CHAPTER 3

GENERAL METHODS

INTRODUCTION

The first aim of the present study was to determine the biological importance of the Tshanini Community Conservation Area in contributing towards the conservation of the rare Sand Forest habitat type. This was done by comparing the Sand Forest bird assemblages that are found in areas characterised by low levels of human utilisation, such as the Tshanini Community Conservation Area, with those characterised by primary wildlife utilisation, such as Tembe Elephant Park. This approach aimed to indicate the extent to which local human activities were having an effect on Sand Forest bird assemblages and it was used here as a point of departure to determine the feasibility of setting aside a part of the Manqakulani Ward as a wildlife resource use area. Birds were selected as a focal taxon because the Maputaland Centre of Plant Endemism has a rich avifauna, including a number of endemic species and subspecies (Clancy 1996; Harrison *et al.* 1997; Van Rensburg *et al.* 2000), the southern African birds are systematically well-known and well-surveyed (Harrison *et al.* 1997), and birds are relatively easy to sample quantitatively when compared with some other vertebrate taxa (Mac Nally 1997).

The second objective of this study was to gather information on the habitat preference and conservation status of selected herbivore species within the Tembe Elephant Park. This was done to identify possible competition between species and/or a decrease in numbers of rare species. It was furthermore aimed to identify herbivores that might be adversely affected by the destruction of Sand Forest, or who may themselves have a destructive effect on Sand Forest. Target herbivores included the nyala, impala, Burchell's zebra, greater kudu, red duiker and suni. Information on the habitat preference and status of the target herbivores is presented in separate chapters. In order to reduce the amount of repetition the detailed methods for the habitat preference and status of the respective target herbivores are presented here. The methods in the respective chapters are restricted to the broad outlines of the methods employed.

Bird surveys

In a previous study, Van Rensburg *et al.* (2000) investigated the habitat-associated heterogeneity and endemism of avian assemblages within and between Sand Forest patches and the savanna-like Mixed Woodland matrix that surrounds it. They collected bimonthly data for 12 months within the Tembe Elephant Park, hereafter referred to as Tembe and Sileza Nature Reserves that are *circa* 20 km apart and concluded that the relevant bird assemblages differed between habitats both within a given reserve and between reserves and also between reserves for a given habitat. No significant difference was, however, found between bird assemblages from different sample sites within the same habitat type within a particular reserve. For the present analysis, we used the basic data of Van Rensburg *et al.* (2000) on Tembe as a measure of avian assemblage structure as being representative of the Sand Forest and Mixed Woodland in a protected area and compared it with that of the Sand Forest and Mixed Woodland assemblages on unprotected communal land in the Tshanini Community Conservation Area, hereafter referred to as Tshanini.

Visual and auditory bird surveys were done monthly in the Tshanini area between 1 July and 31 December 2002 and therefore include data only for the austral winter and summer months. Because this area is not characterised by four distinctive seasons but rather mostly by two (i.e. summer and winter) due to the nature of the climatic conditions associated with the region (Schulze 1982; Matthews *et al.* 2001), this temporal extent during which time surveys were conducted was considered appropriate. Only one breeding migratory bird species present in Tembe from the Van Rensburg *et al.* (2000) study was not recorded in the present study, while five breeding and four non-breeding migratory bird species not recorded in the Tembe study were recorded in the present study.

We followed the same bird surveying protocol as Van Rensburg *et al.* (2000) in Tembe, except that only a single Sand Forest and Mixed Woodland site each were surveyed in Tshanini as opposed to two replicated sites of each habitat type in Tembe. This was mainly done due to the small geographical size of Tshanini (*circa* 2420 ha) and the lack of continuous Sand Forest habitat due to its patchy nature and previous human utilisation, leading to limited space for the placement of more replicated sites without increasing potential edge or pseudoreplication effects. However, knowing that bird assemblages from several study areas within the region showed no significant differences within a given habitat when replicated sites were compared within a small geographical space (Van Rensburg *et al.* 2000), this approach should not greatly effect the outcome of the present study. Also, seeing that the present study focused more on the potential role of a community-based conservation initiative based on the description of a bird assemblages in an area with proportionally few Sand Forest, as opposed to further understand the local scale heterogeneity dynamics or making inferences about the birds of Sand Forests in general, this limitation, although not ideal, should be negligible.

