THE ATLAS OF SOUTHERN AFRICAN BIRDS

VOLUME 1: NON-PASSERINES

Edited by

J.A. Harrison, D.G. Allan, L.G. Underhill, M. Herremans, A.J. Tree, V. Parker and C.J. Brown

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Introduction and methods

To acquire a 'feel' for the information presented in these volumes it is essential that the user be familiar with the background to the Southern African Bird Atlas Project (SABAP), and particularly with the details of the database and the analyses used to synthesize the information therein. This chapter aims to provide the necessary explanations, briefly but comprehensively.

OBJECTIVES

Historical snapshot

The objective of this atlas, as of most biological atlases compiled since 1960, is to provide a 'snapshot' of a changing biogeographical scene. The underlying assumption is that such a snapshot will be different from snapshots taken both in the past and in the future. Therefore 'atlasing', as a form of biological research, should be viewed as a dynamic monitoring exercise rather than a once-only definitive survey. Despite the fact that atlasing is not continuous, it is repeatable and as such has the potential to become 'pulsed monitoring'.

The value of this kind of monitoring has been demonstrated at least once by *The New Atlas of Breeding Birds in Britain and Ireland* (Gibbons *et al.* 1993). In that atlas, the dynamic nature of population densities and distributions, even over a short period of twenty years, was clearly demonstrated. The southern African atlas should be repeated in the not-too-distant future if the full potential of the database is to be realized.

Geographical scope

There is a tradition, particularly within southern African ornithology, of defining the subcontinent of southern Africa as the region to the south of the Kunene, Kavango and Zambezi rivers. This encompasses the countries of Botswana, Lesotho, Mozambique south of the Zambezi River, Namibia, South Africa, Swaziland and Zimbabwe. Ornithologists in these countries have tended to interact and collaborate, and it is this area which is covered by the popular fieldguides (e.g. Maclean 1993b).

It was natural, therefore, to try to cover the same region for the atlas. Unfortunately Mozambique had to be excluded because of the civil war in that country at the time. Despite logistical problems and an unfavourable political climate – South Africa then still being in its apartheid era – the obvious appeal and challenge of a six-nation effort eventually won the day. This appears to be the first atlas, other than those for Britain and Ireland, to have involved more than one nation in simultaneous fieldwork and joint publication. Its subcontinental scope offers a regional perspective and the opportunity to approach both population studies and conservation issues with a biogeographic rather than a national viewpoint.

Taxonomic and seasonal scope

In temperate parts of the world there tend to be dramatic differences between winter and summer climates, resulting in strikingly different seasonal avifaunas; also breeding seasons are short and well-defined. For these reasons, several bird atlases have been limited to breeding birds and the breeding season. Tropical and subtropical regions lack these sharp contrasts, making it appropriate to gather data across all months of the year and all species.

SABAP adopted this comprehensive approach in order to capture the full range of migratory and breeding regimens, and to allow an assessment of the status, not only of breeding species, but also of nonbreeding visitors. By covering all months and all species, it was intended that a profile of seasonality of occurrence and of breeding would be constructed for each species.

For practical reasons it was decided not to distinguish between subspecies in the collection of field data, as they are often difficult to recognize in the field and their taxonomic status is frequently in dispute. One exception to this rule was made for the Yellowbilled Kite *Milvus migrans parasitus* and Black Kite *M. m. migrans* and *M. m. lineatus*.

Research and conservation

An atlas of this kind consists of information and, strictly speaking, is not a product of 'research' in the sense of hypothesis testing. However, it is on information that research thrives. The constant stream of requests for data from the SABAP databank demonstrates unequivocally the need that both pure and applied research have for this information.

From the outset it was in the field of biodiversity conservation that SABAP wished to make a significant contribution. Scientific publications, aimed specifically at addressing issues in conservation planning, that have presented analyses of SABAP data include Harrison & Martinez (1995), Lombard (1995), Robertson *et al.* (1995), Allan *et al.* (1997). These papers, together with several on particular species, are among the first in what promises to be a long series of publications which will stimulate the conservation of birds in southern Africa.

A catalyst for involvement

It has been the experience of organizations in other parts of the world that a bird atlas project, using volunteers drawn from the public, can do much to promote ornithology among lay people and to secure their involvement in further, more challenging, data-collection schemes. SABAP may have been the first atlas project to be launched with this as one of its explicit objectives. It was the recognition of the need for a 'Bird Populations Data Unit' (BPDU) which led to the proposal of an atlas project as a catalyst, both for public participation and for the establishment of a BPDU (Prŷs-Jones 1984).

Happily, SABAP succeeded on both counts by attracting thousands of participants and by providing, together with the South African Bird Ringing Unit (SAFRING), the nucleus for the Avian Demography Unit (ADU) which is the incarnation of the BPDU concept (Underhill *et al.* 1991). The ADU now runs several studies on bird populations, supported enthusiastically by converts to atlasing (Harrison *et al.* 1996). Bird atlasing, as an intrinsically enjoyable pastime, is uniquely suited to achieving such a 'bootstrapping' process.

DATA COLLECTION AND ADMINISTRATION

Geographical resolution

Data were collected by grid cell using a 15' x 15' or 'quarter-degree' grid. The Botswana atlas project had already adopted a 30' x 30' or 'half-degree' grid and this was accepted as satisfactory in a relatively uniform country. The contrasting resolutions of Botswana and the rest of the atlas region are obvious in the distribution maps.

Some coastal grid cells were combined with neighbouring cells because of the small land area falling within the coastal cell; usually only two cells, but in one case three, were combined (Port Elizabeth 3325DC,DD and 3425BA) (see the ***Guide to Species Accounts*** on page 1 of each volume for an explanation of the coding used to designate grid cells). Combined coastal cells are transparent because the same data are mapped into both cells. The atlas did not aim to cover areas of ocean, but data collected at sea and within 20 km of the coast were included; they were ascribed to the nearest coastal grid cell.

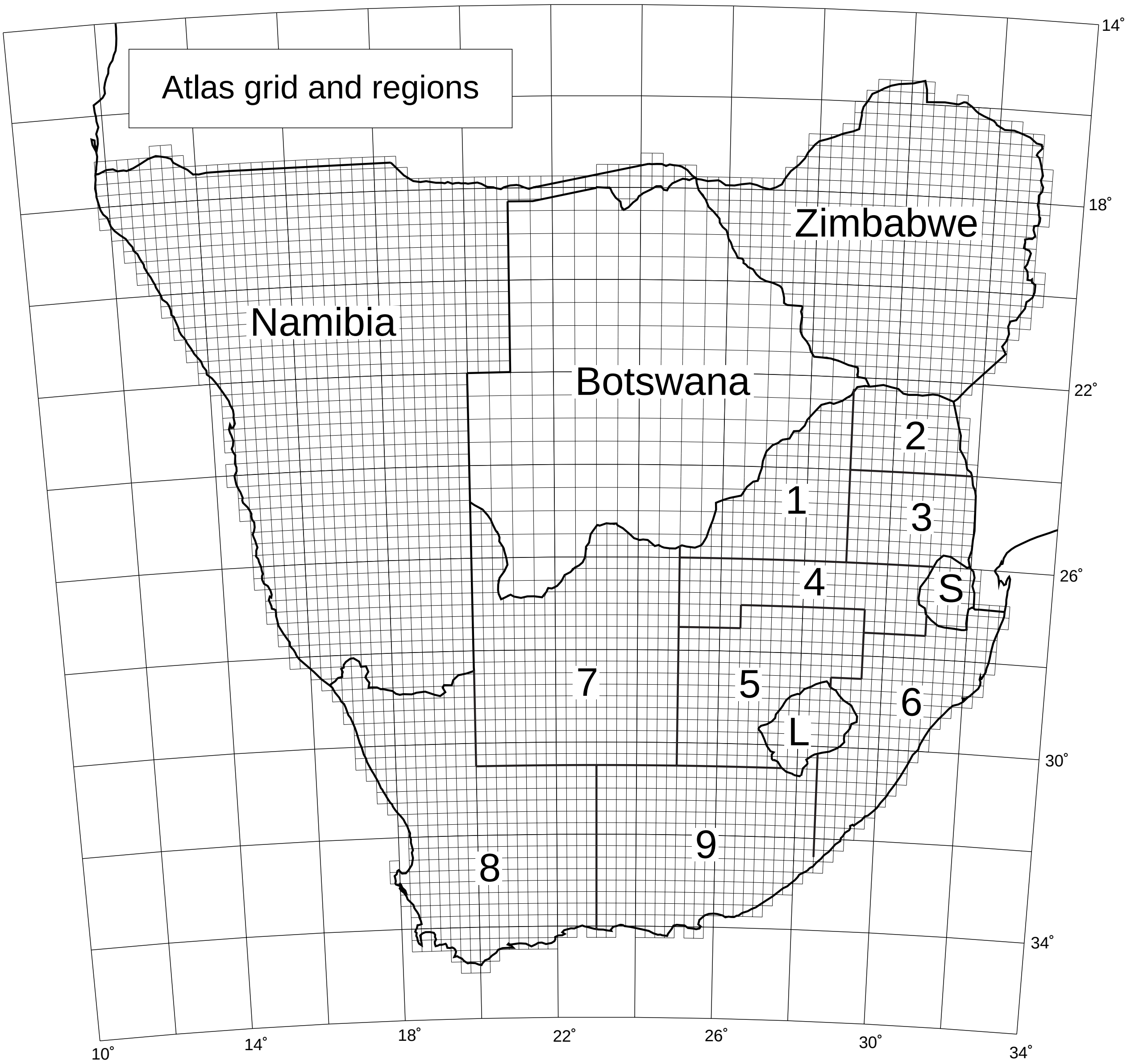


FIGURE 1. Grid map of the atlas region with national boundaries. The boundaries of the areas administered by each Regional Atlas Committee in South Africa are shown (see Table 1). L and S indicate Lesotho and Swaziland respectively. Note the coarser grid in Botswana.

Most of the data for Swaziland was collected on a 7.5' x 7.5' or 'eighth-degree' grid scale, but were amalgamated to quarter-degree cells for use here. The Swaziland bird atlas (Parker 1994) used the finer resolution and makes an interesting comparison with this atlas.

Data collection took place independently on either side of international borders which necessitated the merging of data collected on both sides of a border, but for the same grid cells. This was problematic along the borders of Botswana with South Africa, Zimbabwe and the Caprivi Strip in Namibia because of the different grids used. Where quarter-degree grid cell data were available from South Africa, Zimbabwe and the Caprivi Strip, these data were mapped at the finer resolution; the Botswana data were mapped into the remainder of the half-degree grid cell falling exclusively on the Botswana side of the border.

In the southern hemisphere, meridians converge towards the South Pole, hence the dimensions of grid cells decrease with increasing latitude. In northern Zimbabwe, a grid cell is *c.* 27 km from east to west and *c.* 27.4 km north to south, giving an area of *c.* 740 km^2. In the southern Cape Province these dimensions are *c.* 23.3 km, *c.* 27.5 km and *c.* 641 km^2. There is, therefore, a *c.* 13.4% difference in size between cells at the northern and southern extremities of the atlas region. This variation in size is not important in the interpretation of atlas statistics because it is the proportion of checklists with records, rather than an absolute number of records, which forms the basis for all indices of relative density (see under **Analyses, Reporting rate** below).

The total number of grid cells in the atlas region, taking into account the coarser grid in Botswana, is 3973 (see Figure 1). However, in the summary statistics given below each species' text, the Botswana half-degree grid cells are each counted as four quarter-degree grid cells, giving a maximum total of 4537 cells.

Temporal resolution

The calendar month was the temporal resolution used during data collection; a checklist covered a period of one calendar month or less. Provision was made for recording the observation period as a single day or range of days, but the dates could not span two calendar months. Checklists submitted by observers resident in an area were frequently for whole months. Itinerant observers would usually record the actual day(s) spent in the field. There were, however, some checklists for remote grid cells, particularly in Namibia, which spanned more than one

TABLE 1. The atlas period by region. Numbers refer to Figure 1.

region		pre-SABAP data	SABAP data	comments
Botswana		1981–89	1989–93	Most but not all data used in Penry (1994) were made available to SABAP.
Lesotho		1984–85	1987–93	All the data used in Osborne & Tigar (1990) incorporated.
Namibia		1970–86	1987–93	Pre-SABAP data constitutes *c.* 44% of the total.
Swaziland		1985–86	1987–91	All data used in Parker (1994) incorporated.
Zimbabwe		none	1987–92	Pre-SABAP data computerized but not incorporated.
1	Northern Transvaal	none	1987–92	
2	Northeast Transvaal	none	1987–92	
3	Lowveld	none	1987–91	
4	Southern Transvaal	1982–86	1987–92	Tarboton *et al.* (1987b) and Earlé & Grobler (1987) data included, where appropriate.
5	Free State	1982–86	1987–92	Most data from Earlé & Grobler (1987) included.
6	Natal	1981–86	1987–91	Cyrus & Robson (1980) data not included because pre-1980.
7	Northern Cape	none	1987–92	
8	Western Cape	1982–86	1987–91	All data from Hockey *et al.* (1989) included.
9	Eastern Cape	1985–86	1987–92	All data included.

month; these checklists were excluded from all analyses of seasonality.

