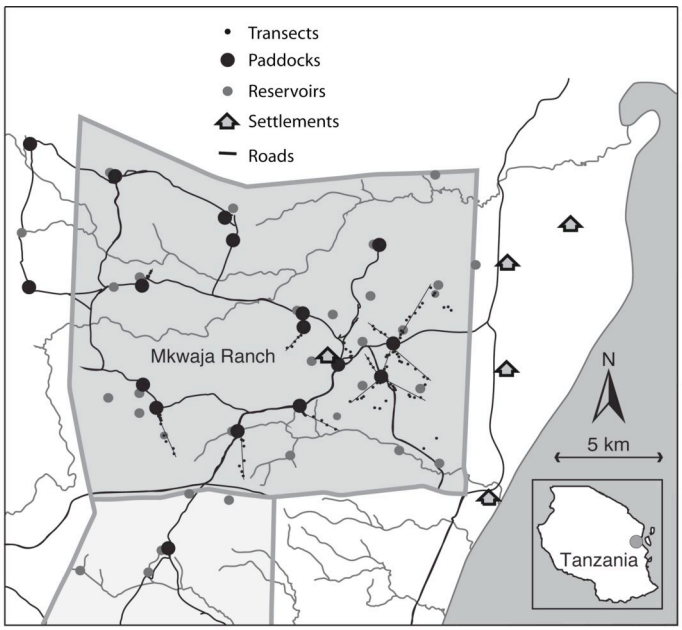


Figure 4

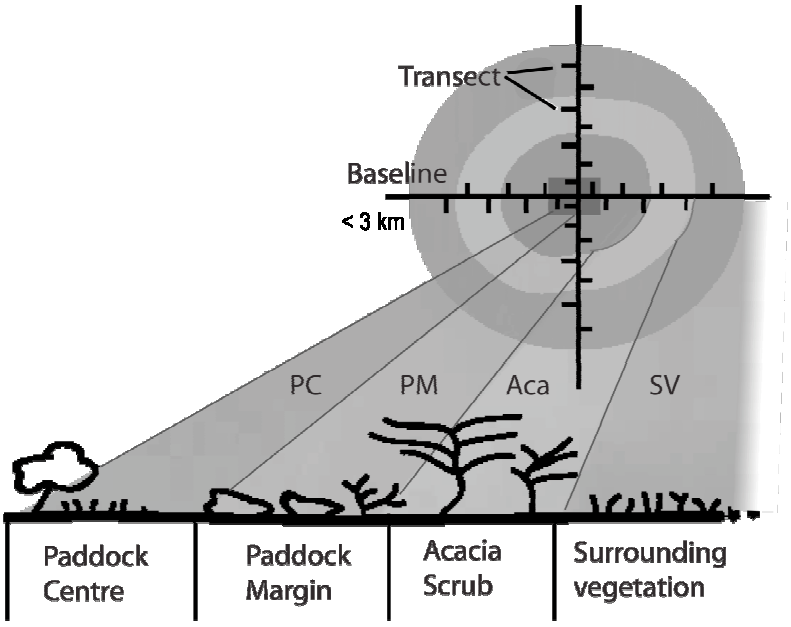
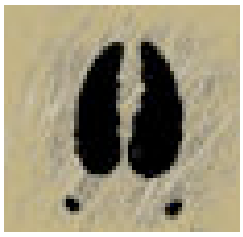


Figure 5

faeces



footprint

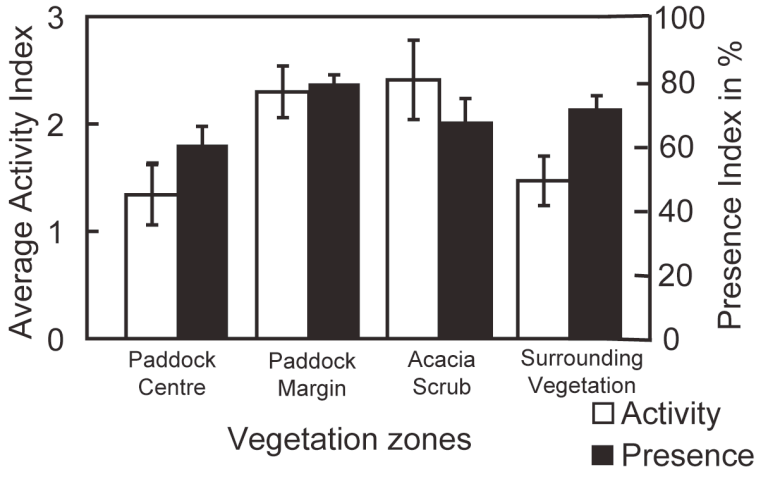
digging

burrow

Results and discussion:

Paddock centres and their adjacent vegetation zones (altogether we described 4 different zones) showed a very distinctive vegetation structure and species composition: in every paddock centre, a very dense short grass layer of *Cynodon dactylon* dominated the vegetation structure, and few big rees, some forb species but little bush cover were characteristic; the adjacent paddock margins showed high grass species diversity and a high bush cover, clumped vegetation of grasses and forbs with many spots of bare soil in between; adjacent to this vegetation zone began dense Acacia scrub, where almost monospecific *Acacia zanzibarica* stands and tall grasses dominated and where the canopy cover was high; the afterwards following surrounding vegetation was a mixture of very tall savanna grasses, interspersed by bushes and Acacia trees and some more dense palm bush-mosaic and here the cattle impact had been least severe. We found most of the tracks and signs of warthogs in the immediate surroundings of the paddock centre, i.e. the paddock margins and the *Acacia* scrub (Figure 6), where bush cover and the grass species diversity were highest. In the surrounding savanna landscape we found only few signs, mainly footprints, indicating that warthogs were also present but not actively digging or searching for food in these areas.

Figure 6



Warthog presence and activity were dependent on the presence of short grasses and rather bushy surroundings, probably due to a better view for and cover from potential predators, respectively. In particular during the dry season the presence and activity of animals was highest within and close to paddocks. The paddock centres and their margins provided important fodder grass species for the warthog (Kingdon 1997, Cumming 1978). Hence, we observed preferences for former paddocks that offer particularly attractive habitat features in the abandoned rangeland.

During the course of our study we observed increasing numbers of other wild grazers including wildebeest (*Connochaetes taurinus*) and waterbuck (*Kobus ellipsiprymnus*), which gathered in small numbers in and close to paddocks. Thus, the common warthog might represent one of the first ungulate species to make use of the nutrient-rich former cattle herding grounds of Mkwaja Ranch. Non-invasive, indirect observation proved useful in documenting first patterns of resettlement in an area where direct observations were difficult. This method allows a rapid assessment of habitat use and preferences by wildlife in heterogeneous environments, and it provides valuable information for developing strategies of habitat restoration and management of degraded landscapes.

3) QUESTION: Do warthogs prefer former paddocks as a feeding ground?

We were interested in whether warthogs would prefer paddock grasses to other savanna grasses and whether paddock grasses showed better forage quality. Would a warthog, adapted to rather nutrient-poor savanna forage grasses, feed locally and prefer the areas that developed a particular accumulation of feeding resources due to

cattle ranching? We investigated whether warthogs were selective in their food choice and if they changed their diet over season. We expected the paddock grasses to be more nutrient rich and therefore, they should represent a high percentage in the diet of a warthog. These animals, non-ruminants of medium size should be selective in their food choice in a savanna landscape to cover their nutrition requirements (Kingdon 1997), and hence they should select patches of high quality grasses, particularly when there is nutrient shortage during the dry season.

Methods:

In the same sample transects we used for our previous question, we collected grass and herb species, together with warthog faeces, in different regions and during different times of the year. We also sampled some areas in the former Saadani Game Reserve and compared the feeding behaviour of warthogs in the cattle un-impacted area with the warthogs on Mkwaja. We used several techniques to analyse the plants and faeces:

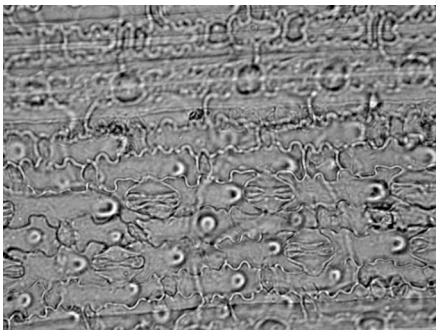
a) Nutrient analyses (Kjeldahl method): We tested whether the nutrient content of grasses differed locally or over season and we tested whether warthogs were nutrient deprived in certain areas or during a certain time of the year (Kinyamario & Macharia 1992).
b) Stable isotope technique (! ^{13}C and ! ^{15}N): We can determine the region of feeding (where the fodder plants grew) using the stable nitrogen isotopic fraction. With the carbon isotopic fraction, we can tell the percentage of grass (C_4 plants) and the non-grass component (C_3 plants) in the diet (Sponheimer et al. 2003).
c) Crude ashes: This technique indicated how much soil was ingested by the warthogs, and thus how intensely they were digging for roots, tubers or other items during foraging behaviour.
d) Microhistological analyses: Epidermal plant fragments in faeces can indicate the plant species that were eaten by the warthog (Stewart 1967).

These techniques were applied to material collected between February 2002 and February 2003. Additionally to our indirect observations on the warthog, we wanted

to achieve more information about the particular diet and to investigate the former paddocks presenting a seasonal or permanent food resource for these animals.

