Introduction

The Atlas of the Birds of Sul do Save, Southern Mozambique, describes the geographical distribution, abundance and seasonality of all bird species which were observed in Mozambique south of the Save River during the period 1980 to 1998. It is an extension of *The Atlas of the Birds of Southern Africa* (Harrison *et al.* 1997a,b) which covered the states of Botswana, Lesotho, Namibia, South Africa, Swaziland and Zimbabwe. Mozambique was excluded from that publication because the civil war made fieldwork impossible at the time.

This study provides the essential information on which initiatives to conserve the avifauna of the region should be based. It is intended furthermore to serve as a prototype for an adequate description of the status of the avifauna of an African state with few experienced observers and minimal infrastructure in a short space of time.

The publication of this atlas marks the completion of the first stage of the Mozambique Bird Atlas Project. The next stage, the preparation of an atlas of the birds of central Mozambique is now under way, and the project will culminate in the production of an atlas of the birds of the whole of Mozambique.

At the commencement of this project, Mozambique represented the southern African state which was clearly the least well known ornithologically. Previous accounts dealing with bird distributions have been based on observations which were made at a limited number of the more accessible localities and moreover tended to be concentrated in the winter months (see e.g. Clancey 1996). For an account of the distribution of bird species which relies principally on sight records and vocal recognition to be credible, all records must be subjected to careful vetting. Previously published accounts for southern Mozambique unfortunately included a number of species whose presence in the region was based on sight records which appear likely to have been misidentifications. The criteria adopted in reassessing these records are that, not only are the records inconsistent with current knowledge (including the results of this survey) of the range and habitat preference of the species concerned, but that a number of such records originated from each of a handful of sources whose accounts have omitted a number of species which do occur regularly at the localities concerned. Clancey (1996) expressed reservations about some records by these observers, but accepted others which are now added to the list of those considered dubious. The species concerned are discussed in Appendix 2. Other species which were not observed during this study but which are believed to occur in the region on the basis of earlier accounts are discussed in Appendix 1.

In recent times, the availability of a great wealth of material relating to bird identification in the form of improved field-guides and audio and video recordings, as well as improved optical equipment, has made it possible to place greater reliance on sight records and call recognition (whether by amateurs or by professionals) than was formerly the case.

The literature dealing with bird distributions in this region previous to 1970 and distribution records based on museum specimens were summarised by Clancey (1971). *The Birds of Southern Mozambique* (Clancey 1996) is a reprint of Clancey's earlier work, incorporating taxonomic revisions. Subsequent accounts (e.g. Tello 1973; Herdam 1994; De Boer & Bento 1999) have been referred to in this text where appropriate. A bird checklist for Mozambique has been compiled by Dowsett & Dowsett-Lemaire (1993), but is unsatisfactory in that it includes species which have not been reported reliably or at all in Mozambique (e.g. Greater Kestrel *Falco rupicoloides*, Whitefaced Storm Petrel *Pelagodroma marina*, Olive Woodpecker *Mesopicus griseocephalus* and Black Crow *Corvus capensis*).

The account by Clancey (1996) included a number of species which were not actually observed within Mozambique but which were assumed to occur on the basis of their occurrence in neighbouring territories. These are also discussed in Appendix 2. It should be noted that in particular the western boundary of southern Mozambique with Swaziland and South Africa coincides with the ridge of the Libombo range, which constitutes a significant discontinuity in habitats.

A bird atlas is never complete, and further exploration in this region is bound to yield new distributional records. On the other hand, this atlas is presented at this stage in the belief that such records will not be too easily obtained. Although species totals for many grid cells appear relatively low, this is at least partly due to low habitat diversity. This author found that whereas checklists of over 100 species could easily be compiled in a morning in neighbouring Swaziland, a full day or more was required to find as many as 50 species in parts of this region.

An atlas for the whole of Mozambique which will include any new observations from Sul do Save is planned for publication at the completion of this project. It is hoped that a greater number of volunteers will participate in the remaining stages of the Mozambique Bird Atlas Project, which involve coverage of central and northern Mozambique, as well as updating the coverage of southern Mozambique. For further information, potential contributors should contact:

Mozambique Bird Atlas Project
Fórum Natureza em Perigo, CP 4203 Maputo
Tel. (+2581) 30-8924 Fax (+2581) 30-8925
or
c/o Endangered Wildlife Trust, Private Bag X11,
Parkview, 2122, South Africa
Tel. (011) 486-1102 Fax (011) 486-1506
ewt@ewt.org.za
or
Avian Demography Unit, University of Cape Town,
Rondebosch, 7701, South Africa
Tel. (021) 650-2423 Fax (021) 650-3434
adu@maths.uct.ac.za
or
Natural History Museum
Maputo
Tel. (+2581) 49-1145
bento@natural.uem.mz