Year was also recorded, although comprehensive coverage on an annual basis was not a practical objective. In some intensively covered areas, the annual coverage may have been sufficient to allow for interesting analyses of year-on-year differences in reporting rates for particular species (e.g. Underhill & Hockey 1988).

A different temporal resolution was applied *post hoc* to the analysis of seasonality of occurrence. Five-day periods or 'pentades' (Berthold 1973) were used to enhance the temporal accuracy of models of seasonality of occurrence for most species, but this necessitated the exclusion of *c.* 50% of the checklists which covered periods longer than the maximum (see **Analyses, Modelling of seasonality**, below).

Atlas period

As a general statement, this atlas presents a snapshot of bird distribution during the late 1980s and early 1990s. However, the atlas period cannot be defined simply because it varied regionally (Table 1; see Figure 1 for regional boundaries). Although data collection for SABAP commenced in January 1987, several earlier datasets, compiled in immediately preceding years, were incorporated to improve overall coverage.

Pre-SABAP data, whether previously published or not, were incorporated provided they were collected after 1980, with the exception of Namibia, for which 1970 was the cut-off. The effort to include post-1980 data was successfully achieved, with two exceptions: (1) Not all checklists used for the Transvaal bird atlas (Tarboton *et al.* 1987b) could be located; only those housed in the Transvaal Museum were available. Most of those were from the 1970s and were therefore not included; (2) Although *c.* 13 000 pre-SABAP Zimbabwean checklists were computerized, it was decided by the Ornithological Association of Zimbabwe (OAZ) not to use them because of difficulties in vetting the data to a satisfactory standard of accuracy.

Data collection mostly ended in December 1991; but to improve coverage, particularly of remote and inaccessible areas, it continued locally into 1992 and even 1993 (Table 1). However, most data were collected in the period 1987–91.

Atlas records

The vast majority of atlas records were of live birds seen and/or heard. A few records were of dead birds found as fresh roadkills or beached on the shore. Beached birds were not necessarily fresh but most are likely to have been less than a few weeks old (Bibby & Lloyd 1977).

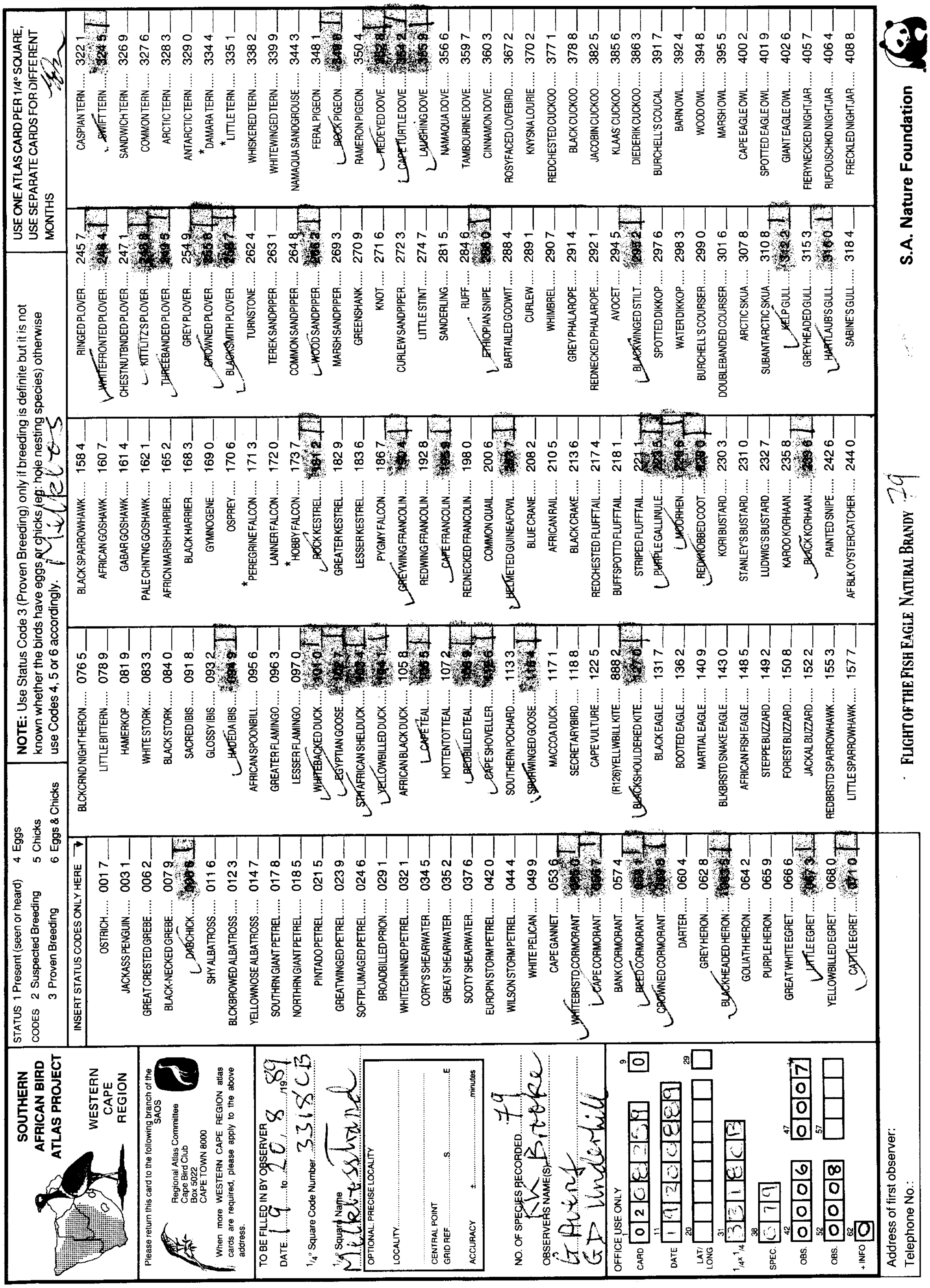
Observers were not encouraged to use more tenuous evidence such as feathers, old nests or second-hand information, and were advised to be wary of mimicry when identifying calls. They were admonished not to guess and to record only those species which they had identified with confidence. Observers were encouraged to provide additional information as an aid to verification of unusual records (see **Vetting** below). Observers allocated one of seven status codes to each record:

- **1:** present only, seen or heard
- **2:** current breeding suspected
- **3:** current breeding proven but nest contents unknown
- **4:** eggs in nest
- **5:** chicks in nest
- **6:** eggs and chicks in same or different nests
- **7:** dependent fledglings seen with parents

If more than one status code was valid, the highest was allocated.

Great emphasis was placed on the accumulation of records in the context of comprehensive checklists, and the submission of single 'special' records was discouraged. The objective was to compile unbiased, unselective lists of all species observed and to make lists as comprehensive and as representative of grid cells as possible. The rationale for this was the intention to use the recording frequencies or 'reporting rates' for species as indices of relative abundance or density. Biases inherent in the recording process are discussed below under Analyses.

Pre-SABAP datasets incorporated into the atlas database were all of this checklist type and therefore compatible with SABAP data.



SOUTHERN AFRICAN BIRD ATLAS PROJECT
WESTERN CAPE REGION

Please return this card to the following branch of the SAOS
Regional Atlas Committee
Cape Bird Club
Box 5022
CAPE TOWN 8000
When more WESTERN CAPE REGION atlas cards are required, please apply to the above address.

TO BE FILLED IN BY OBSERVER
DATE 19 to 20.8.1989
1/4° Square Code Number 3318CB
1/4° Square Name Milkbosstrand
OPTIONAL: PRECISE LOCALITY
LOCALITY
CENTRAL POINT GRID REF ....S ....E
ACCURACY ± ....minutes
NO. OF SPECIES RECORDED 79
OBSERVERS NAME(S) RK Brooke, G Avery, GD Underhill

OFFICE USE ONLY
CARD 0 2 0 8 2 5 9 | 9 0
DATE 11 1 9 2 0 0 8 8 9
LAT/LONG 20 | 29
1/4 x 1/4 31 3 3 1 8 C B
SPEC. 38 0 7 9
OBS. 42 0 0 0 6 | 47 0 0 0 7
OBS. 52 0 0 0 8 | 57
+INFO 62 0

STATUS CODES 1 Present (seen or heard) 2 Suspected Breeding 3 Proven Breeding 4 Eggs 5 Chicks 6 Eggs & Chicks

NOTE: Use Status Code 3 (Proven Breeding) only if breeding is definite but it is not known whether the birds have eggs or chicks (eg: hole nesting species) otherwise use Codes 4, 5 or 6 accordingly. Milkbos

USE ONE ATLAS CARD PER 1/4° SQUARE, USE SEPARATE CARDS FOR DIFFERENT MONTHS

INSERT STATUS CODES ONLY HERE

OSTRICH 001 7; JACKASS PENGUIN 003 1; GREAT CRESTED GREBE 006 2; BLACK-NECKED GREBE 007 9; DABCHICK 008 6; SHY ALBATROSS 011 6; BLCKBROWED ALBATROSS 012 3; YELLOWNOSE ALBATROSS 014 7; SOUTHRN GIANT PETREL 017 8; NORTHRN GIANT PETREL 018 5; PINTADO PETREL 021 5; GREATWINGED PETREL 023 9; SOFTPLUMAGED PETREL 024 6; BROADBILLED PRION 029 1; WHITECHINNED PETREL 032 1; CORY'S SHEARWATER 034 5; GREAT SHEARWATER 035 2; SOOTY SHEARWATER 037 6; EUROPN STORM PETREL 042 0; WILSON STORM PETREL 044 4; WHITE PELICAN 049 9; CAPE GANNET 053 6; WHITEBRSTD CORMORANT 055 0; CAPE CORMORANT 056 7; BANK CORMORANT 057 4; REED CORMORANT 058 1; CROWNED CORMORANT 059 8; DARTER 060 4; GREY HERON 062 8; BLACKHEADED HERON 063 5; GOLIATH HERON 064 2; PURPLE HERON 065 9; GREAT WHITE EGRET 066 6; LITTLE EGRET 067 3; YELLOWBILLED EGRET 068 0; CATTLE EGRET 071 0

BLCKCRND NIGHT HERON 076 5; LITTLE BITTERN 078 9; HAMERKOP 081 9; WHITE STORK 083 3; BLACK STORK 084 0; SACRED IBIS 091 8; GLOSSY IBIS 093 2; HADEDA IBIS 094 9; AFRICAN SPOONBILL 095 6; GREATER FLAMINGO 096 3; LESSER FLAMINGO 097 0; WHITEBACKED DUCK 101 0; EGYPTIAN GOOSE 102 7; STH AFRICAN SHELDUCK 103 4; YELLOWBILLED DUCK 104 1; AFRICAN BLACK DUCK 105 8; CAPE TEAL 106 5; HOTTENTOT TEAL 107 2; REDBILLED TEAL 108 9; CAPE SHOVELLER 112 6; SOUTHERN POCHARD 113 3; SPURWINGED GOOSE 116 4; MACCOA DUCK 117 1; SECRETARYBIRD 118 8; CAPE VULTURE 122 5; (R126) YELLWBILL KITE 888 2; BLACKSHOULDERED KITE 127 0; BLACK EAGLE 131 7; BOOTED EAGLE 136 2; MARTIAL EAGLE 140 9; BLKBRSTD SNAKE EAGLE 143 0; AFRICAN FISH EAGLE 148 5; STEPPE BUZZARD 149 2; FOREST BUZZARD 150 8; JACKAL BUZZARD 152 2; REDBRSTD SPARROWHAWK 155 3; LITTLE SPARROWHAWK 157 7

BLACK SPARROWHAWK 158 4; AFRICAN GOSHAWK 160 7; GABAR GOSHAWK 161 4; PALE CHNTNG GOSHAWK 162 1; AFRICN MARSH HARRIER 165 2; BLACK HARRIER 168 3; GYMNOGENE 169 0; OSPREY 170 6; *PEREGRINE FALCON 171 3; LANNER FALCON 172 0; *HOBBY FALCON 173 7; ROCK KESTREL 181 2; GREATER KESTREL 182 9; LESSER KESTREL 183 6; PYGMY FALCON 186 7; GREYWING FRANCOLIN 190 4; REDWING FRANCOLIN 192 8; CAPE FRANCOLIN 195 9; REDNECKED FRANCOLIN 198 0; COMMON QUAIL 200 6; HELMETED GUINEAFOWL 203 7; BLUE CRANE 208 2; AFRICAN RAIL 210 5; BLACK CRAKE 213 6; REDCHESTED FLUFFTAIL 217 4; BUFFSPOTTD FLUFFTAIL 218 1; STRIPED FLUFFTAIL 221 1; PURPLE GALLINULE 223 5; MOORHEN 226 6; REDKNOBBED COOT 228 0; KORI BUSTARD 230 3; STANLEY'S BUSTARD 231 0; LUDWIG'S BUSTARD 232 7; KAROO KORHAAN 235 8; BLACK KORHAAN 239 6; PAINTED SNIPE 242 6; AFBLK OYSTERCATCHER 244 0