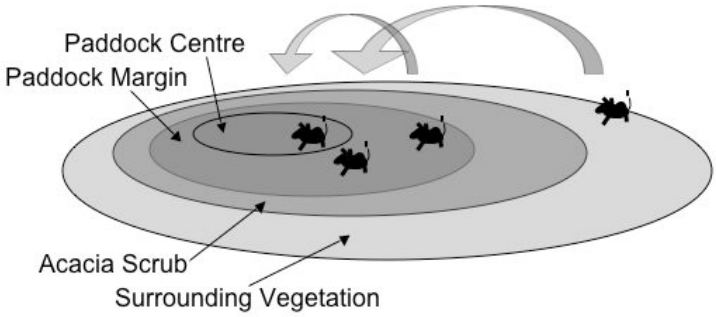
Results and discussion:

We found that the grasses and herbs with the highest nutritional quality grew in and around the former paddocks, where cows had been herded at night. Samples of paddock grasses presented the highest nitrogen and phosphorus contents, being four times higher than those of grasses in the surrounding vegetation during the dry season. Nitrogen and phosphorus contents of faeces samples of the warthog indicated that the animals did not suffer from shortage of these nutrients at any time during the year. Faecal ! ^{13}C analyses revealed that the proportion of C_4 grasses in the diet of warthogs averaged 83%, with regional but no seasonal differences. We found that the diet of warthogs on the former rangeland in some cases consisted to only 77% of grasses (with the lowest average values in faeces found in the paddock margins) whereas in Saadani, the former Game Reserve, warthogs almost exclusively lived on grasses (98% grass in faeces). Epidermal fragment analyses showed that a large proportion in faeces found close to paddocks contained paddock grass species, and mainly *Cynodon dactylon* was eaten. ! ^{15}N values of soil, plants, and faeces were highest in paddock centres and decreased significantly with distance from the paddock. Based on these ! ^{15}N values, it seems that warthogs preferred paddock vegetation, and they foraged selectively on locally available plants, especially on paddock grasses. Warthogs did not seem to ingest more soil during the dry season to compensate for possible nutrient deficits, as had been suggested by several authors (Cumming 1975, Rodgers 1984, Kingdon 1997). They might travel rather far to reach some nutrient-rich paddock ground, they might stay there for a while, and they probably drop their faeces close to where they



feed (Figure 7). Hence, they do contribute to nutrient-redistribution away from paddock centres into the surrounding vegetation over time, but in very small steps.

Figure 7



GENERAL CONCLUSIONS

On Mkwaja Ranch, rather few wild animals remained after long-term cattle grazing. The numbers of individuals counted in MN were particularly low, representing only 5 % of the total number of individual ungulates in Saadani National Park (mean data 1991-2001). While the ranch was in operation, most individuals of native wild ungulates including the African warthog were scatted because they were thought to be potential carriers of cattle diseases (Amboni Ltd. 1954-1999, Ford & Blaser 1971). Only small browsers such as duiker species or the bushbuck, that forage in bushland and that were able to hide, could evade human intervention. Competition for feeding resources between livestock and wildlife leading to an avoidance of rangeland by native ungulates (Fritz et al. 1996, Voeten & Prins 1999) could have caused the absence of large grazing species such as the wildebeest, hartebeest or the zebra at Mkwaja. The livestock density was on average 22.3 animals/km^2 between 1955 and 1994 (That 2004). The high grazing pressure by cattle led to important ecosystem changes including encroachment of woody species and nutrient transfer away from pastures to patchily distributed herding places (Augustine 2003, Tobler et al. 2003).

After abandonment of ranching and protection of the area, we expected native ungulates to resettle quickly in the protected former farmland. The former paddock grounds contain vegetation of high nutritious quality and represent a particularly attractive habitat for wildlife (Stelfox 1986, Augustine & McNaughton 1998).

Wildlife could also use the about 20 still remaining reservoirs that were built to provide water for cattle (Tobler et al. 2003). However, we found no evidence of an increase in wildlife in MN between 2001 and 2003.

One possible reason for the small size of ungulate populations on the former ranch might be because it requires more time until animals resettle in the area and our study period was too short to discover any increasing trends. Also, poaching pressure had been high shortly after closing of the ranch in 2000 until protection of the area by TANAPA in 2001 and could have increased shyness of the animals in Mkwaja. A tendency for African wildlife to avoid former livestock grounds has been shown by Fritz et al. (1996). We also suggest that a savanna largely devoid of ungulate herbivores presents a difficult environment for recolonising grazers, mainly because of the local reduction in plant food quality and the extensive spread of bush, which occurs in the absence of grazing. This may explain why the majority of wildlife on the former ranch was of browsing species. Resettlement of such an area by the grazing guild is likely to be a stepwise process, in which different herbivore species establish in a distinct sequence reflecting behavioural and physiological traits associated with their nutritional needs. We suppose that populations of nutritionally demanding, mostly smaller grazers, can only become established where food resources have been altered by less demanding pioneer species, or by fire.