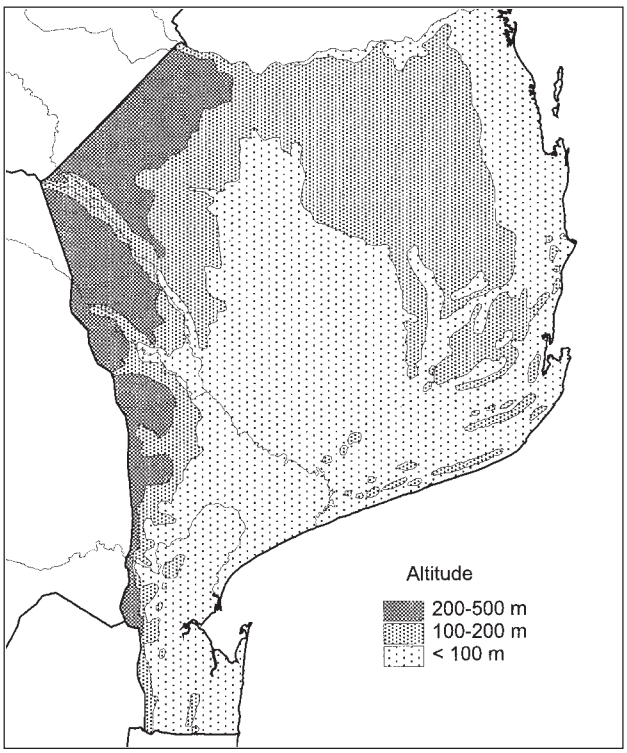

Figure 1. *Topography.*

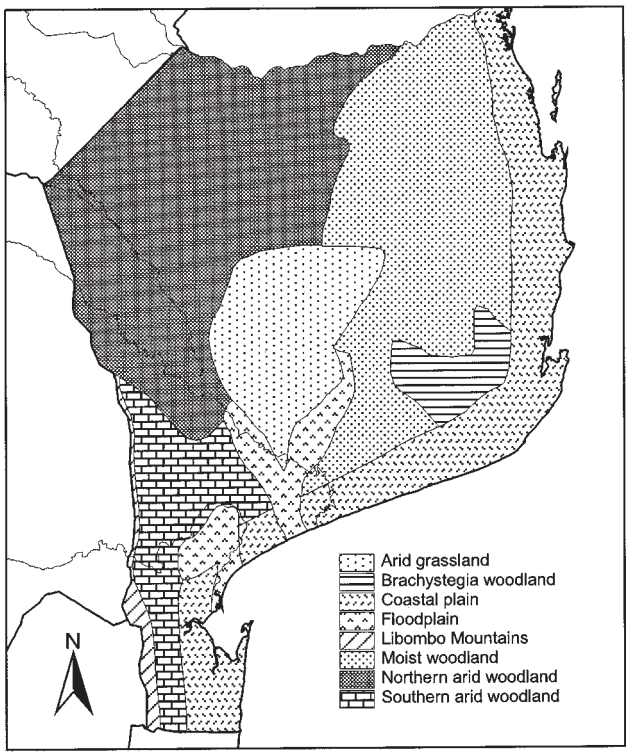

Figure 2. *Vegetation types.*

TOPOGRAPHY AND VEGETATION

The Libombo Mountain range is a rhyolite ridge which forms the western boundary with Swaziland and South Africa. It is punctuated by the gorges of the Usutu/Maputo, Inkomati, Olifants and Shingwedzi rivers. The range is highest south of the Inkomati River where its peaks rise to over 500 m. North of the Inkomati, it rises to no more than 200 m. The vegetation on the Libombo range is diverse and includes *Acacia* savanna, ironwood *Androstachys johnsonii* forests, riparian forest, small pockets of Afromontane forest in the south and Mopane woodland in the north.

The rest of southern Mozambique consists of a flat plain, interrupted only by the valleys of the Maputo, Inkomati and Limpopo rivers, and bounded in the north by the Save River. An extensive floodplain is associated with the mouths of each of these rivers.

The vegetation of the plain south of the Inkomati River consists of *Acacia* woodland over the western two-thirds, while the coastal region consists of a mosaic of sour grasslands, dense mixed woodlands and tall forests, in which *Albizia, Afzelia* and *Sclerocarya* species are dominant. Between the Inkomati and Limpopo rivers, *Acacia* woodlands occur to the west, while towards the coast broadleaved woodlands and forest patches dominated by *Afzelia quanzensis* occur, and close to the littoral a narrow strip of moist grassland.

North of the Limpopo River, a broad strip of arid woodland occurs in the west. These woodlands include Mopane and *Acacia* woodlands as well as broadleaved woodlands in which *Combretum* and *Terminalia* species are prominent and are interspersed with small patches of Lebombo Ironwood *Androstachys johnsonii* forest. The arid woodlands give way to an area of grassland overlapping the southeastern part of the Banhine National Park (2233CC), merging into *Acacia* savanna to the east.

From the centre of the region towards the littoral is a broad band of moist woodlands, including *Julbernadia* and mixed broadleaved woodlands. Tall *Brachystegia spiciformis* woodlands occur only in a small area near Panda (2434BA). Ironwood forests intrude into the moist woodlands from the west and one such forest near Mawayela (2433BD) is possibly the largest extant stand of this tree species, which is a near-endemic to Sul do Save.

The coastal strip north of the Limpopo River has been densely populated and cultivated since the colonial period. Consequently, most of the natural vegetation has been replaced by plantations of coconut, cashew, mango and citrus trees, and grain fields. The surviving patches of natural woodland and forest are dominated by *Afzelia quanzensis*.

CLIMATE

The region is warm and frost free with summer rainfall. Rainfall is highest at the coast, with over 1200 mm/year recorded at places, and decreases inland, with less than 300 mm/year recorded at Pafuri (2231AD), where the Limpopo River enters Mozambique (see Figure 3).

METHODS AND AN OVERVIEW OF RESULTS

As far as was appropriate, the methodology of *The Atlas of Southern African Birds* (Harrison *et al.* 1997a,b) was adhered to.

Quarter-degree grid cells

Observations of bird species were recorded on a quarter-degree grid, where each grid cell comprises a quarter degree (15') of latitude by a quarter degree of longitude. The use of a hand-held GPS (global positioning system) unit was found to be the most convenient way for an observer to determine his position relative to the grid.

A unique name consisting of four digits followed by two letters is assigned to each grid cell. The four digits comprise

Moist grassland, coastal plain, Ponta Douro.

Coastal forest, near Macia.

Slash-and-burn agriculture, coastal region.

Limpopo River floodplain.

Moist woodlands (mixed).

Arid woodlands (Mopane).

Arid grassland, Banhine.

Brachystegia woodland, near Panda.

Intertidal zone, Vilanculos.

Lebombo Ironwood Androstachys johnsonii *forest.*

Cape Vulture colony, Libombo Mountains, near Goba.