RINGED PLOVER 245 7; WHITEFRONTED PLOVER 246 4; CHESTNUTBNDED PLOVER 247 1; KITTLITZ'S PLOVER 248 8; THREEBANDED PLOVER 249 5; GREY PLOVER 254 9; CROWNED PLOVER 255 6; BLACKSMITH PLOVER 258 7; TURNSTONE 262 4; TEREK SANDPIPER 263 1; COMMON SANDPIPER 264 8; WOOD SANDPIPER 266 2; MARSH SANDPIPER 269 3; GREENSHANK 270 9; KNOT 271 6; CURLEW SANDPIPER 272 3; LITTLE STINT 274 7; SANDERLING 281 5; RUFF 284 6; ETHIOPIAN SNIPE 286 0; BARTAILED GODWIT 288 4; CURLEW 289 1; WHIMBREL 290 7; GREY PHALAROPE 291 4; REDNECKED PHALAROPE 292 1; AVOCET 294 5; BLACKWINGED STILT 295 2; SPOTTED DIKKOP 297 6; WATER DIKKOP 298 3; BURCHELL'S COURSER 299 0; DOUBLEBANDED COURSER 301 6; ARCTIC SKUA 307 8; SUBANTARCTIC SKUA 310 8; KELP GULL 312 2; GREYHEADED GULL 315 3; HARTLAUB'S GULL 316 0; SABINE'S GULL 318 4

CASPIAN TERN 322 1; SWIFT TERN 324 5; SANDWICH TERN 326 9; COMMON TERN 327 6; ARCTIC TERN 328 3; ANTARCTIC TERN 329 0; *DAMARA TERN 334 4; *LITTLE TERN 335 1; WHISKERED TERN 338 2; WHITEWINGED TERN 339 9; NAMAQUA SANDGROUSE 344 3; FERAL PIGEON 348 1; ROCK PIGEON 349 8; RAMERON PIGEON 350 4; REDEYED DOVE 352 8; CAPE TURTLE DOVE 354 2; LAUGHING DOVE 355 9; NAMAQUA DOVE 356 6; TAMBOURINE DOVE 359 7; CINNAMON DOVE 360 3; ROSYFACED LOVEBIRD 367 2; KNYSNA LOURIE 370 2; REDCHESTED CUCKOO 377 1; BLACK CUCKOO 378 8; JACOBIN CUCKOO 382 5; KLAAS' CUCKOO 385 6; DIEDERIK CUCKOO 386 3; BURCHELL'S COUCAL 391 7; BARN OWL 392 4; WOOD OWL 394 8; MARSH OWL 395 5; CAPE EAGLE OWL 400 2; SPOTTED EAGLE OWL 401 9; GIANT EAGLE OWL 402 6; FIERYNECKED NIGHTJAR 405 7; RUFOUSCHKD NIGHTJAR 406 4; FRECKLED NIGHTJAR 408 8

Address of first observer:
Telephone No.:
FLIGHT OF THE FISH EAGLE NATURAL BRANDY 79
S.A. Nature Foundation