Each survey site comprised 16 randomly selected fixed survey points as determined originally by Van Rensburg *et al.* (2000) following the method of Buckland *et al.* (1994). To minimise the probability of double detection, to ensure data independence and to provide suitable replicates for the present study, the distances between the 16 survey points within a site and between the different sites were at least 200 and 500 m respectively. Bird surveys were done using point sampling as discussed by Buckland *et al.* (1994). The 16 survey points from a single site representing a given habitat type, were surveyed in one morning, taking 10 minutes per survey point. Each of the two sites was surveyed four times per month (i.e. 24 times over the six month sampling period). We varied the order in which the survey points was visited to ensure that each point was surveyed at different times during different mornings. The surveys were not done during rain that exceeded a light drizzle or during periods of strong winds.

The number of individuals of each species observed over the course of each sampling period in Tembe by Van Rensburg *et al.* (2000) and during the present study was summed for each survey point within each site. Multivariate community analysis of the absolute bird species abundance data was then made by using PRIMER v 5.2 (Clark & Warwick 1994). Cluster analysis, using group averaging and Bray Curtis similarity measures (Bray & Curtis 1957) was used to examine the relationships between habitat types both within and between study areas, and within a given habitat type between study areas. These data were double square root transformed prior to analysis so as to weight the common and rare species equally (Clark & Warwick 1994). Analyses of similarity were used to establish the significance of differences in bird assemblages between and within habitats. In this procedure a significant global *R*-statistic of close to 1 indicates distinct differences between the assemblages or habitats compared (Clark 1993). Non-metric multi-dimensional scaling was used to display the relationship between the survey sites in a two-dimensional ordination analysis.

To further describe and compare the bird assemblage that is found in Tshanini with those in Tembe, the degree of variation between the bio-indicator species that were identified for the different habitat types was calculated. Characteristic bird species (indicator species) were identified for each habitat type using the Indicator Value Method (Dufrêne & Legendre 1997). This assesses the degree (expressed as a percentage) to which each species fulfils the criteria of specificity (uniqueness to a particular site) and fidelity (frequency within that habitat type) for each habitat cluster compared with all other habitats. The higher the percentage IndVal (indicator value) obtained, the higher the specificity and fidelity values for that species, and the more representative the species is of that particular habitat.

The species abundance matrix from each survey site was used to identify the indicator species. The following comparisons were made: Tshanini Sand Forest versus Tshanini Mixed Woodland, Tembe Sand Forest versus Tembe Mixed Woodland, Tshanini Sand Forest versus Tembe Sand Forest, Tshanini Mixed Woodland versus Tembe Mixed Woodland, and Tshanini versus Tembe. Dufrêne and Legendre's (1997) random re-allocation procedure of sites among site groups was used to test the significance of the *IndVal* measures for each species. Those species with significant *IndVals* > 70% (a subjective benchmark) were then regarded as indicator species for the habitat in question (Van Rensburg *et al.* 1999; McGeoch *et al.* 2002).

The identification of rare species on a local scale seems unlikely to provide insight into the conservation requirements of the species involved unless information on their regional distribution and abundance elsewhere is taken into account (Van Rensburg *et al.* 1999). To assess whether such diffusive rarity occurs between habitat types at a fine spatial scale and/or nationally at a broad spatial scale, rare bird species were identified for each habitat type and each study area. This part of the study was done by using the proportion of species method of Gaston (1994) that defines rare species as the 25% least abundant species in a sample area.