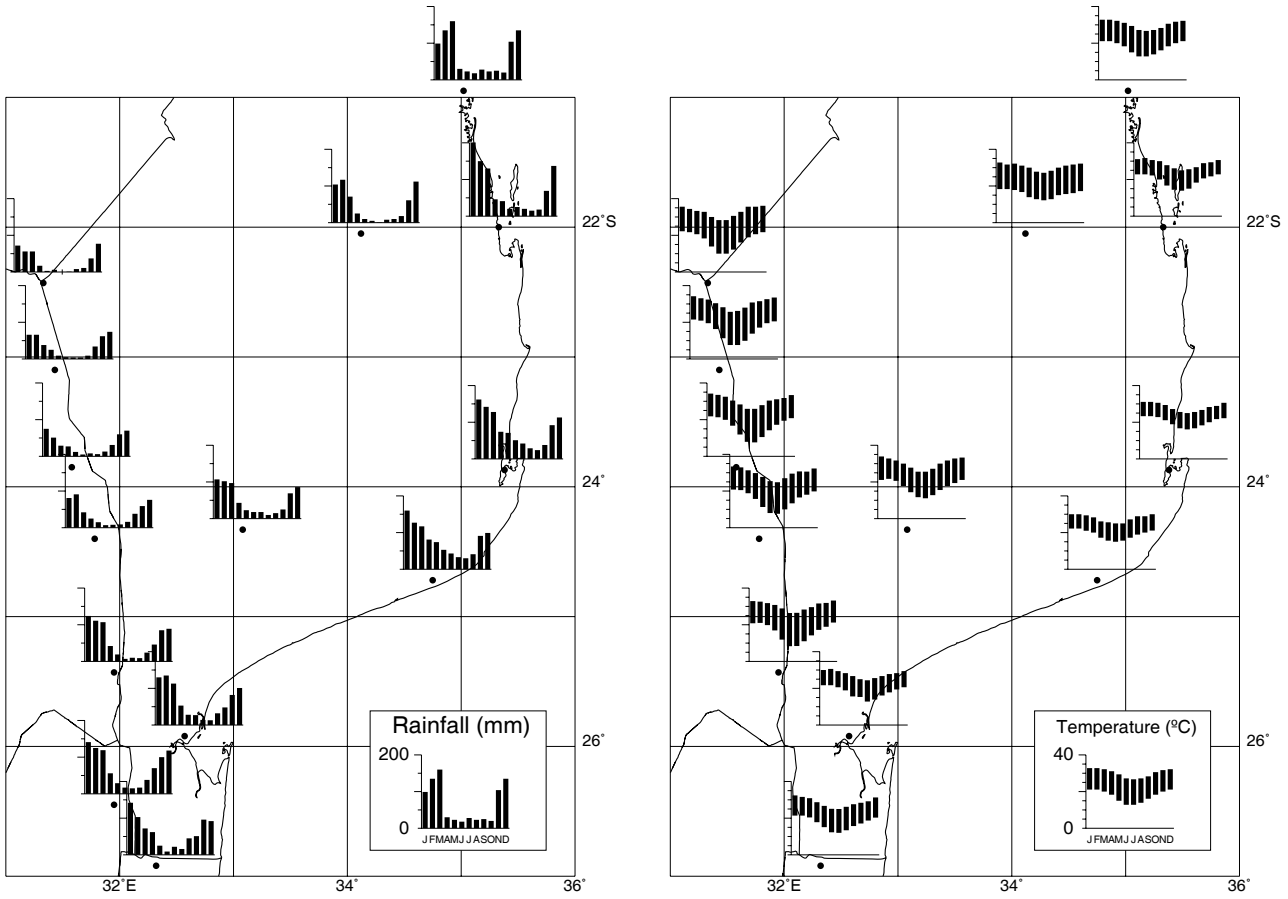

Figure 3. *Climate.*

the latitude (in degrees) followed by longitude of the cell, and its position within a degree cell is uniquely defined by the two letters as illustrated in Figure 4.

Data were accumulated on checklists on which observers marked all species which were identified on each visit to a grid cell.

Coverage

The goals set for coverage were that each grid cell should be visited in each of three seasons, namely early summer (September to December), late summer (January to April) and winter (May to August). Of the 253 grid cells in the region, eight were not visited at all because of difficulties of access. A total of 1778 checklists were accumulated during the period 1980 to 1997. A total of 15 checklists were accumulated between 1980 and 1994 by visitors to coastal localities and islands which were relatively untouched by the armed conflict. The balance of the checklists were accumulated between December 1994 and March 1998. The project obtained the loan of a four-wheel-drive vehicle in October 1995, until which time field-work was limited to the more accessible localities. The mean number of checklists per grid cell was seven.

The species totals per grid cell are low by comparison with the neighbouring parts of South Africa and Swaziland (Harrison *et al.* 1997a,b). Although this is partly due to more intensive coverage in those regions, it reflects lower avian species diversity owing to lower habitat diversity (see Figure 5 and the **DISCUSSION** section).

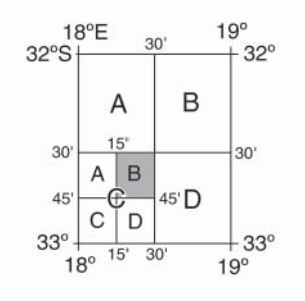

Figure 4. *Nomenclature of grid cells. Note that 3218 is the degree (1° × 1°) grid cell with 32°S 18°E at its northwestern corner, 3218C a half-degree (30′ × 30′) grid cell, and 3218CB a quarter-degree (15′ × 15′) grid cell.*

Seasonal coverage

Of the 253 grid cells, 96% were visited in early summer, 96% in late summer and 95% in winter. The goal of visiting all of these squares in each of the seasons was not met because the loan of the project vehicle was terminated at the end of December 1997 (see Figure 6).

Reporting rates

The reporting rate for a species in a grid cell is the proportion of checklists for the cell on which the species is recorded (Harrison & Underhill 1997). The reporting rate is regarded as an indication of the relative density of a species in the area, in the sense that a species is believed to be most numerous in the grid cells where its reporting rates are highest. The justification and limitations of the reporting rate as a measure of

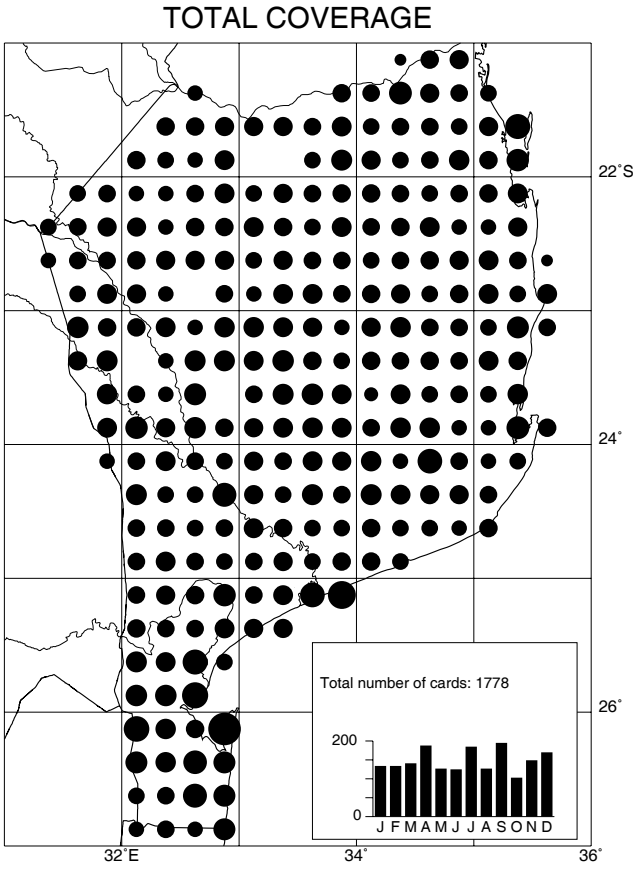

Figure 5. *Coverage.*

relative density were discussed by Parker (1996) and Harrison & Underhill (1997).

In order for reporting rates to reflect relative densities as accurately as possible, it is desirable that the number of checklists per grid cell be maximised, subject to the conditions outlined below.