FIGURE 2. One side of an A4-size atlas checklist for the Western Cape region. Note that it is designed both for recording in the field, and for data capture. (This is an actual submission by three avid atlasers, the late Richard Brooke, the late George Underhill, and Graham Avery.)

```
    LESOTHO   SQUARE  2927 BC 32 THABA BOSIU                                                                    BATCHES 000-010-901


NUMBER OF CARDS PER MONTH  :  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  TOTAL
                               17   20   20   27   23   24   16   14   17   16   20   14    228

SPECIES OBSERVED PRESENT

NUMBER OF SPECIES PER MONTH:  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  TOTAL
                              113  109  108  101   97   95   89   85   88   94  112  123    179

                      PSB JFMAMJ JASOND T                           PSB JFMAMJ JASOND T                           PSB JFMAMJ JASOND T

  8          DABCHICK..1 877554 465668  57 264   COMMON SANDPIPER..1 000000 000001   0 596         STONECHAT..1 00102R 112120    7
 55 WHITBRST CORMORANT..1 122210 112121  13 266     WOOD SANDPIPER..1 010R00 000101   3 601        CAPE ROBIN..1 213323 443422   26
 58     REED CORMORANT..1 875455 346758  53 269    MARSH SANDPIPER..1 000000 000001   1 614       KAROO ROBIN..1 000010 000010    2
 60             DARTER..1 153422 120222  22 270        GREENSHANK..1 100000 000000   0 622  LAYARD TITBABBLER..1 000000 000010    1
 62         GREY HERON..1 555475 368486  54 297     SPOTTED DIKKOP..1 01110R 001002   5 628 GREAT REED WARBLER..1 100000 000000    1
 63   BLACKHEADED HERON..1 466575 534448  50 348       FERAL PIGEON..1 123122 331112  18 631   AFR MARSH WARBLER..1 100000 100111    4
 64      GOLIATH HERON..1 000011 100000   3 349        ROCK PIGEON..1 656667 786677  62 634 ERPN SEDGE WARBLER..1 100000 000000    0
 65       PURPLE HERON..1 221100 110101   8 350     RAMERON PIGEON..1 001000 000000   0 635  CAPE REED WARBLER..1 213000 111124   10
 66  GREAT WHITE EGRET..1 00020R 000100   3 352       REDEYED DOVE..1 677554 644576  55 638  AFR SEDGE WARBLER..1 000000 000100    0
 67       LITTLE EGRET..1 010000 000031   4 354  CAPE TURTLE DOVE..1 888788 899899  82 643     WILLOW WARBLER..1 122000 000013    7
 68 YELLOWBILLED EGRET..1 110001 100011   5 355      LAUGHING DOVE..1 899999 998999  88 661         GRASSBIRD..1 000R00 001000    1
 71       CATTLE EGRET..1 988788 887899  79 356       NAMAQUA DOVE..1 000R0R 110101   3 664 FANTAILD CISTICOLA..1 2010R0 000003    4
 72      SQUACCO HERON..1 001001 000000   1 377  REDCHESTED CUCKOO..1 661000 000665  23 665   DESERT CISTICOLA..1 200000 000001    2
 76 BLKCRN NIGHT HERON..1 472211 444346  32 382     JACOBIN CUCKOO..1 523000 000022  11 666    CLOUD CISTICOLA..1 200000 000001    2
 78     LITTLE BITTERN..1 000000 001100   2 386    DIEDERIK CUCKOO..1 361010 000257  19 667   AYRES' CISTICOLA..1 200000 000010    2
 81           HAMERKOP..1 766434 855649  54 392           BARN OWL..1 100000 000000   0 677 LEVAILNT CISTICOLA..1 4241R2 102546   25
 84       BLACK STORK..1 0000RR 111012   4 393         GRASS OWL..1 000000 110000   1 681          NEDDICKY..1 343332 335365   35
 85      ABDIM'S STORK..1 220000 000010   3 395          MARSH OWL..1 01000R 100001   3 685 BLACKCHESTD PRINIA..1 000110 002000    4
 91        SACRED IBIS..1 610253 242425  29 411     EUROPEAN SWIFT..1 000000 000110   1 686     SPOTTED PRINIA..1 11312R 122114   15
 92          BALD IBIS..1 111111 111111   7 412        BLACK SWIFT..1 224201 000134  15 689 SPOTTED FLYCATCHER..1 030000 000000    2
 93        GLOSSY IBIS..1 000000 000001   1 415  WHITERUMPED SWIFT..1 011100 000000   2 706    FAIRY FLYCATCHER..1 0010R0 100001    2
 94        HADEDA IBIS..1 999556 879899  75 416        HORUS SWIFT..1 213100 000121   8 710 PARADSE FLYCATCHER..1 240000 000010    5
 95  AFRICAN SPOONBILL..1 1001R1 000110   5 417       LITTLE SWIFT..1 234100 001326  18 713       CAPE WAGTAIL..1 233135 342323   28
 99    WHITEFACED DUCK..1 452321 122125  25 418       ALPINE SWIFT..1 433R00 044564  25 716     RICHARD'S PIPIT..1 1110R1 113124   11
101   WHITEBACKED DUCK..1 142322 110211  18 424 SPECKLED MOUSEBIRD..1 675433 866656  51 717   LONGBILLED PIPIT..1 0000R0 000000    0
102     EGYPTIAN GOOSE..1 230210 011123  14 426 REDFACED MOUSEBIRD..1 01000R 011001   4 721         ROCK PIPIT..1 000000 000011    1
103 S AFRICAN SHELDUCK..1 000000 000001   1 428     PIED KINGFISHER..1 243110 113345  20 727 ORNGTHRTD LONGCLAW..1 131R11 110013    9
104  YELLOWBILLED DUCK..1 779545 855866  60 429    GIANT KINGFISHER..1 1121R2 112511  13 732      FISCAL SHRIKE..1 999998 999999   90
105 AFRICAN BLACK DUCK..1 201120 101124  10 431 MLCHITE KINGFISHER..1 482111 001010  16 746        BOKMAKIERIE..1 456433 234354   37
106          CAPE TEAL..1 000000 110000   1 451             HOOPOE..1 000111 112322  11 759       PIED STARLING..1 545345 867888   56
108      REDBILLED TEAL..1 343312 120234  22 465        PIED BARBET..1 000010 001010   2 760   WATTLED STARLING..1 000000 001000    0
113    SOUTHERN POCHARD..1 000000 001010   1 473      CRESTED BARBET..1 100100 000000   2 764    GLOSSY STARLING..1 21032R 213014   15
116   SPURWINGED GOOSE..1 111001 000011   4 474 GREATER HONEYGUIDE..1 100000 000000   0 769 REDWINGED STARLING..1 655785 985686   63
117        MACCOA DUCK..1 212201 112111  12 476   LESSER HONEYGUIDE..1 000000 001001   1 775   MALACHITE SUNBIRD..1 123332 124223   22
118      SECRETARYBIRD..1 000000 030000   2 480  GROUND WOODPECKER..1 122R12 012120  11 796     CAPE WHITE-EYE..1 535133 465335   36
119    BEARDED VULTURE..1 000100 000000   1 489 REDTHROATD WRYNECK..1 100100 010000   4 799 WTBR SPARROWWEAVER..1 000010 000010    2
                  .                                         .                                         .
                  .                                         .                                         .
                  .                                         .                                         .
226            MOORHEN..1 899675 887887  72 550   WHITENECKED RAVEN..1 123133 532111  21 870 BLACKTHRTED CANARY..1 122112 110112   11
228     REDKNOBBED COOT..1 989655 665879  67 567       REDEYED BULBUL..1 898575 879877  71 872        CAPE CANARY..1 133122 235656   29
234       BLUE KORHAAN..1 010000 003001   4 577        OLIVE THRUSH..1 424012 423212  20 878      YELLOW CANARY..1 000R01 000011    3
239      BLACK KORHAAN..1 000000 002011   4 581    CAPE ROCK THRUSH..1 0010R1 100000   3 881 STREAKYHDED CANARY..1 101103 300000    7
240     AFRICAN JACANA..1 000000 000001   1 582 SENTNL ROCK THRUSH..1 00000R 110000   2 885       CAPE BUNTING..1 134112 231222   18
249 THREEBANDED PLOVER..1 111121 111123  10 586      MOUNTAIN CHAT..1 111112 110313  11 886       ROCK BUNTING..1 133133 421334   24
255     CROWNED PLOVER..1 00001R 112000   4 589      FAMILIAR CHAT..1 1122R1 112232  14 888  R126 YLLWBLL KITE..1 530000 001324   13
258  BLACKSMITH PLOVER..1 577435 558436  50 591     SICKLEWING CHAT..1 111001 100000   4

SPECIES OBSERVED BREEDING OR SUSPECTED BREEDING

NUMBER OF SPECIES BREEDING :  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  TOTAL
                               12    9   12    3    2    2    1    4   12    8   13   16     40

                      PSB JFMAMJ JASOND T                           PSB JFMAMJ JASOND T                           PSB JFMAMJ JASOND T

  8          DABCHICK..2 300000 000700   3 355      LAUGHING DOVE..2 702000 002000   6 769 REDWINGED STARLING..2 050000 000050    2
 71       CATTLE EGRET..2 400000 002022   5 377  REDCHESTED CUCKOO..2 900000 000000   1 801      HOUSE SPARROW..2 000003 330030    4
 81           HAMERKOP..2 055000 000000   2 412        BLACK SWIFT..2 000000 000009   2 803       CAPE SPARROW..2 033003 000003    4
 84        BLACK STORK..2 000000 000090   1 480  GROUND WOODPECKER..2 000000 000090   2 804 GREYHEADED SPARROW..2 003300 000003    3
 94        HADEDA IBIS..2 000000 009000   1 520 WHITETHRTD SWALLOW..2 000000 009000   1 813        CAPE WEAVER..2 000000 000333    3
102     EGYPTIAN GOOSE..2 090000 000000   4 529         ROCK MARTIN..2 090000 000000   1 814      MASKED WEAVER..2 200000 001321   14
104  YELLOWBILLED DUCK..2 300000 022202   6 567       REDEYED BULBUL..2 009000 000000   2 824         RED BISHOP..2 3X2000 000XX3   17
108      REDBILLED TEAL..2 000000 000009   1 601          CAPE ROBIN..2 900000 000000   1 826      GOLDEN BISHOP..2 300000 000007    3
127 BLACKSHOULDRD KITE..2 000500 000050   2 681            NEDDICKY..2 009000 000000   2 856     REDHEADED FINCH..2 000000 090000    1
172      LANNER FALCON..2 000090 000000   1 686      SPOTTED PRINIA..2 000000 000090   1 870 BLACKTHRTED CANARY..2 000000 000009    1
226            MOORHEN..2 132000 002100   9 727 ORNGTHRTD LONGCLAW..2 000000 000009   2 872        CAPE CANARY..2 000000 000009    1
228     REDKNOBBED COOT..2 X2X0X0 0XXX2X  21 732       FISCAL SHRIKE..2 X20000 00X322  13 885       CAPE BUNTING..2 007300 000000    3
258  BLACKSMITH PLOVER..2 000000 009000   2 746         BOKMAKIERIE..2 000000 009000   2
349        ROCK PIGEON..2 003000 000070   3 759       PIED STARLING..2 003000 005003   4
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FIGURE 3. A sample of Phase 2 output which provided a summary of all atlas data for a particular grid cell. The 13 columns per species contain reporting rates per month (one digit each) and across all months (two digits). The monthly figures for breeding data are proportions of the total number of breeding records (column 13).

Checklists and coding

Each atlas region (Figure 1) had its own printed checklist with an appropriate list of species (Figure 2). Provision was made at the end of the list for the addition of species not listed, and space was provided for additional information on such species. Each species had a three-digit code number and a computer check-digit (see **Computerization** below). The observer added the status code as the fifth digit for each species observed.

Basic information, such as date, grid-cell code and observer name, was filled in by the observer and coded centrally in a 'for office use only' section (see Figure 2). Each checklist was allocated a unique number.

This checklist design provides a regional list of species and helps reduce misidentifications; the amount of writing required is minimal; the amount of coding required of administrators is minimal; and data-capture can be done directly from the checklist.

The checklist also carried reminders which reinforced the instructions contained in an introductory instruction booklet, and helped to ensure that observers who had not read the booklet knew what to do.

Computerization

Keying in of raw data was done directly from checklists by the data-capture service of the University of Cape Town (UCT). Data were stored and processed on successive mainframe systems. Data processing was mostly done using in-house custom-written FORTRAN programs.

New data were initially processed to produce 'echoes' of the checklists. These were checked against the original checklists to verify accuracy of data capture. The checking process was aided by a variety of computer checks for numbers falling outside defined limits, discrepancies between the number of species entered and the total claimed, etc. The computer check digit, which formed part of each species' code, allowed for a simple calculation to check whether the code had been correctly keyed in. Mistakes located in this 'Phase 1' stage were corrected by centralized online editing.

Checked data went through to a 'Phase 2' process which summarized all data for a particular atlas region into a single compact file. This file was used to generate various interim reports of which the most important were: (a) a summary of all occurrence and breeding records for each grid cell (Figure 3), (b) a set of coverage statistics for each grid cell, and (c) a simple grid map of distribution and reporting rates for each species (Phase 3, Figure 4). All of these were designed for rapid output on line-printers and were regularly distributed by post to the regions as a form of feedback.

Subsequent processes amalgamated data from all atlas regions to produce distribution maps with reporting rates per grid cell, analyses of reporting rates by vegetation types, and models of seasonal fluctuations in reporting rates of occurrence and breeding (see **Analyses** below).

The presentation of the analyses in the form of publication-quality graphics was a challenge because of the need to print copies on office-level equipment, for *c.* 900 species, and to do this repeatedly as the need for updates arose. The process was expedited by the development of a local-area network at UCT which allowed easy communication between the campus mainframe computer and desktop personal computers. FORTRAN programs were written to produce graphics as PostScript files which could be printed on a standard laser printer.

The entire atlas publication was typeset in-house using the Adobe PageMaker 6.0 desktop publishing (DTP) package. PostScript graphics were linked to the document as 'encapsulated' files. The line-art illustrations were scanned as TIFF graphics files with a Hewlett Packard ScanJet IICX scanner.

The SABAP approach to computerization may be relevant to other projects in a number of respects. The use of FORTRAN programs on a mainframe platform allowed for rapid and efficient data-processing and frequent database updates during the course of the project. The use of a professional data-capture service meant that the quantity of data collected was not a major obstacle. It was invaluable to have a computer programmer as an integral part of the project team, both for the maintenance of software and the development of new software as needs arose. The use of custom-written software gave the project freedom from the limitations of cumbersome database and geographic information system (GIS) packages which, because of their generality, were inevitably too slow for SABAP's needs.

Workforce and administration

The work of SABAP was conducted on three organizational levels: observers, Regional Atlas Committees (RACs) and the Project Coordinator's office. Overall management was by a Steering Committee, which was not involved in the day-to-day running of the project.

Observers

The observer workforce consisted of anyone who volunteered to assist in collecting data. Volunteers were recruited by means of extensive publicity in the media, including the printed media,

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800     SOCIABLE WEAVER.. BREEDING STATUS : 1

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    ////../////1//222//R/////.//////////
     //////////R1222/11R////////////////
     ////////R11/55611R//1//.//////..///
      //////////9//1////////////////////
       /////////3/51///////RR/////./////
       ///////////242/////21/1///.//.///
        ////////////1////1//2//////9.///
        /////1R/1/////11RR12/////2//////
         ////////////2R1121/////////////
         /////////1//3/123222/2/////////
          /////////2221213/52///3///////
          ////////11/5228558////32/1////
           ///////////32425865832///////
           ////////1R111/1V439//3///////
            //////R1/1RR1/2///3//3//
             ////4//1/11R/21////1///
             //1/111//RRR/81/5//////
             ///R121/116R///////73//
             /1//24111322925/35/734/
             /1/11R151563986537/9755
              //VR/265795596/735323/
             ///5462241/963689995583
             //..54476////6543958979
              /..52586/1333388959959
              ///1132//31/1179559788
               /./.154/44//298579999
               /.//445/194///3569999
               ///1656/159/R/5599788
               ////3573195///5/99787
               /./.3//447556//7799/4
               /././336929//23279/89
               /////111./7/4455/559/
                ////22252/1/132/2299
                /////2/5/21///259552
                ///////5../1.3599585
                 /////3////2946959/5
                 /////1/4/3454828959