Habitat preference

Road counts of the spatial distribution of the target herbivores were done in Tembe from December 2002 to November 2003. Three transects were used, together covering all the vegetation types occurring in the reserve (Figure 6). Transects were set out independent of ungulate distribution and the observations were done at random. The counts were done by driving a given transect during the first hours after sunrise and again during the last hours before sunset on the same day whenever possible. The route direction was reversed on alternate surveys during every month to minimise observer bias. The total study area was consequently surveyed four times per month for a full year.

All the observations were documented on a field form and the closest coordinates of the position of an observed herbivore on the transect was determined by using geographic positioning equipment (GPS). Where more than one animal was

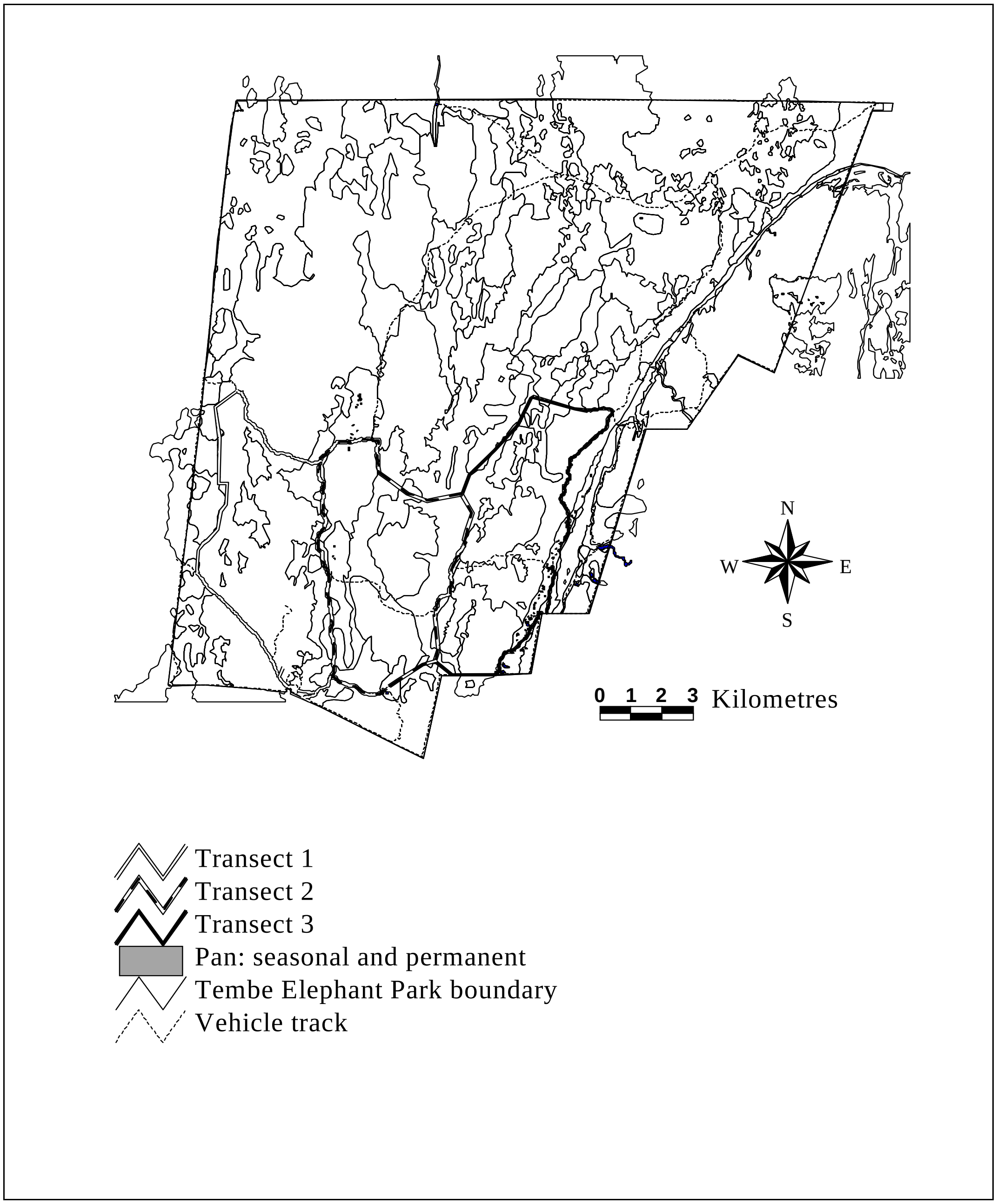

Figure 6: Transects that were used to determine the spatial distribution of the impala in Tembe Elephant Park, South Africa from December 2002 to November 2003.