A minimum standard of observer effort per checklist should be adhered to. Checklists reflecting a short period of observation, when combined with checklists representing longer periods, tend to depress the reporting rates for species that were not observed. Hence, checklists generally represented more than one hour of observation and no more than one week. A few checklists representing shorter periods of observation were accepted where they involved observations of unusual species.

Multiple checklists for the same small area on successive days tend to be duplicates of each other. This was avoided in the following way. A new checklist was generated on moving to a new locality within a grid cell, with localities separated by at least 5 km. Typically, three or four independent checklists were generated for each visit to a grid cell over one or two days.

Reporting rates can be affected by differences in the levels of skills of observers. Reporting rates for inconspicuous species tend to be lower in areas visited by the less skilful observers. This problem was minimised in this study because the majority of checklists were compiled by a single observer.

Vetting

The credibility of a bird atlas which represents data collected by volunteers with varying levels of bird identification skills depends on careful vetting of the data. Records of species which were considered to be unlikely because they were far removed from the known range of the species, far from suitable habitat, or present at times of the year when they were usually absent, were queried. The observers concerned were invited to submit details of the sighting, including an account of how the bird was identified. Frequently, unusual records were found to have arisen from transcription errors. Accounts submitted in support of unusual records were evaluated principally on the grounds of whether the features by which the bird was identified are in fact diagnostic.

The Rarities Committee of BirdLife South Africa was approached to evaluate records of species which are considered rare within southern Africa, because it was felt that there was insufficient expertise available within Mozambique to evaluate such records.

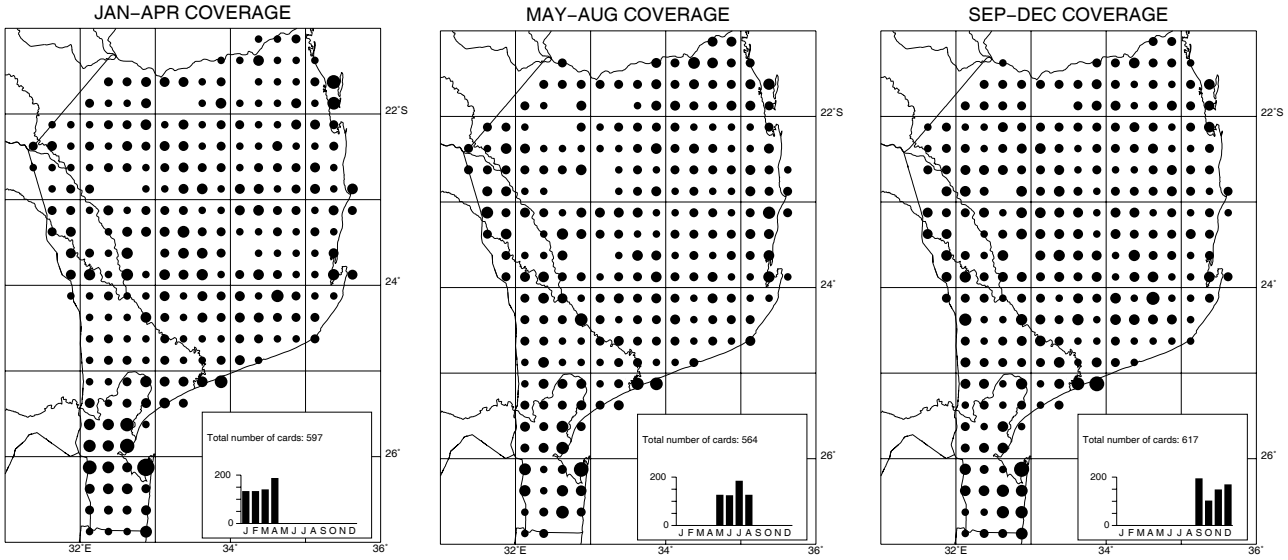

Figure 6. *Seasonal coverage.*

Table 1. *Number of checklists per grid cell.*

Checklists	No. of grid cells
0	8
1	0
2	1
3	22
4	35
5	49
6	32
7	34
8	28
9	12
10	11
11	6
12	5
13–47	15
Total	253

Table 2. *Number of species recorded per grid cell.*

Species	No. of grid cells
0	8
1–24	0
25–49	2
50–74	48
75–99	101
100–124	55
125–149	18
150–174	13
175–199	7
200–223	6
Total	253

Table 3. *Grid cells with the highest species counts.*

Grid cell	Checklists	Species
2632BB	47	223
2632AA	22	220
2533BA	19	211
2632DA	16	208
2632BD	10	206
2532DA	20	200
2331DD	8	191
2432BD	16	188
2532DC	24	185
2632BC	15	185

Species new to the region

The following species which had never previously been reported in Mozambique were observed during this survey:

Redfooted Booby *Sula sula*, Blackbellied Storm Petrel *Fregetta tropica*, Steppe Eagle *Aquila nipalensis*, Jackal Buzzard *Buteo rufofuscus*, Lesser Kestrel *Falco naumanni*, African Black Oystercatcher *Haematopus moquini*, Bartailed Godwit *Lamosa lapponica*, Common Noddy *Anous stolidus*, Feral Pigeon *Columba livia*, European Wheatear *Oenanthe oenanthe*, Marico Flycatcher *Malaenornis mariquensis*, Indian Myna *Acridotheres tristis*, Redheaded Finch *Amadina erythrocephala* and Lesser Frigatebird *Fregata ariel*.

In addition, the following species which had previously been reported from other regions of Mozambique were recorded south of the Save River for the first time:

Honey Buzzard *Pernis apivorus*, African Hawk Eagle *Hieraaetus spilogaster*, Lanner Falcon *Falco biarmicus*, Hobby Falcon *Falco subbuteo*, Sooty Falcon *Falco concolor*, Rednecked Falcon *Falco chicquera*, Redchested Flufftail *Sarothrura rufa*, Lesser Gallinule *Porphyrula alleni*, Roseate Tern *Sterna dougallii*, Sooty Tern *Sterna fuscata*, Gullbilled Tern *Gelochelidon nilotica*, Barred Cuckoo *Cercococcyx montanus*, Black Coucal *Centropus bengalensis*, Freckled Nightjar *Caprimulgus tristigma*, Black Swift *Apus barbatus*, Angola Pitta *Pitta angolensis*, Redbreasted Swallow *Hirundo semirufa*, House Martin *Delichon urbica*, Yellowbellied Sunbird *Nectarinia venusta*, Cuckoo Finch *Anomalospiza imberbis*, East African Swee *Estrilda quartinia*, Cutthroat Finch *Amadina fasciata*, Purple Widow Finch *Vidua purpurascens* and Cabanis's Bunting *Emberiza cabanisi*.