                  ///.1//12426643995
                  ///.//2//.3/553335
                    //// 1/22938535.
                     //  //2.7.955/
                           ///95.7/     .
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FIGURE 4. A sample of Phase 3 output for Namibia. Each grid cell is represented by a symbol: a dot for no data; a slash where checklists obtained but the relevant species not recorded; and numbers and letters representing different levels of reporting rate. These maps could be produced easily in bulk and were an essential aid in the data-vetting process.

radio and television. The various national ornithological associations played an important role in promoting SABAP to their respective memberships.

New volunteers were sent introductory materials, including an instruction booklet and printed checklists. The instruction booklet contained simple grid maps of the atlas regions and lists of the names and codes of the grid cells, but observers needed to acquire their own detailed maps of the areas they intended to visit. Inexpensive, high-quality 1:50 000 and 1:250 000 maps, with minutes of latitude and longitude indicated, were available from state and retail outlets.

There was tremendous interest in SABAP and *c.* 7000 people volunteered. There was a high attrition rate; 5000 people submitted at least one checklist but only about 2000 of these were regular contributors. A rough estimate is that 80% of the data was collected by 15% (750) of the observers. Most, but by no means all, active observers were also members of bird clubs.

Despite the simple protocols of SABAP, many volunteers appeared to find the impression of technical complexity off-putting. Apart from the information provided in regular newsletters and occasional atlas outings organized by some bird clubs, there were few attempts to train volunteers. A greater degree of personal contact with volunteers, and more training, could contribute to higher levels of participation in future projects. On the other hand, the project demonstrated that success can be achieved with a relatively small number of enthusiastic participants.

Regional committees

Regional Atlas Committees (RACs) were based mainly at various bird clubs situated within the administrative regions (Figure 1; see the **Acknowledgments** and the section **History of the project** below). Indeed, it was the availability of these organizations which determined the demarcation of atlas regions in the first place. SABAP could not have succeeded without the infrastructure which these clubs provided.

RACs were responsible for receiving all checklists for their respective regions, providing replacement blank checklists to observers, checking the information on checklists, doing the necessary coding on each checklist, numbering, batching and posting checklists to the Coordinator's office, verifying data-capture by comparing checklists against printouts and generally liaising with observers.

In addition to these clerical and administrative jobs, the RACs had the essential task of vetting the records on every checklist, and querying unusual records which were insufficiently substantiated. In so doing the RACs made an invaluable contribution of local expertise (see **Vetting** below), and also helped to elevate the levels of expertise amongst observers.

Central coordination

The Project Coordinator, with the assistance of the RACs, was responsible for managing the atlas effort in all six participating countries, with Zimbabwe operating largely independently. In Zimbabwe, fieldwork and data capture were carried out according to different protocols and priorities and the data were transferred to SABAP only in the final stages of the project. In Botswana, Lesotho, Namibia and Swaziland, work was coordinated by local committees which liaised directly with the Project Coordinator, as did the nine RACs within South Africa.

Central coordination was an important feature of SABAP which helped to maintain standards and protocols with respect to data collection, coverage, vetting of data, computerization, access to data, etc., and also had advantages for communication and feedback. The Coordinator was assisted by computer programmers, statisticians, administrative assistants, and a full-time fieldworker.

Steering and Publication committees

The Steering Committee represented the interests of the sponsors and other interested parties, and scrutinized annual reports, budgets and statements of expenditure. The annual meetings provided a forum at which the institutions supporting the project could be informed of progress and difficulties.

The Publication Committee was appointed by BirdLife South Africa to oversee the publication phase of the project and was concerned with practical issues surrounding the design of this book, its publication and marketing.

Feedback

Feedback to participants was provided by means of a six-monthly newsletter which reported coverage statistics from the atlas regions and highlighted priority grid cells. Guides to the identification of species groups were featured. RACs also promoted the project and provided feedback in the newsletters of their respective bird clubs. The amount of personal contact with observers varied from RAC to RAC but was generally limited because of the large numbers of observers involved.

Fieldwork

Initially, fieldwork was deliberately conducted on a *laissez faire* basis with geographical coverage being dictated by the distribution and inclinations of the observers. Large areas were neglected owing to their remoteness from major population centres and, in some cases, the perception that they were unsafe to visit. Various strategies were used later to improve coverage in those areas: an emphasis on priority grid cells in feedback; sponsorship of the petrol expenses of selected volunteers who were prepared to target particular grid cells; special expeditions of volunteers were organized; a fieldworker was employed. All of these were successful to some degree; employment of the fieldworker was indispensable and had the most important effect on coverage. His time was allocated primarily to the most poorly covered regions of South Africa, but he also visited Lesotho and southern Namibia.

Grid cells incorporating metropolitan areas, or adjacent to them, received a disproportionate amount of attention. Such grid cells were 'closed' to further casual effort once thorough coverage had been achieved. This was in order to reduce the amount of administration associated with processing new checklists and to help redirect effort to priority grid cells; selected observers were invited to continue submitting checklists, however.

Vetting

Quality control of the data was one of the greatest challenges of the project. Basically, three measures were taken to eliminate inaccurate records:

(1) Observers were given the instruction: 'If in doubt, leave it out!'. In other words, speculative records were discouraged. Observers were also strongly advised to provide additional information for all unusual records, including records of common species seen outside their normal range.
(2) RACs screened all incoming checklists for unusual and out-of-range records. Such records were evaluated in the light of additional information provided or, if necessary, an Unusual Record Query form was sent to the observer. In this manner, local expertise was brought to bear and many errors were eliminated. Records of rare species on 'national rarities' lists were accepted only after the appropriate forms had been submitted to the relevant national rarities committees and the records accepted according to the criteria of those committees.
(3) Interim data summaries and distribution maps were used to detect records falling outside of the known ranges of species. This was done both by the RACs and the central coordinating office with liaison between them. Several iterations of vetting were undertaken, necessitated both by the developing patterns in the data, and the improving knowledge and insight of the people involved.

The end result of the effort put into data vetting is, we believe, a dataset which is largely free of gross errors or distortions. Vetting may have erred on the side of conservatism because the 'If in doubt, leave it out' principle was also applied during *post hoc* vetting. Particular difficulties are discussed below under **Problem species**.

A HISTORY OF SABAP

The need for an atlas project for southern Africa was recognized at a *Workshop Towards a Bird Populations Data Bank* held in Johannesburg in 1983, led by Dr R.J. O'Connor, then Director of the British Trust for Ornithology (Prŷs-Jones 1984). The matter was taken further at a *Workshop on Bird Atlasing*, held in Cape Town in August 1984 (Hockey & Ferrar 1985).

Following the workshop, an Interim Committee consisting of Dr P.A.R. Hockey, Dr D.P. Cyrus, Mr N.F. Robson and Prof. L.G. Underhill was appointed. This committee designed a checklist and helped to initiate a regional atlas project in the eastern Cape Province. (During the decade between the initiation of SABAP and publication of this atlas, many organizations changed their names; as far as possible, we are using the names applicable at the time of going to press.)

First year: April 1986–March 1987

In April 1986, the Atlas Steering Committee met for the first time and was formally constituted. At this meeting, finance for three years from WWF-SA and Distillers Corporation was confirmed. The post of Atlas Coordinator was advertised; Mr James A. Harrison was appointed and began service on 1 July 1986.

Nine Regional Atlas Committees (RACs) were established in South Africa and Lesotho and existing RACs in the eastern Cape Province, Namibia and Swaziland were integrated into SABAP. All South African RACs were based at branches of BirdLife South Africa (BLSA) (at that stage still the Southern African Ornithological Society), except the northern Cape Province where it was based at the local branch of the Wildlife and Environment Society of South Africa. The Botswana Bird Club (BBC) and the Ornithological Association of Zimbabwe (OAZ) gave positive commitments to participate in SABAP.

SABAP was extensively publicized in the media, including TV, leading to the registration of *c.* 4000 volunteers. SABAP was publicly launched in Johannesburg, Durban and Cape Town in January 1987. The RACs were instructed in their functions and began to handle incoming checklists.

Second year: April 1987–March 1988

The Coordinator initiated fund-raising efforts which led to commitments from Gold Fields Foundation, Wildlife Society of South Africa, BLSA, Distillers Corporation and De Beers Chairman's Fund.

The first issue of the project newsletter, *SABAP News*, was produced and distributed. The mailing list swelled to over 5700. A special edition of the introductory package for Zimbabwe was designed and 1000 copies printed.

2600 checklists collected for the Orange Free State Bird Atlas Project 1983–86 were computerized.

Dr John Ledger stood down as chairman of the Steering Committee and was replaced by Mr Hardy E. Wilson, chairman of the BLSA Council.

Third year: April 1988–March 1989

21 000 post-1986 checklists were incorporated into the SABAP databank, bringing the grand total to almost 45 000. The number of volunteer observers increased to 6600. The value of the SABAP databank was reflected in 14 requests from researchers for data.

The need for further development of computer software led to the appointment of a part-time programming assistant, Dr Peter Martinez.

Coverage of Lesotho was boosted by Dr Patrick Osborne of the Royal Society for the Protection of Birds (RSPB) and Ms Barbara Tigar who spent six weeks systematically sampling most grid cells in Lesotho with a view to publishing a baseline atlas for Lesotho (Osborne & Tigar 1990) and made their data available to SABAP.

Atlasing in Zimbabwe made good progress. The OAZ divided the country into nine regions; 2200 checklists were submitted and a start was made with the computerization of 13 000 pre-SABAP checklists.

The main topics at an Atlas Workshop for RACs, held in September 1988, were vetting and goals. Agreement on a defined set of operational targets represented a major development in policy which would guide the data-gathering effort for the remaining years.

In July 1988, SABAP found itself in a precarious financial position. As an interim measure, BLSA made a donation. Mr Rob Soutter of WWF-SA, Mr Hardy Wilson of BLSA and the Project Coordinator prepared an appeal and motivation for financial support to send to the Department of Environment Affairs and Tourism (DEA&T). With the late Mr P. le Roux of DEA&T acting as an invaluable ally, this met with success. At the Steering Committee meeting held in October 1988, the DEA&T representative announced that funding for three years would be provided for SABAP.

From 1989, administration of the project was transferred within the University of Cape Town from the Percy FitzPatrick Institute of African Ornithology to the Department of Statistical Sciences. A newly constituted Steering Committee was recognized as the policy-making and executive leadership of SABAP. Hardy Wilson was elected Chairman at the Committee's meeting in January 1989.

Fourth year: April 1989–March 1990

The Atlas Workshop in September 1989 was attended by delegates from 12 RACs. Tactics for the achievement of goals were discussed and agreed upon: encouragement and education of observers to improve the quality of their checklists; comprehensive report-back on coverage for all atlas regions in each issue of *SABAP News*; greater emphasis on subsidized fieldtrips to high-priority grid cells; appropriate deployment of a professional fieldworker in areas unlikely to be covered by volunteers. These guidelines gave SABAP renewed purpose and direction.

Gold Fields provided a major funding boost for SABAP. An Atlas Art Competition culminated in an exhibition at the Gold Fields Conservation Centre at Delta Park, Johannesburg. The competition, sponsored by Drizit South Africa, produced original illustrations of 56 species for use in the atlas.

Mr René Navarro was employed as SABAP's computer programmer.

Fifth year: April 1990–March 1991

Mr David Allan was employed as full-time professional fieldworker from April 1990. This was made possible with funds from BLSA, raised on Birding Big Day, and a donation from the Natal Bird Club. The Endangered Wildlife Trust (EWT) made a vehicle available. This development lead to a vast improvement in coverage. His goal was to achieve basic summer and winter coverage for all unvisited grid cells in the country. His efforts were centred on the Limpopo Valley, the northern Cape Province, Transkei, and Lesotho. David Allan's services were extended owing to further donations from BLSA and EWT. The Mazda Wildlife Fund made a new vehicle available and fieldwork was assisted by the donation of a pair of binoculars from Zeiss.

Significant progress was made with the computerization of pre-SABAP data. Pre-1987 data were received from Zimbabwe and KwaZulu-Natal. Mrs Meg Kemp of the Transvaal Museum began transcribing the checklists used for Tarboton *et al.* (1987b).

James Harrison visited Gaborone; the Botswana Bird Club (BBC) agreed to participate in SABAP. In October 1990 James Harrison and David Allan visited Gaborone again and participated in a meeting on bird identification for BBC members. Arrangements for the processing of data in Gaborone and their transfer to Cape Town were made.

At the 1989 Steering Committee meeting it had been agreed that the project management, together with BLSA nominees, should take the initiative in forming a committee to handle the publication of the atlas. BLSA set up a Publication Committee to guide the project through the publication phase. This committee had its first business meetings and developed a framework within which the atlas would be produced.

Sixth year: April 1991–March 1992