encountered in the same location, such as a group of animals feeding together, the observation was regarded as one record and no distinction was made between the sex or age of the observed animals. All the data were captured on a computer database for further analysis. A measure of habitat preference for the target herbivore was obtained by comparing patterns of habitat use with habitat availability within the study area. Marked coordinates were used to determine the specific habitat where an animal was observed by plotting the points on the vegetation map of Tembe and using ArcView GIS (ESRI Inc. 1998). Habitat availability was calculated by dividing the area covered by habitat *x* within the study area by the total area covered by the study area. The Index of Jacobs (1974) was then used to calculate a preference index of use (*P*) for each vegetation type. A value of 0 indicated that a vegetation type was used in the same ratio as its proportional occurrence, a positive value ($P > 0$, maximum +1.0) indicated preference of use for a specific vegetation type and a negative value ($P < 0$, minimum –1.0) indicated no preference of use for the vegetation type. Habitat preference was then calculated with the following equations:

when $U > A$ then $\quad P_{(x)} = (-1 \div U) \times (A - U)$ ——— equation 1

when $U < A$ then $\quad P_{(x)} = (+1 \div A) \times (U - A)$ ——— equation 2

where: *P* = preference for vegetation type *x*,
U = proportion of use of vegetation type *x*,
A = proportion of vegetation type *x* available in the study area.

Preference was defined as the degree of difference between the use and availability of a specific vegetation type in the study area and gave an index of habitat preference. However, the preference index only provided a ratio of habitat use to habitat availability and was not based on a statistical test. This was overcome by performing a Chi-square goodness-of-fit test. The observed counts in each vegetation type were compared with the expected counts if each vegetation type were used in proportion to its availability. When a significant difference in use versus availability was detected, a Bonferroni *Z*-statistic was used to determine which vegetation types were used more or less often than expected by constructing 95% simultaneous confidence intervals around the proportion of the target herbivore recorded in each vegetation type (Beyers *et al*. 1984; Allredge & Ratti 1992; Pienaar *et al*. 1992). The confidence intervals were calculated by using the following equation:

$$U \pm Z_{1-\alpha/2k} [U (1-U) / n]^{½} \qquad \text{——— equation 3}$$

where: U = the proportion of use,

$Z_{1-\alpha/2k}$ = the upper standard normal table value corresponding to a probability tail area of α/2k,

k = the number of vegetation types,

n = the total number of observations.

Confidence intervals were calculated for α = 0.05, k = nine vegetation types and $Z_{1-\alpha/2k}$ = 2.75. The results indicated whether each vegetation type was used significantly more or less than expected by checking for overlap with the percentage availability of the corresponding vegetation type.

Population status

An aerial survey that was done in October 2003 was used to determine the current population status of the target herbivores in Tembe. It was the third major survey of large herbivores that was done in Tembe since 1994 and was built on the recommendations of the previous surveys that were done in August 2000 and October 2002 (Matthews 2000; 2002). The overall aim of the survey was to derive trends and estimates of the large herbivore populations in Tembe that would be useful for management decisions and would stand as a record of abundance for future trend analyses. Total aerial counts and transect distance sampling counts were used to estimate the number of the target herbivores in Tembe and to calculate trends in the population from 1993 to 2003 (Matthews 2004).