In all, 29 terrestrial species and nine shore and pelagic species were recorded for the first time in the region. By comparison, 13 terrestrial species and 17 shore and pelagic species were reported previously but were not encountered during this survey (Appendix 1). This reflects the fact that during this survey more attention was paid to the interior and less to the coast in comparison with previous exploration.

This study identified the Oliveheaded Weaver *Ploceus olivaceiceps* as globally threatened although it had not been included in previous Red Data lists (Collar *et al.* 1994). This highlights the necessity for field exploration of the type represented here in order to identify threatened species and determine conservation priorities.

Population density estimates

In order to compare the densities of the more common woodland species across woodland types, population density estimates were obtained by a line-transect method (Bibby *et al.* 1992). Each transect was conducted at a different location by walking at a slow pace along a path or track for 15 minutes, covering a distance of *c.* 750 m. All birds encountered (heard or seen) within *c.* 20 m either side of the path were counted. Thus each transect represented an area of *c.* 3 ha. All transect counts were carried out by the author alone. Transect counts were not carried out when weather conditions were unfavourable (extreme heat, windy conditions and rain were avoided). Counts were carried out between 06h30 and 15h30.

It is certain that a number of birds would have remained undetected during the transect counts, so that the densities estimated can be considered as a lower bound for the true densities. This method was selected rather than more rigorous methods in order not to divert time and energy away from the primary atlasing task of determining which species were present within each grid cell.

The methods were too crude to establish accurate measures of absolute densities, but the results reproduced in the species accounts serve to illustrate the preferences of the individual species across woodland types. The density estimates are similar to published estimates from similar habitats elsewhere in southern Africa (Tarboton *et al.* 1987; Harrison *et al.* 1997a,b).

Table 4. *Estimated densities of woodland birds in four woodland types.*

ACACIA

Species	Birds/100 ha
Blue Waxbill	71
Rattling Cisticola	50
Blackeyed Bulbul	41
Redfaced Mousebird	35
Whitebellied Sunbird	31
Cape Turtle Dove	29
Whitebrowed Robin	29
Greenspotted Dove	29
Longbilled Crombec	29
Crested Francolin	27
Yellowbilled Hornbill	25
Chinspot Batis	25
Southern Boubou	23
White Helmetshrike	22
Sombre Bulbul	21
Grey Lourie	20
Lilacbreasted Roller	18
Forktailed Drongo	18
Terrestrial Bulbul	17
Acacia Pied Barbet	12
Striped Kingfisher	11
Yellowbreasted Apalis	10
Yelloweyed Canary	10

MOPANE

Species	Birds/100 ha
Cape Turtle Dove	80
Blackeyed Bulbul	30
Whitebellied Sunbird	23
Greenspotted Dove	22
Yellowbilled Hornbill	22
Blackheaded Oriole	22
Redfaced Mousebird	18
Crested Francolin	17
Whitebrowed Robin	17
Blue Waxbill	17
Longbilled Crombec	15
Forktailed Drongo	13
Yelloweyed Canary	13
Chinspot Batis	13
Grey Hornbill	10
Southern Boubou	10

MIOMBO

Species	Birds/100 ha
White Helmetshrike	45
Blackeyed Bulbul	39
Blue Waxbill	37
Redbilled Helmetshrike	35
Forktailed Drongo	25
Southern Black Tit	25
Mozambique Batis	21
Puffback	21
Yelloweyed Canary	21
Blackheaded Oriole	19
Yellowbreasted Apalis	19
Whitebellied Sunbird	19
Greenspotted Dove	18
Blackcollared Barbet	16
Whitebrowed Robin	16
Longbilled Crombec	16
Yellowthroated Sparrow	16
Neddicky	12
Pallid Flycatcher	12
Southern Boubou	11

OTHER BROADLEAVED WOODLANDS

Species	Birds/100 ha
Cape Turtle Dove	39
Blackeyed Bulbul	39
White Helmetshrike	32
Yellowbilled Hornbill	30
Blue Waxbill	29
Greenspotted Dove	26
Longbilled Crombec	26
Whitebellied Sunbird	25
Whitebrowed Robin	24
Forktailed Drongo	16
Redbilled Woodhoopooe	14
Crested Francolin	13
Blackheaded Oriole	13
Southern Black Tit	13
Yellowbreasted Apalis	13
Grey Lourie	12
Southern Boubou	12
Puffback	11
Rattling Cisticola	10
Yelloweyed Canary	10

A total of 130 line-transect counts were carried out in *Acacia*, Mopane, miombo (*Brachystegia* and *Julbernadia*) and other broadleaved woodlands (including *Terminalia*, *Combretum*, and mixed woodlands). The estimated densities of the more common bird species in each woodland type are shown in Table 4.

Woodland species whose densities were not estimated may be assumed to have densities of below 5 birds/100 ha.

The extent to which flocking behaviour influences estimated densities requires further investigation. Flocking enhances the conspicuousness of individuals, and the reported densities for helmetshrikes in particular are probably inflated relative to other species.

Overall bird densities estimated for each woodland type are shown in Table 5.

Density estimates varied little according to the time of day, although transect counts were *c.* 15% higher in the early morning (Table 6).

The transect counts were carried out between March and December 1997. A decline in estimated densities for non-migratory species in the late winter (July to August) was

Table 5. *Overall bird densities in each woodland type.*

Woodland type	No. of transects	Birds/100 ha
Acacia	32	816
Mopane	20	500
Miombo	19	637
Other broadleaved	59	654

observable (Table 7). The peak in estimated densities in September and October coincided with the start of the breeding season for most insectivorous species.

The seasonal fluctuation in observed densities was smaller than expected. A larger breeding season peak followed by a greater decline due to mortality among first-year birds in winter might have been expected. That this was not observed may be due to some if not all of the following factors. Newly fledged birds may have been successful in escaping detection. Secondly, birds were more conspicuous in winter owing to lighter vegetation cover and owing to having to range more widely in search of food and water. Finally, the transect counts were carried out during a period of relatively high rainfall, and a greater fluctuation in densities might be observed under harsher conditions.

In order to obtain the population estimates of woodland species reflected in the species accounts, density estimates for each habitat in which the species occurs were obtained from the transect counts or published estimates of densities from similar habitat elsewhere in southern Africa (e.g. Tarboton *et al.* 1987; Harrison *et al.* 1997a,b) and multiplied by an estimate of the total area of the habitat present in the region.