At the end of 1991, five years of large-scale data collection were completed and general collection of data ceased in South Africa, Swaziland and Lesotho. 393 grid cells remained open for further atlasing till July 1992. David Allan's fieldwork ensured that minimum summer and winter coverage for nearly all grid cells in South Africa was achieved. The Mazda Wildlife Fund made their vehicle available for a further period. Namibia, Botswana and Zimbabwe continued to collect data. The Zimbabwe Atlas Committee stopped submitting data to Cape Town because they had elected to undertake their own computerization effort.

Demand for SABAP data continued with a marked increase in the number of requests connected with environmental impact assessments.

Peter Martinez and René Navarro made further contributions to the suite of computer programs used to process, analyse and present atlas data. A major technological advance in the production of high-quality distribution maps was achieved, enabling publication-quality maps to be produced on an office laser printer. This put SABAP in a position to supply maps to authors and print-files to the publishers. This was a crucial advance in the progress towards production of a manuscript.

Great strides were made with the computerization of pre-1987 data from the southwestern Cape Province, KwaZulu-Natal and Transvaal. Pre-1990 Botswanan atlas cards were transcribed and computerized.

The SABAP Publication Committee made substantive progress: editors were appointed by BLSA; 60 authors for species texts were identified; the committee was expanded to include representatives from Botswana, Namibia, Swaziland and Zimbabwe; proposals for the atlas were distributed to an advisory panel and their responses were collated.

A research unit within the Department of Statistical Sciences was formally recognized by UCT and became the home of both SABAP and SAFRING. It was named the Avian Demography Unit (ADU). The ADU provides a structure within which similar projects can be coordinated.

DEA&T committed funding for a further three-year period. Dr Mike Cohen of DEA&T did much to advance the cause of SABAP.

Seventh year: April 1992–March 1993

Data collection ended in South Africa and in Swaziland in July 1992 but continued in other states until the end of December 1992. Significant fieldwork was done in the northern Cape Province and southern Namibia by David Allan, Richard Brooke and others. Fieldwork was done during specially organized expeditions to the Upington area, Kalahari Gemsbok Park, the Aroab area and the Transkei. Data collection in Namibia continued till the end of the summer season in 1993 in order to improve the coverage in certain critical areas. Vetting of data was tackled on a regional basis by the RACs.

David Allan produced a vegetation map of southern Africa. This was a vital step towards the analysis of the distribution patterns for each species. René Navarro manipulated the vegetation map to calculate the vegetation types in each grid cell. Statistical modelling techniques to describe the seasonality of occurrence and breeding were developed.

BLSA continued to give the project financial support. Gold Fields made a generous pledge of funds to SABAP over three years through WWF-SA.

The SABAP Publication Committee made progress in finalizing the planning for the atlas publication. In addition to James Harrison, David Allan and Prof. Les Underhill, Tony Tree of Zimbabwe, Dr Chris Brown of Namibia, Dr Marc Herremans of Botswana and Vincent Parker of Swaziland were appointed as editors.

Eighth year: April 1993–March 1994

Ms Felicia Stoch was appointed as typesetter and technical editor responsible for page origination for the atlas.

In February 1994, Mr John Austin, chairman of the SABAP Publication Committee visited Zimbabwe and was successful in getting the majority of the OAZ management committee to support the participation of the OAZ in the project.

The species-text authors received their instructions and data packages for their delegated species. By March 1994, 240 texts had been received from authors and forwarded to referees. David Allan completed the vetting of data from the Northern Cape atlas region. He assisted the relevant people with vetting in the Southern Transvaal, Northern Transvaal and Lowveld atlas regions and in Namibia and Botswana.

Requests for atlas data continued to flow in. SABAP was, for example, able to make a contribution to the planning of conservation priorities in the Karoo for WWF-SA and to the planning of powerline routes for ESKOM.

Ninth year: April 1994–March 1995

The final dataset for Zimbabwe was delivered to the ADU in April 1994. Its late arrival caused delays with data analysis. David Allan, with the assistance of Vincent Parker and Andrew Jenkins, made significant progress towards achieving a final 'clean up' of the atlas data. This effort included visits to some of the regions to allow for close liaison with local expertise.

Species texts from outside authors accumulated at a slow rate. 200 texts were still outstanding early in May 1995. Editing of species texts by the three Cape Town-based editors started; they found that the amount of time required for the editing of each text was more than anticipated.

After five years of the Atlas Art Competition, sponsored by Drizit South Africa, the accumulation of *c.* 600 species illustrations was almost completed.

The design of the graphics and page layout for the species accounts were finalized by the Publication Committee at a meeting in December 1994.

DEA&T and Mazda Wildlife Fund made generous donations towards the 95/96 budget.

Tenth and eleventh years: April 1995–June 1997

This was a period of intensive activity in preparing the atlas manuscript. There were two main causes of delay: it was not anticipated that so much additional vetting would need to be done after final vetting by RACs and, in order to set a high standard for the species texts, a great deal of deleting, correcting, adding, reinterpreting and rewriting of text was needed in addition to normal reorganization and stylistic editing. Editing became an unavoidable bottleneck in progress towards a manuscript of high quality.

Contingency plans were made. Additional *ad hoc* assistants were hired to help with the clerical work associated with vetting, Ms Claire Spottiswoode being the principal amongst these. Marc Herremans became an additional Cape Town-based editor from January 1996. An adverse development was the departure of David Allan in May 1996 to take up a position at the Durban Natural Science Museum. Mr James McFarlane was appointed as proof-reader. UCT Information Technology Services lent the necessary equipment to enable the 600 illustrations to be scanned.

National editing by the relevant editors, proof-reading, approval of revised texts by authors, and typesetting all proceeded in parallel with initial editing.

A commitment of financial assistance with printing costs was made by the John Voelcker Bird Book Fund. The typeset manuscript went to CMYK Pre-press on magnetic disks for image-setting in April and May 1997. The last litho-positives were delivered to the printers, CTP Book Printers, in June.

RESULTS AND ANALYSES

Although the manner in which the data are presented in this book is designed to make much of the information self-explanatory, the details of the analyses are important, as are the limitations of the data themselves. This section is especially relevant to anyone wishing to use the atlas data in research or any interpretive analysis.

Dataset

The SABAP dataset comprises 147 605 checklists and 7 332 504 individual records; 88 grid cells (2.2%) have no data at all. The data are not evenly spread over geographical areas, species or months of the year. For any given combination of grid cell, species and month, the data quality varies from 'excellent' to 'inadequate'. The results must therefore be interpreted in the light of the coverage statistics and in terms of the relevant characteristics of species, especially with regard to their conspicuousness and ease of identification.

Sources of error

There were three significant sources of error in the database: (1) inadequate coverage in some grid cells and in some months, (2) errors in species identification, and (3) biases in the reporting process. These topics are discussed under the headings **Vetting** (above), **Coverage** and **Problem species** (directly below), and **Analyses, Reporting rate** (below).

Coverage

The maps showing the extent of coverage provide keys to the interpretation of results: Figure 5 is relevant to the distribution maps, and Figure 6 to the seasonal distribution maps used to describe local movements in some species. Figures 5 and 6 also have relevance to the interpretation of the results of the vegetation analysis and the models of seasonality, respectively.

In and around major population centres and popular tourist destinations, coverage was generally excellent. Remote areas, especially mountain tops and deserts, were on the whole poorly covered. Areas considered to be unsafe were also visited less. These included the former 'homelands' of South Africa and Namibia, e.g. KwaZulu, Transkei, Ciskei, Venda, Bophuthatswana and Lebowa in South Africa, and Owambo in Namibia, as well as tribal trust lands in Zimbabwe. In all countries attempts were made to counteract these biases in coverage by means of special expeditions by skilled observers to poorly covered areas. The effects of different levels of coverage are discussed under the various analyses below.

Problem species

A problem species is one which presented difficulties for one or more of the following reasons: (a) it is inherently difficult to identify, (b) it is difficult to find and observe, and (c) its taxonomy was/is unresolved. It cannot be claimed that any species is totally problem-free, but most uncertainties were satisfactorily dealt with in the vetting process. Below are listed the most problematic species, some of which were particularly intractable cases which could not be completely resolved by vetting. In those cases special caution should be exercised in interpreting atlas data and analyses, and the relevant species' texts should be consulted for expert opinion.

It should be borne in mind that atlas records came from birds both seen and heard calling; therefore misidentifications could have been based on similarities either in plumage or vocalizations. For many cryptic species (e.g. owls, nightjars, tinker barbets, robins, thrushes, warblers, bush shrikes, etc.) the bulk, or at least a large proportion, of the atlas records are likely to have been based on vocalizations, and possible confusion between species in this regard is more relevant than confusion based on plumage features. Also, for many species typically located/identified by call, seasonal changes in singing frequency had an important effect on seasonal reporting rates.

Pelicans: The White *Pelecanus onocrotalus* and Pinkbacked *P. rufescens* Pelicans are occasionally confused.

Cormorants: The cormorants are problematic for the uninitiated, particularly the Crowned *Phalacrocorax coronatus* and Reed *P. africanus* Cormorants which, in practice, are usually distinguished on the basis of habitat. Also, immature Reed and Cape *P. capensis* Cormorants have pale underparts which can cause them to be confused with the Whitebreasted Cormorant *P. carbo.*

Herons and egrets: The white egrets can be confusing. The biggest problem is presented by the Great White Heron *Casmerodius albus* and the Yellowbilled Egret *Egretta intermedia.* Inexperienced observers can also confuse the Goliath *Ardea goliath* and Purple *A. purpurea* Herons. The Black *E. ardesiaca* and Slaty *E. vinaceigula* Egrets present similar appearances, causing the uncommon latter species to be misidentified for the common former species. Several Bittern *Botaurus stellaris* records could not be accepted owing to the possibility of confusion with the juvenile Blackcrowned Night Heron *Nycticorax nycticorax* not being ruled out.

Storks: There can be confusion between Black *Ciconia nigra* and Abdim's *C. abdimii* Storks.

Vultures: The Whitebacked *Gyps africanus* and Cape *G. coprotheres* Vultures, particularly juveniles, are not easy to distinguish in the field and the two are probably regularly confused in the areas where they occur together. In areas of overlap, the Whitebacked is usually the more common of the two.

Kites: Although the Black Kite *Milvus migrans migrans* and *M. m. lineatus* and Yellowbilled Kite *M. m. parasitus* are classified as one species, they were surveyed independently for the atlas. Discrimination of these two forms is difficult, however, and observers are insufficiently aware of the difficulties. It appears likely that immature Yellowbilled Kites are frequently misidentified as Black Kites.

Eagles: The brown eagles, especially the Tawny *Aquila rapax,* Steppe *A. nipalensis,* Lesser Spotted *A. pomarina,* and Wahlberg's *A. wahlbergi* Eagles, are difficult to distinguish. It is probable that an unknown proportion of the records for each of these is for other species.

Buzzards: The Steppe *Buteo buteo vulpinus* and Forest *B. trizonatus* Buzzards are particularly difficult to distinguish. This problem is compounded by the fact that Steppe Buzzards also frequent the fringes of forested habitats favoured by Forest Buzzards and the former species also occasionally overwinters in southern Africa. Under field conditions, the juveniles of the two species are, in practice, indistinguishable. Juvenile Jackal Buzzards *B. rufofuscus* are also frequently confused with Steppe Buzzards.

Accipiters: Most members of the genus *Accipiter* are inconspicuous and have subtle distinguishing features not easily seen in a rapidly moving bird. These species are probably under-reported in many parts of their ranges.

Harriers: Female and juvenile Pallid *Circus macrourus* and Montagu's *C. pygargus* Harriers are particularly tricky to distinguish, as well as being unfamiliar to many observers because of their rarity. It is probable that each is occasionally misidentified for the other.

Falcons: The Peregrine *Falco peregrinus,* Lanner *F. biarmicus* and Hobby *F. subbuteo* Falcons are regularly confused, especially juveniles.

Francolins: The 'partridge-like' francolins (Greywing *Francolinus africanus,* Shelley's *F. shelleyi,* Redwing *F. levaillantii* and Orange River *F. levaillantoides* Francolins) caused confusion, although careful vetting largely corrected this problem. There is also confusion between the Redbilled *F. adspersus,* Cape *F. capensis* and Natal *F. natalensis* Francolins, and between the Rednecked *F. afer* and Swainson's *F. swainsonii* Francolins, in the areas where these species either overlap or come into close proximity. Similarity in vocalizations in these last five rather skulking species are a particular problem.

Quails: The Common *Coturnix coturnix* and Harlequin *C. delegorguei* Quails, especially females, are difficult to distinguish (also on call), particularly as both species are usually seen in flight.

Guineafowl: Helmeted Guineafowl *Numida meleagris* are occasionally recorded as Crested Guineafowl *Guttera pucherani* owing to confusion between the common names of these two species (the former is also still widely known by its former name, the 'Crowned Guineafowl'). This happened especially in KwaZulu-Natal but was corrected by careful vetting.

Buttonquails: All records of Blackrumped Buttonquails *Turnix hottentotta* had to be carefully vetted to rule out possible confusion with the very similar Kurrichane Buttonquail *T. sylvatica.*

Rallids: Species in the family Rallidae are mostly secretive birds in dense wetland or grassland vegetation. This is particularly true of the African Rail *Rallus caerulescens,* crakes, rails and flufftails. As a result, these species were under-reported in most parts of their ranges.

Bustards: Some inexperienced observers confused the Kori

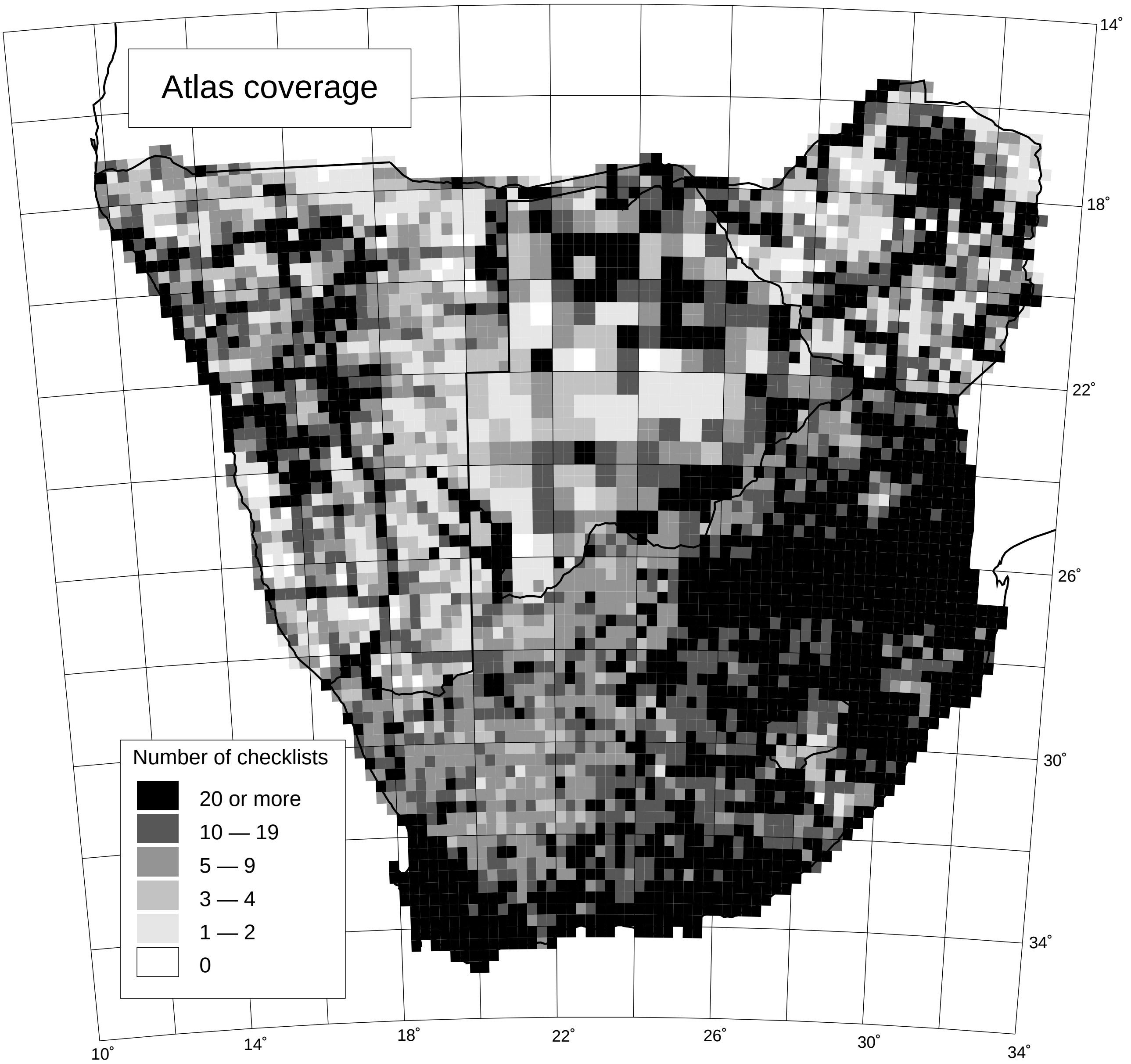


FIGURE 5. Coverage per grid cell – all months. The influence of the principal road routes on coverage is obvious in places.