The method used in 2002 for the total aerial counts was similar to that used in 2000, but both were refined and improved versions of that used in 1994 (Matthews 2004). A helicopter, with the pilot and recorder at the front and two observers at the back, was flown on pre-determined transects. Transects were orientated in a parallel north-south direction, situated one kilometre apart, and arranged systematically to cover the whole park (Figure 7). Devices were fitted to both sides of the helicopter to

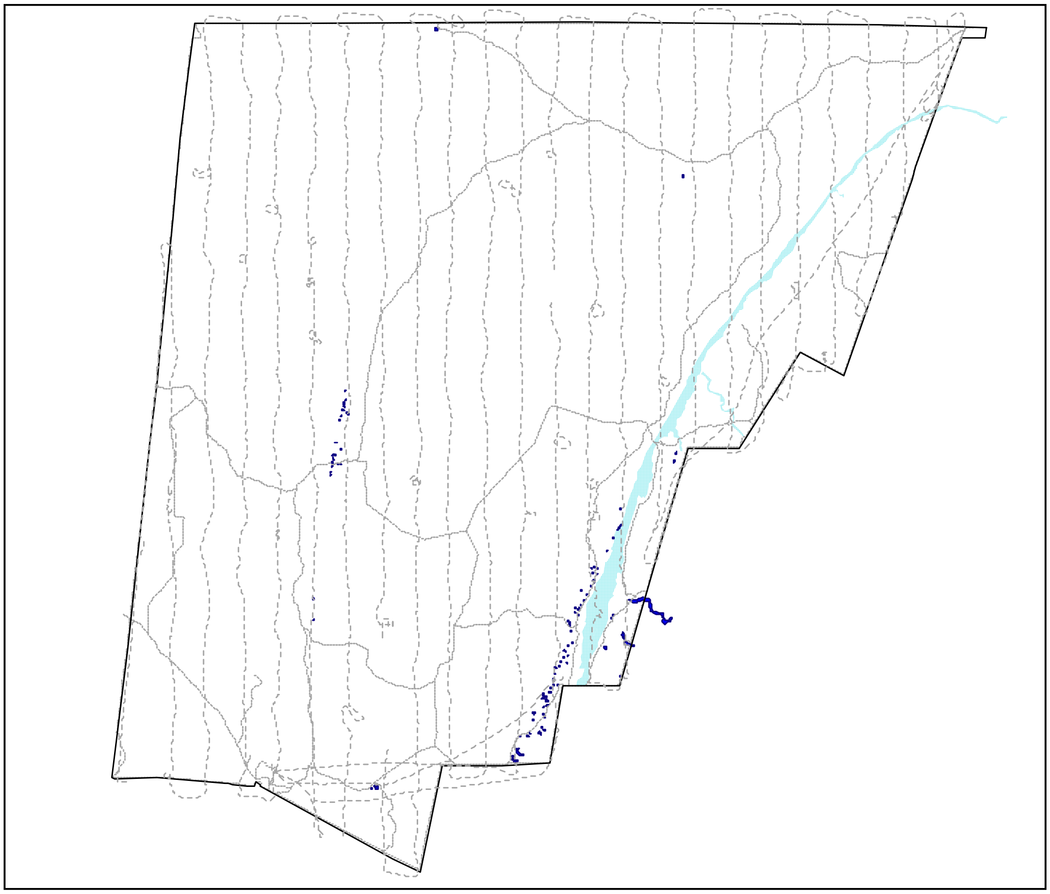

Figure 7: Flight path used for the total aerial counts and the transect distance sampling counts in Tembe Elephant Park, South Africa during October 2003 (Matthews 2004).

demarcate a distance of 500 m on each side when flying at a height of 90 m above the ground. Individuals of all large herbivore species within this belt were recorded.

Data for the transect distance sampling counts were also collected during the total aerial count. For this purpose, the devices on both sides of the helicopter were divided into distance classes with intervals of: 0 to 91 m, 91 to 200 m, 201 to 350 m and 351 to 500 m. All observed large herbivores were recorded within one of these distance sectors for further analysis (Matthews 2004).

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