CONSERVATION

Protected areas

Conservation efforts in southern Mozambique are presently concentrated in three areas: the Maputo Elephant Reserve (2632B,D), a hunting concession area south of Pafuri (2231D), and the Bazaruto Archipelago (2135CB,D). Plans are being made to create effective conservation areas to include the largely defunct Banhine (2232) and Zinave (2133) Reserves, an area along the western border with the Kruger National Park in South Africa (including the hunting concession), and a proposed coastal reserve at Pomene (2235DC). The current emphasis in conservation planning in Mozambique is the transfrontier parks concept, which involves establishing conservation areas which are contiguous with national parks or nature reserves in neighbouring states. This approach does not necessarily include the most threatened habitat types within Mozambique and potentially diverts resources away from the conservation of such habitats.

The two most threatened avian habitats in southern Mozambique are the tall *Brachystegia* woodlands in the vicinity of Panda (2434BA), the habitat of the Oliveheaded Weaver, and the coastal forests north of the Limpopo River. These coastal forests are distinct from those found south of the Limpopo as the occurrence of species such as the Bluethroated Sunbird, Chestnutfronted Helmetshrike and Livingstone's Flycatcher shows. A substantial proportion of the coastal forests south of the Limpopo River are protected within the Maputo Elephant Reserve.

Table 6. *Bird densities by time of day.*

Time	Birds/100 ha	No. of transects
06h30–07h30	767	26
07h30–08h30	633	13
08h30–09h30	667	23
09h30–10h30	633	21
10h30–13h30	667	17
13h30–14h30	633	7
14h30–15h30	633	22

Table 7. *Bird densities by month (excluding migratory species).*

Months	No. of transects	Birds/100 ha
Mar–Apr	25	708
May–Jun	50	693
Jul–Aug	17	587
Sep–Oct	22	773
Nov–Dec	16	693

The two most threatened habitats enjoy no form of protection at present and are rapidly being depleted as a result of slash-and-burn agriculture. These habitats are not included in any of the existing or proposed conservation areas in southern Mozambique. Tall *Brachystegia* woodland is extremely limited in extent, covering less than 100 000 ha, and the present rate of expansion of cultivation in the area suggests that it could be completely eliminated in the near future. The coastal forests have been under pressure from dense human settlement since colonial times, and their depletion continues into the present. The largest remaining stands occur near Pomene, but lie outside the proposed nature reserve, which includes part of the coastline, reefs and mangrove swamps.

Deforestation

The extent of commercial logging in the south is less than in central Mozambique, where large areas are reported to have been devastated (e.g. Ryan 1995). Nevertheless, the Pod Mahogany *Afzelia quadrensis* is much sought after, and the larger specimens are being removed virtually throughout the region. The near-endemic Lebombo Ironwood *Androstachys johnsonii* is also sought after but is difficult to harvest owing to its great density. Exploitation of the ironwood forests is proceeding slowly at present, but could become of grave concern in the future.

Charcoal made from indigenous trees is the major source of energy for residents of Maputo and other large towns. Large areas of woodland are being cleared to satisfy this need. This is most obvious along the main roads, and the charcoal-makers are venturing ever farther into previously untouched areas.

Rivers and floodplains

All of the major rivers which flow through this region arise in South Africa, Swaziland or Zimbabwe to the west. The floodplains of these rivers represent important habitats for waterbirds. The rivers and floodplains have been severely affected by management and exploitation of the rivers and riverbanks in the neighbouring states. River flows have been reduced by increased offtakes upstream, and cultivation of the banks and overgrazing in the catchment areas have led to increased silting. Changes in conditions and waterbird populations in the floodplains have not been monitored and are likely to have been negative. Prevention of further degradation of the floodplain habitats depends on responsible management of water resources and riverbanks in the neighbouring states.

A survey of wetlands in southern Mozambique in 1972 identified Lake Chuali as a highly significant refuge for waterfowl (Milstein 1984). Subsequently, a weir was built on the Inkomati River below the lake, which has resulted in higher water-levels in the lake. The deeper waters appear to be less favourable for waterfowl, and numbers of waterfowl, especially Fulvous Duck, have been much lower in recent times than those counted by Milstein (1984).

Hunting

Milstein (1984) cited sport hunting as a threat to waterfowl in the region in 1972. Since the end of the colonial era, sport hunting of waterfowl appears to have decreased in popularity. On the other hand, hunting for subsistence is widespread and it is not known whether this is having a significant effect on waterfowl populations.

Hunting continues to be a serious threat to a few larger species, especially Ostrich and Kori Bustard. Although smaller gamebirds are widely hunted for food, this is not likely to seriously affect the populations. Fruit-eating birds such as hornbills, pigeons and louries, are regarded as pests by farmers and persecuted to the extent that their populations may be diminished in the main fruit-producing areas.

The extermination of larger mammals from most of southern Mozambique during the years of armed conflict led to a drastic reduction in the numbers of vultures and other carrion-eating birds. These birds are now concentrated in areas bordering the Kruger National Park in South Africa, emphasising the importance of that reserve as a refuge for these birds (Parker 1995a). It is anticipated that numbers of these birds will increase if the reintroduction, and protection of larger mammals, to extensive conservation areas goes ahead as planned. At present, surviving larger mammals continue to be hunted relentlessly. In other states within southern Africa, especially Zimbabwe and Botswana, hunting of game animals by resident communities has been limited to sustainable levels as communities involved have become aware of the commercial value of the game (P. Mundy pers. comm.). Development of structures to facilitate commercial utilisation of game will hopefully have similar results in Mozambique. The return of livestock to areas where it is presently absent or sparse may also benefit carrion-eating birds.

Seabirds

The conservation of seabirds depends on the conservation of fish and other marine resources. These resources are under pressure from commercial, subsistence and sport fishermen. Strict control in all three areas is necessary to ensure that exploitation is limited to sustainable levels.

The cage-bird trade

The keeping of indigenous cage-birds has long been popular in Mozambique (Vincent 1933). Typically, Yelloweyed Canaries are kept in home-made wooden cages. More recently, the capture and export of cage-birds is a growing industry. In 1995, as many as 12 companies were licensed to capture and export cage-birds, while only two companies had been active in this field previously. As many as 10 000 Yelloweyed Canaries, 2000 Lemonbreasted Canaries, 2000 Pinkthroated Twinspots and 800 Grey Waxbills have been exported under licence in some years (M. Rees pers. comm.). Most of the trapping for export is carried out near to Maputo and close to main roads for logistical reasons. As a result, Maputo Province and the southernmost parts of Gaza and Inhambane Provinces are over exploited. In addition, large numbers are captured illegally and either sold locally or smuggled abroad. The Brownheaded Parrot is possibly the most popular among the illegally traded birds. Smaller numbers of this species are traded legally.