Bustard *Ardeotis kori* with the two *Neotis* bustards (Stanley's *N. denhami* and Ludwig's *N. ludwigii)*, i.e. they recorded all large bustards as Kori Bustards. In addition, Stanley's and Ludwig's Bustards are only subtly different in the field; but most of these problems were solved during vetting. The Black Korhaan *Eupodotis afra* was treated as one species during data collection, but has subsequently been split into the Black Korhaan *E. afra* and Whitewinged Black Korhaan *E. afraoides*. There is some confusion between the Redcrested *E. ruficrista*, Whitewinged Black and Blackbellied *E. melanogaster* Korhaans, also largely resolved by vetting.

Pratincoles: The Redwinged *Glareola pratincola* and Blackwinged *G. nordmanni* Pratincoles are difficult to distinguish in the field. They prefer different habitats, but it is possible that their respective limits have been distorted to some degree by misidentifications.

Waders: This group presents a number of challenges to the inexperienced observer, particularly as the large number of Palearctic migrants all occur in the region in their drab nonbreeding plumage. Some observers did not have sufficient confidence in their identifications to record these species.

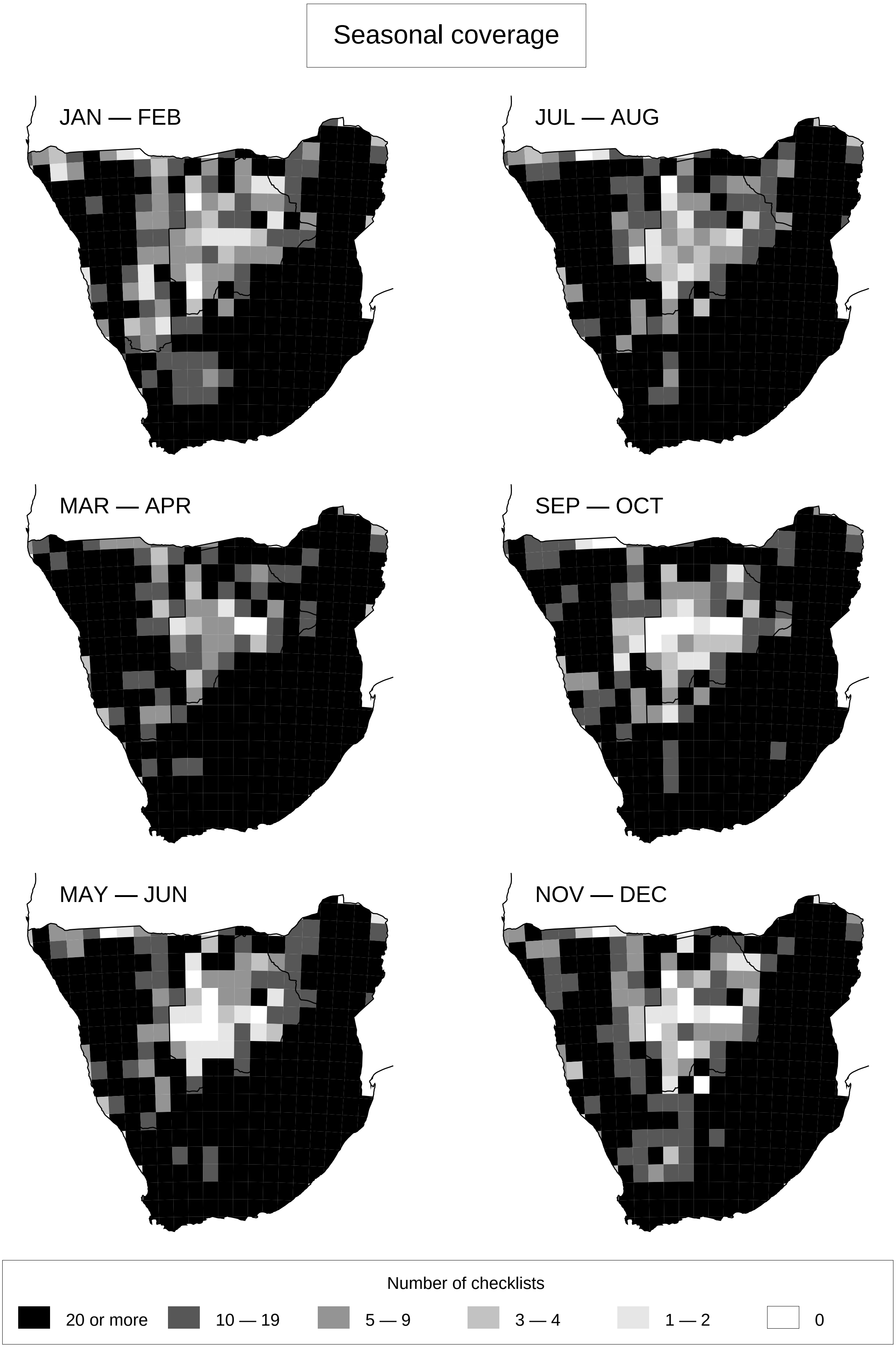
Terns: Common *Sterna hirundo* and Arctic *S. paradisaea* Terns are notoriously difficult to distinguish in the field, to the extent that observers tend to give up and label them 'Commic' terns. Because the Common Tern is known to be more abundant, it is possible that the Arctic Tern is under-reported owing to misidentifications. Whiskered Terns *Chlidonias hybridus* in nonbreeding plumage may have been misidentified as Whitewinged Terns *C. leucopterus* on occasion.

Doves: The Greenspotted *Turtur chalcospilos* and Bluespotted *T. afer* Doves can be difficult to distinguish, especially on call. In addition, the calls of the Greenspotted and Tambourine *T. tympanistria* Doves are easily confused.

Louries: The calls of the Knysna *Tauraco corythaix* and Purplecrested *T. porphyreolophus* Louries are easily confused. The Knysna Lourie was treated as one species during data collection, but has subsequently been split into the Knysna and Livingstone's *T. livingstonii* Louries.

Cuckoos: Many of the cuckoos are very inconspicuous and therefore under-reported when not calling. The European *Cuculus canorus* and African *C. gularis* Cuckoos are extremely difficult to distinguish and some erroneous records are likely to have been missed during vetting.

Coucals: Burchell's Coucal *Centropus burchellii* was treated



Seasonal coverage maps; one-degree grid.

FIGURE 6. Coverage per degree grid cell, per two-month period. These coverage statistics are relevant to the interpretation of the seasonal distribution maps.

as one species during data collection, but has subsequently been split into Burchell's and Whitebrowed *C. superciliosus* Coucals.

Owls: The Cape *Bubo capensis* and Spotted *B. africanus* Eagle Owls can be difficult to distinguish (especially the rufous form of the latter), and many observers are insufficiently familiar with the Cape Eagle Owl and its distinguishing features (including its vocalizations). As the ranges of the two species overlap completely, the problem of misidentifications could not be entirely resolved, although most records of Cape Eagle Owl were confirmed.

Nightjars: Being nocturnal and having similar plumages, all nightjars were probably quite severely under-reported (except the Fierynecked Nightjar *Caprimulgus pectoralis* whose distinctive call is well known), and occasionally misidentified in the case of sight records. Most atlas records probably comprise birds heard calling, and road casualties.

Swifts: The group of uniformly dark swifts, the European *Apus apus,* Black *A. barbatus,* Bradfield's *A. bradfieldi,* Pallid *A. pallidus* and Mottled *A. aequatorialis* Swifts, are very difficult to distinguish while flying high overhead. The problem is particularly severe in the case of European and Black Swifts, both being relatively common and with widely overlapping ranges. Regional biases in observer expectations exacerbated the issue (see **Reporting rates**, **Observer effects**, below, and the text for the European Swift, for further details). Some observers also have difficulties in distinguishing Little *A. affinis* and Horus *A. horus* Swifts.

Mousebirds: The Speckled *Colius striatus* and Whitebacked *C. colius* Mousebirds were regularly confused, with the latter typically misidentified for the former. This occurs especially when observers resident in mesic areas, where only the Speckled occurs, visit arid areas where only the Whitebacked is found. This problem was largely resolved by careful vetting.

Kingfishers: Halfcollared *Alcedo semitorquata* and juvenile (dark-billed) Malachite *A. cristata* Kingfishers were occasionally confused. Mangrove *Halcyon senegaloides* and Woodland *H. senegalensis* Kingfishers can also easily be confused and all records of the former were carefully vetted.

Bee-eaters: The European *Merops apiaster,* Bluecheeked *M. persicus* and Olive *M. superciliosus* Bee-eaters can be confused, especially in juvenile or abraded plumage, and especially the last two species. It is possible that the distribution of the relatively uncommon Olive Bee-eater is distorted by misidentifications of immature individuals of the more common Bluecheeked Bee-eater. Swallowtailed Bee-eaters *M. hirundineus* are also sometimes misidentified as the more familiar Little Bee-eater *M. pusillus.*

Hornbills: The Redbilled *Tockus erythrorhynchus* and Crowned *T. alboterminatus* Hornbills are occasionally confused, especially in KwaZulu-Natal (although mistakes in that region at least were corrected).

Barbets: The Redfronted *Pogoniulus pusillus* and Yellowfronted *P. chrysoconus* Tinker Barbets are not easily distinguished (the latter occasionally shows an orange forehead). In addition, their calls are similar, which necessitates great care in the small area of overlap.

Woodpeckers: Bennett's *Campethera bennettii* and Goldentailed *C. abingoni,* and Cardinal *Dendropicos fuscescens* and Knysna *C. notata* Woodpeckers, respectively, are easily misidentified for each other.

Larks: The larks in general are a problematic group for identification. Particular problems include misidentification of the 'streaked-backed' form of the Red Lark *Certhilauda burra* as Karoo Lark *C. albescens* and the misidentification of the 'thickbilled' form of the Sabota Lark *Mirafra sabota* as either Karoo or Thickbilled *Galerida magnirostris* Larks. The Karoo *C. albescens* and Dune *C. erythrochlamys* Larks have recently been reorganized into three species with the addition of Barlow's Lark *C. barlowi,* not recognized during the atlas period. In addition, the larks present several unresolved taxonomic problems. The Longbilled Lark *C. curvirostris* is considered to require splitting into two or more species; atlas data may be useful in defining the ranges of these putative species.

Swallows: The range limits of the Greater *Hirundo cucullata* and Lesser *H. abyssinica* Striped Swallows are difficult to assess owing to misidentifications and the fact that they are both migrants and therefore may be seen outside of their normal ranges while on passage. Two other particular identification problems are confusion between the Greyrumped Swallow *Pseudhirundo griseopyga* and House Martin *Delichon urbica,* and between the Whitethroated *H. albigularis* and Wiretailed *H. smithii* Swallows.

Drongos: The Forktailed *Dicrurus adsimilis* and Squaretailed *D. ludwigii* Drongos are easily confused in the general area of their distributional overlap, and the latter is also occasionally mistaken for the Black Flycatcher *Melaenornis pammelaina.*

Orioles: Female and juvenile European *Oriolus oriolus* and African *O. auratus* Golden Orioles are also easily confused.

Tits: The Southern Grey *Parus afer,* Ashy *P. cinerascens* and Northern Grey *P. griseiventris* Tits can be difficult to distinguish and each overlaps at least partially with one of the others. In Namibia the Southern Black *P. niger* and Carp's Black *P. carpi* Tits overlap in places, making correct identifications particularly challenging.

Thrushes: The Kurrichane *Turdus libonyana* and Olive *T. olivaceus* Thrushes are occasionally confused in the areas where they overlap; a problem compounded by their similar vocalizations; this could not be entirely resolved by vetting. The Sentinel *Monticola explorator* and Shorttoed *M. brevipes* Rock Thrushes, although largely allopatric, are superficially similar and sometimes confused; a problem largely resolved by careful vetting.

Chats: Sicklewinged *Cercomela sinuata* and Tractrac *C. tractrac* Chats are subtly different and not well known to many observers. In Namibia a pale form of the Karoo Chat *C. schlegelii* further complicates the issue. A major adjustment to the Tractrac Chat data was made for the Free State because there was evidence that the Sicklewinged was frequently misidentified as the Tractrac Chat in that area. The 'grey' form of the Mountain Chat *Oenanthe monticola* can also be confused with the Karoo Chat.

Robins: The Chorister *Cossypha dichroa* and Natal *C. natalensis* Robins have similar and highly variable vocalizations which include large amounts of mimicry. The two can therefore easily be confused when singing. It can only be guessed to what extent their renowned abilities as mimics resulted in records of other species. An example is the penchant of the Chorister Robin to mimic the calls of the Starred Robin *Pogonocichla stellata* and Emerald Cuckoo *Chrysococcyx cupreus.*

Warblers: The warblers in general provide many identification challenges, particularly in wetland habitats (*Acrocephalus* warblers and the African Sedge Warbler *Bradypterus baboecala),* because there are several species which look and sound similar, share similar habitats and are difficult to observe in dense wetland vegetation. The greatest problem is presented by the very similar appearance and calls of the African Marsh *A. baeticatus* and European Reed *A. scirpaceus* Warblers (possibly conspecific), and the similar appearance of the African Marsh and European Marsh *A. palustris* Warblers.

Bleating Warbler: The Bleating Warbler *Camaroptera brachyura* was treated as one species during data collection. The respective ranges of the subsequently split Greybacked *C. brevicaudata* and Bleating *C. brachyura* Warblers cannot be accurately determined from atlas data.

Cisticolas: Cisticolas present many problems for observers not familiar with their calls. The dependence on calls strongly biased the seasonality of records for some species, particularly the 'short-tailed' group. In particular, Cloud *Cisticola textrix* and Ayres' *C. ayresii* Cisticolas are easily confused, a problem largely ignored during the vetting process owing to the overwhelming number of records of both species and their apparently extensive area of overlap. Another major difficulty was Wailing *C. lais* and Greybacked *C. subruficapilla* Cisticolas which are very similar both in plumage and call. Difficulty in distinguishing them has made their respective range limits uncertain in the areas where they meet or overlap.

Prinias: The Spotted Prinia *Prinia maculosa* was treated as one species during data collection. The respective ranges of the subsequently split Spotted *P. hypoxantha* and Karoo *P. maculosa*

Prinias cannot be accurately determined from atlas data. Blackchested *Prinia flavicans* and Spotted *P. hypoxantha* (*sensu lato*) Prinias are regularly confused in the general area where they overlap, partially because the nonbreeding plumage of the former results in an appearance somewhat similar to the latter, and partially because many identifications are likely to be on the basis of their similar vocalizations.

Flycatchers: The Spotted *Muscicapa striata* and Dusky *M. adusta* Flycatchers were frequently confused; partial evidence for this comes from the relatively large number of winter records received, and subsequently vetted out, for the former species.

Batises: The Chinspot *Batis molitor* and Pririt *B. pririt* Batises were occasionally confused in their area of overlap, owing to the similarity in appearance of the males and the similarity of their vocalizations.

Pipits: The pipits are a particularly problematic group for field identification. As a result, the atlas data for several of these species, particularly the Buffy *Anthus vaalensis,* Plainbacked *A. leucophrys,* Longbilled *A. similis,* Wood *A. nyassae* and Mountain *A. hoeschi* Pipits, although probably essentially correct in the overall range delineation for each species, are far from wholly reliable.

Shrikes: The Southern *Laniarius ferrugineus* and Tropical *L. aethiopicus* Boubous are only subtly different, especially on call, and their ranges abut, overlapping slightly in places. The data for these species suffered from regional biases, with South African observers expecting to see Southern Boubous and observers in Botswana and Zimbabwe expecting to see Tropical Boubous. The data required considerable adjustment, and further study may lead to greater insight into their respective limits. The Orangebreasted *Telophorus sulfureopectus* and Olive *T. olivaceus* Bush Shrikes are also a problem because, although distinctly different in plumage, their vocalizations are similar and a large proportion of atlas records were based on birds heard calling.

Starlings: The glossy starlings as a group present identification challenges, but the Lesser *Lamprotornis chloropterus* and Greater *L. chalybaeus* Blue-eared Starlings are particularly difficult to distinguish in the field; the atlas data for these species in Zimbabwe, where they both occur, are not reliable. Similar confusion exists between the Glossy Starling *L. nitens* and both these species, and between the Glossy and Blackbellied *L. corruscus* Starlings. Overall, inexperienced observers tended to misidentify these other starlings as Glossy Starlings. Burchell's *L. australis* and Longtailed *L. mevesii* Starlings, although not as difficult as the above, also lend themselves to confusion. Palewinged Starlings were sometimes misidentified as Redwinged Starlings, especially by observers familiar with the latter species when visiting arid areas.

Sunbirds: Adult male sunbirds in breeding plumage provide few identification problems, but females and juveniles are notoriously difficult to distinguish. The existence of a seasonal eclipse plumage in the males of several species (Malachite *Nectarinia famosa,* Coppery *N. cuprea,* Purplebanded *N. bifasciata* and Dusky *N. fusca* Sunbirds, and possibly in the Lesser Doublecollared Sunbird *N. chalybea* (Maclean 1993b), makes identification during the nonbreeding season, and the interpretation of the seasonality analyses, difficult. The species pairs where breeding males can be difficult to distinguish are: Marico *N. mariquensis* and Purplebanded Sunbirds, Greater *N. afra* and Lesser Doublecollared Sunbirds, and Yellowbellied *N. venusta* and Collared *Anthreptes collaris* Sunbirds. Male Whitebellied Sunbirds *N. talatala* can also be confused with the males of Yellowbellied and Bluethroated *Anthreptes reichenowi* Sunbirds at particular stages of their plumage development.

White-eyes: Cape *Zosterops pallidus* and Yellow *Z. senegalensis* White-eyes can be confused in the regions where their ranges abut.

Weaver and bishops: The widespread occurrence of drab nonbreeding plumages in the males of most of these species both presented identification problems in winter and greatly affected seasonal reporting rates. In some species, even breeding males can be confused by inexperienced observers, e.g. Masked *Ploceus velatus*, Lesser Masked *P. intermedius* and Spottedbacked *P. cucullatus* Weavers; Cape *P. capensis,* Golden *P. xanthops* and Yellow *P. subaureus* Weavers; Spectacled *P. ocularis* and Brownthroated *P. xanthopterus* Weavers; Red *Euplectes orix* and Firecrowned *E. hordeaceus* Bishops; and Golden Bishop *E. afer* and Yellowrumped Widow *E. capensis.*