Further studies on Mkwaja should investigate the sequence in which native herbivores return to the former ranch, their preferred habitat areas, and their impact upon the structure and species composition of the vegetation. For ecologists interested in the dynamics of savannas, watching recolonization by wildlife provides an insight into the processes and relationships that develop between different savanna plants and wild herbivores (du Toit & Cumming 1999). Long-term monitoring and tracking of the main wild ungulate species in this area could help identifying patterns of resettlement in this coastal savanna and predicting further shifts in species composition on the former rangeland. Future management policies should take advantage of facilitation processes involving wildlife. For example, browsers and mixed feeders such as elephants may open up the bush vegetation (van de Koppel & Prins 1998), in our case caused by high cattle densities, and thus facilitate recolonization by grazers. Long-term trends in population dynamics and patterns in

habitat use can show resilience of wildlife in a coastal savanna ecosystem and such information is needed not only for the sustainable use of wildlife and habitat resources but also to restore degraded habitats.

ACKNOWLEDGEMENTS

The results are published in more detail as PhD dissertation work, conducted by A.C. Treydte at the Swiss Federal Institute of Technology in Zurich, Switzerland (Diss ETH No. 15585, ETH Zurich). The thesis will be available as PDF version via internet and offprints can be ordered directly from the author. Some pictures were kindly provided by D. Heile, by S. Aebischer and M. Svoboda. The study was funded by the Swiss National Fund (SNF). Research was conducted with permission and support given by Tanzania Wildlife Research Institute (TAWIRI), Commission of Science and Technology (COSTECH), The Wildlife Division and Tanzania National Parks (TANAPA). We thank Prof. S. Maganga (SUA) in Morogoro, Dr. R. Baldus and K. Roettcher (Saadani Conservation and Development Programme / GTZ) in Dar Es Salaam and Mr. Njau (TANAPA Saadani) for fruitful discussions and for their logistic support during our field studies in Tanzania. Our gratitude goes to Mzee Ndauka (GTZ Saadani Project), to all rangers of the former Saadani Game Reserve and to several other helpers for their assistance in the field.

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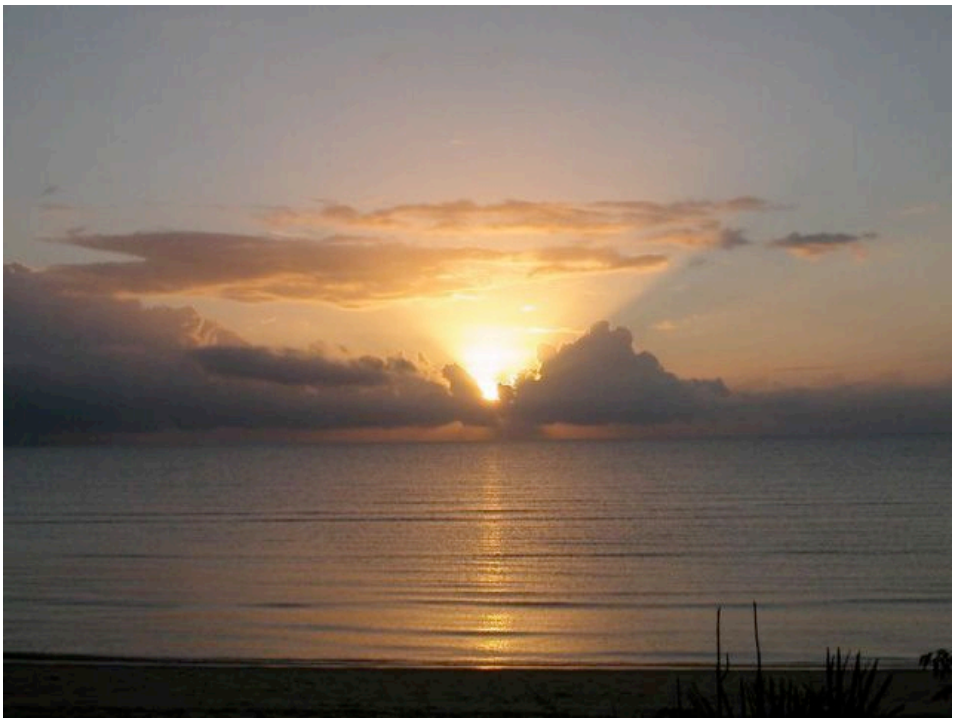

Sunrise over the Indian Ocean at Saadani beach.