The Yelloweyed Canary and Brownheaded Parrot, two of the most commonly captured species, are sufficiently numerous in the wild for the numbers captured at present to be sustainable. However, some of the less common seedeaters particularly sought after by the cage-bird trade are seriously threatened as a result. Although the Lemonbreasted Canary occurs locally in large numbers, the numbers exported are cause for concern because the species is a near endemic. The practice of using a captive calling bird as a decoy to lure birds into traps can lead to local extinction of some species. The Pied Mannikin and Grey Waxbill are particularly vulnerable.

Quotas for export of various species are allocated annually by the Department of Wildlife. However, no censuses have been carried out on which quotas could be based, and for some species the quotas allocated may exceed the population within Mozambique.

Among the quotas reported to CITES for 1997,Table 8 shows quotas which are excessive in relation to the estimated populations in southern Mozambique (CITES 1997).

The annual quota for the Steelblue Widowfinch almost certainly exceeds the total wild population of the species in Mozambique.

There appears to be inadequate control of export consignments. Species for which quotas have not been allocated are regularly exported and Blackthroated Canaries *Serinus altrogularis* and Blackcheeked Waxbills *Estrilda erythronotos*, which do not occur in Mozambique and were probably captured in Zimbabwe, have been exported from Mozambique (pers. obs.).

Among the illegally imported birds confiscated at the Komatipoort Border Post by South African officials between 1995 and 1997 were 79 Brownheaded Parrots, 33 Pygmy Geese and 15 Purplecrested Louries (K. Herholdt pers. comm.).

Poisons

The use of poisons to protect crops from insect pests and to destroy problem animals, including jackals and stray dogs, has caused damage to bird populations, particularly birds of prey, throughout southern Africa (Harrison *et al.* 1997a, p. lxxx). At present, intensive agriculture in southern Mozambique in the aftermath of the civil war is limited, and the use of poisons is not common. However, as agricultural activities expand, the use of poisons is likely to become more widespread. The fact that toxic compounds whose use is banned in other regions may be available at lower costs than more environmentally friendly compounds could result in serious threats to wildlife.

Trade in traditional medicines

Body parts of birds, especially vultures and other large birds of prey, are used in traditional medicines. Measures to protect these birds in neighbouring states could lead to increased

Table 8. *Excessive annual quotas for export of species.*

Orangebreasted Waxbill	10 000
Golden Bishop	8 000
Redcollared Widow	5 000
Blackbellied Korhaan	500
Bluebilled Firefinch	15 000
Redbilled Firefinch	15 000
Redbacked Mannikin	12 000
Pied Mannikin	10 000
Pygmy Goose	3 000
Spurwing Goose	5 000
Redheaded Quelea	15 000
Green Pigeon	11 000
Bluespotted Dove	15 000
Steelblue Widowfinch	15 000

demand from practitioners from those states for birds obtained in Mozambique, resulting in increased hunting of the birds here.

Threatened species

On the basis of the results of this survey, the Oliveheaded Weaver is described here as 'globally threatened: vulnerable', according to the criteria laid down by the IUCN (Collar *et al.* 1994). It had not previously been recognised as threatened (Collar *et al.* 1994), presumably because no precise information about its status was available.

The following species which occur as nonbreeding visitors in this region are considered globally threatened (Collar *et al.* 1994):

- ❑ Lesser Flamingo
- ❑ Lesser Kestrel
- ❑ Corncrake

All three species occur marginally in this region and are likely to be hunted here.

Near-threatened

Southern Banded Snake Eagle

It has disappeared from much of the coastline but in the extreme south, where it still occurs, its habitat is protected within the Maputo Elephant Reserve and neighbouring proposed conservation areas.

Neergaard's Sunbird

Its status is of concern because it has a restricted range which has contracted as a result of the destruction of coastal forest. There is no immediate threat to its remaining strongholds.

Vulnerable

Cape Vulture

Foraging opportunities within Mozambique are limited for the small breeding colony in the Libombo Mountains near the border with Swaziland.

Locally threatened

Table 9 lists species regarded as threatened within southern Mozambique, but which are not globally threatened. A species is regarded as locally threatened if it has an estimated population in the region of fewer than 1000 birds and is decreasing. The main threats to each are listed in Table 9 and discussed in the species texts.

Table 9. *Locally threatened species.*

Ostrich	hunting
Saddlebilled Stork	disturbance of wetlands
Secretarybird	hunting
Hooded Vulture	game hunting
Lappetfaced Vulture	game hunting
Martial Eagle	hunting
Crowned Eagle	deforestation
Palmnut Vulture	deforestation
Crowned Crane	hunting
Blue Quail	disturbance of wetlands
Kori Bustard	hunting
Stanley's Bustard	hunting
Lesser Jacana	disturbance of wetlands
Painted Snipe	disturbance of wetlands
Whitecrowned Plover	disturbance of riverbanks
Emerald Cuckoo	deforestation
Green Coucal	deforestation
Pel's Fishing Owl	disturbance of riverbanks
Mangrove Kingfisher	deforestation
White-eared Barbet	deforestation
Slenderbilled Honeyguide	deforestation
Slender Bulbul	deforestation
Blackheaded Apalis	deforestation
Woodwards' Batis	deforestation
Wattle-eyed Flycatcher	deforestation
Pinkthroated Longclaw	disturbance of wetlands
Chestnutfronted Helmetshrike	deforestation
Olive Sunbird	deforestation
Green Twinspot	deforestation
Redthroated Twinspot	deforestation
Grey Waxbill	deforestation & cage-bird trade
Pied Mannikin	cage-bird trade

DISCUSSION

Current fieldguides and reference works for the southern African region (e.g. Newman 1983; Maclean 1993; Sinclair *et al.* 1993) depict most bird species distributions as uniform across southern Mozambique. By contrast, this survey shows many species to have sharply discontinuous distributions across the region. Many of the discontinuities correspond with the boundaries of the major vegetation types.

It has been noted above that species totals in most grid cells are lower than those for the neighbouring parts of South Africa and Swaziland (see **Coverage** under **METHODS AND AN OVERVIEW OF RESULTS**). Also, for many waterbirds (e.g. Dabchick and Fish Eagle) there is a discontinuity in reporting rates across the border with the Kruger National Park, South Africa. This is only partly due to more intensive coverage in the neighbouring regions during the southern African atlas project. The lower species diversity in this region reflects environmental factors. The western border with Swaziland and South Africa coincides with the ridge of the Libombo Mountain range. By contrast with the diverse topography and vegetation types to the east, this region consists of a flat plain with a sandy, nutrient-deficient substrate with poor water-retention properties. It is largely devoid of watercourses and artificial impoundments. It supports large tracts of continuous homogenous woodlands.

Many woodland species show gaps in their distributions which correspond with the floodplains of the Inkomati and Limpopo rivers. The fact that apparently suitable woodland areas do occur within the gaps in distribution suggests that the rivers and their floodplains have acted as a barrier to the movements of the species over a long period of time. In some instances, subspecific differences between populations on either side of the floodplains have been documented (Clancey 1996) and are commented on in the species accounts (e.g. Flappet Lark, Black Sunbird and Forest Weaver). Further investigations along these lines may yield interesting results.

The distributions of most waterbirds reflect the concentration of freshwater wetland habitats in the floodplains of the Inkomati and Limpopo rivers.

Comparison of habitat preferences observed in this survey with the vegetation analysis presented in the southern African atlas (Harrison *et al.* 1997a,b) highlights a potential problem in interpreting that analysis. Several species which were

shown to have a strong association with the Mopane biome, relative to other biomes in that analysis, were found in this survey to be marginally or not at all associated with Mopane woodlands. These include African Hawk Eagle, Bronze-winged Courser, Doublebanded Sandgrouse, Cape Parrot, Mottled and Böhm's Spinetails and White Helmetshrike. The reported association with Mopane in the southern African analysis may be due to the species occurring within habitats which interdigitate with Mopane woodlands and not the Mopane woodlands themselves. In some cases (Rackettailed Roller, Trumpeter Hornbill, Yellowbellied Bulbul, Olivetree Warbler, Lesser Grey Shrike and Melba Finch) the authors of the species texts in that publication pointed out that the associations with Mopane were potentially misleading.

This survey provides a clear picture of the status and range within the region of the majority of species which occur there. As a result of the limited number of observers and time available, it is inevitable that some rare and inconspicuous species were overlooked. The status of, for example, the Green Tinker Barbet and East African Swee remain tantalisingly obscure.

Some coastal species that were reported in the north of the region prior to this survey were observed less widely (e.g. Little Spotted Woodpecker, Slender Bulbul, Blackheaded Apalis, Shortwinged Cisticola) or not at all (Vanga Flycatcher and Redwinged Warbler). While it is likely that these species have declined as a result of the destruction of natural vegetation in the densely populated coastal region, it is also likely that they persist in the increasingly fragmented remnants of the natural vegetation, not all of which were visited during this survey. Further fieldwork is likely to yield additional distributional records for these species.

A number of difficulties were experienced during the fieldwork, some of them relating to the lasting effects of the civil war. Of greatest concern was the number of land-mines which were laid throughout Mozambique. The process of mine clearing commenced in 1992, but was still ongoing when fieldwork was completed in 1998. As a consequence, observers were often inhibited from venturing away from well-worn roads and paths. Fortunately, no land-mines were detonated by observers.

Available maps date back to the 1970s and are no longer up to date with respect to the road network. During the civil war, many roads fell into disuse and practically ceased to exist, while subsequently new roads have been created, the existence and destinations of which are not generally known, let alone mapped. In addition, many roads become impassable after heavy rains.

Malaria-control measures lapsed during the civil war, and the disease has been rampant during subsequent years. More than one observer suffered acutely from this disease during the course of fieldwork. Conditions in the field were often uncomfortably hot and humid. Observers frequently suffered the painful attentions of horse flies of the family Tabanidae, and stingless bees of the subfamily Meliponinae caused much irritation by swarming persistently in the faces of observers. The fact that previous ornithological exploration in the region has been concentrated in the winter months (see e.g. Clancey 1996, pp. 7–8) is probably related to some of these difficulties.

Much of the interior is undeveloped and largely uninhabited, and consequently fuel, drinking water and other supplies are unobtainable over large areas.

In contrast to other parts of southern Africa, where more than 5000 observers contributed to the bird atlas project (Harrison *et al.* 1997a,b), the number of potential contributors with the necessary skills and inclination within Mozambique is very small. Furthermore, as a result of severe communication difficulties, it is likely that some potential contributors were unable to establish contact with the atlas project and that checklists submitted to the project may not have been received. Among other administrative difficulties, the author spent more than 50 days in total attending to immigration formalities.

Explanation of species accounts

DISTRIBUTION MAPS

On the species maps, a black circle is placed at the centre of each grid cell in which the species was reported. The area of the circle is proportional to the reporting rate of the species in that grid cell; the diameter is proportional to the square root of the reporting rate.

The map is accompanied by a seasonality histogram showing the fluctuations in reporting rates within the range of the species throughout the year, and summary statistics representing the total number of observations of the species, the number of grid cells in which it was reported and the mean reporting rate within its range. Reporting rates reflected in the seasonality histogram are calculated over the range of the species, not over the whole region.

The species maps include data from the neighbouring parts of South Africa, Swaziland and Zimbabwe, taken, with permission, from *The Atlas of Southern African Birds* (Harrison *et al.* 1997a,b).

The seasonality histograms and summary statistics do not include the data from the neighbouring states.

SPECIES TEXTS

Species texts are headed by English and scientific names (following *Roberts' Birds of Southern Africa* (Maclean 1993)) and Portuguese names (M. de Melo *et al.*; see Acknowledgements). Species numbers are those of Maclean (1993).

References in the species accounts to *The Atlas of Southern African Birds* are given using the abbreviation ASAB, followed by the volume and page numbers, e.g. ASAB1: 2–3.

Habitat

The species accounts describe the habitat types in which the species was most often observed during this survey (which may differ from the preferred habitat of the species in other parts of its range). Wherever possible, explanations are offered for discontinuities in reporting rates on the maps.

Seasonal movements

Seasonal movements are discussed with reference to fluctuations in reporting rates represented in the graphics, together with information from neighbouring regions.

Social organisation

An indication of whether a species is solitary or gregarious and of typical flock sizes is given. Mention is made of any noteworthy concentrations, especially for waterbirds. For each species which was recorded more than a handful of times, an estimate of the population within the region is given.

Estimated densities

For the more numerous woodland species, the estimated densities in each of the main woodland types is tabulated. Abbreviations used for woodland types in the tables are:

ACA: Acacia
MOP: Mopane
MIO: Miombo (*Julbernadia* and *Brachystegia* woodlands)
OBW: Other broadleaved woodlands (including *Terminalia*- and *Combretum*-dominated woodlands and mixed woodlands).

Breeding data

The timing of breeding for the species in the neighbouring regions is reported, based on the data supplied by Harrison *et al.* (1997a,b), Tarboton *et al.* (1987), Irwin (1981) and Dean (1971). Breeding records from this survey are also mentioned.

Subspecies

Where more than one subspecies has been described within the region, these are mentioned, together with their supposed ranges.

Conservation status

Past and ongoing changes and threats to the status of the species are discussed.

Interspecific relationships

Ecological relationships between similar species and the relationships between brood parasites and their hosts are mentioned.