Whydahs and widowfinches: The nonbreeding plumage in the males of these species also resulted in marked seasonal fluctuatiuons in reporting rates and identification problems. In addition, breeding Purple Widowfinch *Vidua purpurascens* males were often misidentified as Black Widowfinch *V. funerea* males, as they frequently have a pinkish tinge to their legs, similar to the red legs of the latter species; this problem appeared to be particularly severe in the atlas data from the Transvaal. Breeding males of the race of the Steelblue Widowfinch *V. chalybeata* found west of Victoria Falls have white bills and are therefore confused with Black Widowfinch males; although this was easily corrected during vetting, as the latter species is absent from this area.

Canaries: Yellow Canaries *Serinus flaviventris* were occasionally misidentified as Yelloweyed Canaries *S. mozambicus* at the eastern edge of the former's range by observers visiting from the east. Yellow Canaries were frequently misidentified as Bully Canaries *S. sulphuratus* for the same reason, especially along the west coast of the southwestern Cape Province and even elsewhere, e.g. in Lesotho. Whitethroated Canaries *S. albogularis* were often misidentified as Streakyheaded Canaries *S. gularis* in the southwestern Cape Province.

Analyses

This atlas goes beyond descriptions of distribution in terms of presence/absence. The following discussion of the quantitative analyses of atlas data is therefore necessary to an appreciation of the information presented in the maps and graphs. In particular, the description of the reporting rate statistic and its biases is vital to an informed interpretation of the results of the analyses, all of which use reporting rates in some way. Biases, sources of error, and any ameliorative actions taken to reduce the impact of these, are discussed with the relevant analyses.

Records

For the purposes of the discussion of analyses, a 'record' is taken to be an accepted report of a species, within a particular grid cell, during the atlas period. Any given grid cell may have none, one, or more records of a given species.

Reporting rates

Reporting rates are a way of extracting quantitative information from presence/absence data; observers did not count birds, they recorded the presence of identified species on checklists. The reporting rate is the proportion of checklists on which a species is recorded; a species which was recorded on 10% of checklists is said to have reporting rate equal to 10%. Subject to the caveats listed below, differences in reporting rate between different geographical areas and different times of year may be interpreted as pointing to changes in abundance (or density). However, reporting rates are not proportional to density (birds per hectare), but provide an index which fluctuates with changes in density.

In reality, however, the reporting rate measures conspicuousness, which may crudely be defined as the likelihood that the average observer, with an average amount of search effort, records a species. Many factors influence reporting rate, only one of which is relative abundance. Therefore its use as an index of relative abundance is subject to distortion. The sources of bias discussed below are frequently referred to in species' texts. They can be categorized into species, geographic, observer and arithmetic effects:

(1) **Species effects:** Given the same abundance, a relatively conspicuous species is recorded more frequently than an inconspicuous and secretive species. Generally speaking, reporting rates should only be used within species; comparisons based on reporting rate may be made between areas

and seasons for one species, but not between species. Only if it can be argued that two species are equally conspicuous and identifiable may their respective reporting rates be used to compare their relative abundance.

For some species, conspicuousness varies between seasons with no change in abundance, particularly if there are seasonal changes in plumage or behaviour. Bright breeding plumage makes birds conspicuous and easy to identify while drab nonbreeding plumages do the opposite. The bishops and whydahs are examples of this. Some species call more frequently during the breeding season; this increases their conspicuousness, particularly for skulking species which are more easily heard than seen. Burchell's Coucal is a good example. Many passerines undergo moult soon after breeding and then behave more quietly and secretively; this decreases their conspicuousness.

The way in which individuals are grouped has an effect on reporting rates. Many species tend to flock in the nonbreeding season and to disperse as pairs in the breeding season, e.g. the Blue Crane. Consider a species for which even single individuals are conspicuous. If the species forms nonbreeding flocks or breeding colonies, and the birds become clustered, the probability of the species being encountered is smaller while it is clustered, thus reducing reporting rates. On the other hand, if single birds are cryptic and clusters are more readily observed and identified, reporting rates will be greater during the period of clustering.

(2) **Geographic effects:** Geographic effects on reporting rates are caused by the way geographical features influence the access of observers to the places where species occur. For example, species which are restricted to patchily distributed habitats will be encountered only if the relevant habitat patches are specifically targeted by observers. Some grid cells have good networks of roads allowing access to all parts; others have few roads making access to some important habitats difficult. Mountain tops and isolated wetlands and forest patches were difficult to reach in many grid cells.

Seasonal changes in habitat structure, such as reduced foliage in woodland during winter, can affect the conspicuousness of birds, and hence reporting rate. It is possible that the conspicuousness of some species varies between habitats. The presence of utility poles, fences and wires affects the conspicuousness of perching birds.

(3) **Observer effects:** Species which observers find easy to identify are recorded more frequently than those which are more challenging to identify, and identifiability can vary seasonally with plumage and behaviour. The fact that identifiability affects reporting rate means that the level of observer skill and experience will also affect this statistic. The possibility that the average skill of atlas observers may have varied regionally, or have improved differentially during the project, cannot be discounted. This is especially likely to have been a factor in those areas where coverage was achieved primarily by the professional fieldworker.

Another observer effect relates to the effort expended in compiling a checklist. The longer the time period spent compiling a checklist, the greater the likelihood of rare and secretive species being recorded. Some grid cells were intensively sampled on a regular basis; others received only transitory attention. Any given checklist represented as little as a few minutes effort or as much as 31 days of intensive effort. A recommendation for future atlas projects is to standardize the amount of effort per checklist.

Observers were also subject to certain traditional ideas about the distribution of species and these ideas sometimes differed from country to country. The worst example is the European Swift which is believed to be common in Botswana, while the Black Swift is believed to be rare and localized. In South Africa, the Black Swift is regarded as common and the European Swift is widely believed to be an irregular visitor. The distribution maps for these two species show these contrasting perceptions along the border between the two countries. These problems were addressed in the vetting process, but could not always be satisfactorily counteracted.

(4) **Arithmetic effects:** These relate to the number of checklists available for a given grid cell, in other words, the denominator in the calculation of the reporting rate statistic. If there is one checklist, the only possible values for the reporting rate are 0% and 100%. If there are two checklists, values of 0%, 50% and 100% are possible. If there are 100 checklists, the reporting rate can have any integer value from 0% to 100%. The implication is that if a relatively rare species is recorded in a cell with few checklists, it will have a high reporting rate in that cell. This would be reflected in the distribution map, giving a misleading impression of relatively high abundance in that area. Ameliorative action was taken to reduce the impact of this bias for cells which had only one or two checklists. For mapping purposes, such cells with reporting rate values of 100% or 50% were allocated the intermediate shade (see section on **Distribution maps** below).

The list of biases above is probably not exhaustive (see also Underhill *et al.* 1992b). The reader may be asking whether the reporting rate statistic has any value at all. While its usefulness is certainly less for some species and sets of circumstances than others, it has demonstrated its value in several ways. Perhaps the most obvious example of its value is in describing the phenology of migratory species. The clear rise and fall in reporting rates with the arrival and departure of migrants is what one would expect to find and is indeed what can be seen clearly in the analyses of seasonality (described below). The way in which reporting rates vary over geographical space often conforms to prediction. For example, reporting rates are usually highest in the core of a species' distribution and fall off towards the periphery. This is consistent with studies on the structure of distributions (e.g. Brown 1984). Similarly, the fact that the reporting rates for different vegetation types usually conform to the known habitat preferences of species gives confidence in their being meaningful.

There have been studies which have used reporting rates from this atlas database and related them to independent quantitative measures of species' densities, and found there to be a consistent positive correlation; the fact that reporting rates increase in a monotonic manner with increasing density has been demonstrated convincingly (e.g. Du Plessis 1989; Bruderer & Bruderer 1993; Allan 1994b; Robertson *et al.* 1995). However, the relationship is not such that a doubling of reporting rate indicates a doubling of bird density. Further investigation of how reporting rate varies with density is needed, but preliminary results suggest that it is sensitive to small changes in density when density is low, and insensitive when density is high. In other words, the relationship between reporting rate and density may be a logarithmic one; analyses by Robertson *et al.* (1995) support this.

The correct approach to explaining seasonal differences in reporting rate is to consider first all factors that might influence it through the year. If the only factor that cannot be rejected is a change in relative abundance, then movement or migration can be inferred to be the likely explanation for seasonal variation in reporting rates.

Summary statistics

Summary statistics are provided for all species which have distribution maps. These statistics are designed to give a basic description of the dataset for each species as an aid to the interpretation of the data and analyses.

The size of the dataset for a species is reflected in the total number of atlas records collected in the atlas period. The geographical distribution of those records is indicated by the total number of grid cells in which the species was recorded, also expressed as a percentage (4537 grid cells = 100%). In the calculation of the number of grid cells in which the species was recorded, the half-degree grid cells in Botswana were counted as four quarter-degree grid cells (with adjustments for irregular cells along the border with South Africa, Zimbabwe and the Caprivi Strip). On the other hand, those grid cells for which data collection was amalgamated were only counted once, even though the data are duplicated into both coastal cells. Thus a count of shaded cells does not necessarily coincide with the count given in the summary statistics. The percentage of cells in which the species was recorded cannot easily be converted into a measure of area because the areas of grid cells decrease southwards.

A mean reporting rate for the species for the grid cells in which it was recorded is given. This is calculated as the ratio of the total number of records for the species and the total number of checklists for all the grid cells in which it was recorded. A comparison of reporting rates between species is not valid as an assessment of relative density (see discussion of biases in **Reporting rates** above) but does provide an indication of the relative likelihood of encountering different species within their respective ranges.

Distribution maps

The distribution maps summarize the geographical distribution of records of species, in grid format. All maps in this atlas were drawn according to Albers' Equal Area Projection (Snyder 1982); all maps are plotted to one of three scales, approximately 1:16 000 000, 1:27 000 000 and 1:34 000 000. Grid cells in which a species was recorded are shaded, those in which no records were obtained are left blank; no data are interpolated. There are many grid cells in which more fieldwork would have revealed further species; such 'false negatives' are shown as blanks. False positives (a species indicated present where it does not occur) have largely been eliminated by vetting procedures.

This approach to false negatives was adopted because (1) there is no universally accepted method for the interpolation of complex biological distributional information, and (2) those consulted felt strongly that interpolation should not be attempted, and that readers should draw their own conclusions. The likely 'real' distribution of a species should be assessed on the basis of: (a) the distribution of atlas records; (b) coverage statistics; (c) comments in the accompanying text; (d) the biology of the species, especially whether it is resident or migratory; and (e) other factors affecting the species' 'recordability', especially its conspicuousness and the ease with which it can be identified.

The blank cells produced by false negatives give distributions the appearance of being fragmented and 'thin' in areas where coverage was inadequate. An example of this is the map for the Spotted Eagle Owl in which the distribution appears to be more continuous in the east than the west. In South Africa coverage was generally more thorough in the east than in the west; however, the reporting rates shown in the models for eight geographic Zones (see **Modelling of seasonality** below) showed little difference between Zones (except Zone 5) and therefore densities are probably similar. In this way the models provide a useful balance to impressions created by the maps.

The distribution maps do not discriminate between breeding and nonbreeding ranges. In other words, all records, both breeding and nonbreeding records, were treated as equivalent for the mapping process. The reason for this is that the effort to obtain breeding records was secondary to the effort to obtain records of presence; atlas breeding records were too sparse to enable reliable maps of breeding distribution to be plotted. This remains a challenge for the future.

In addition to the presence/absence pattern provided in a map, indices of relative abundance, based on reporting rates, are presented as shades and symbols in the maps. The object is to provide an indication of where a species is most common, where it is least common, and where it is of intermediate abundance. This information is relevant to an appreciation of the ecology and conservation requirements of a species. It is also useful to birders wanting to see a particular species.

Species for which the distribution of values of reporting rate are likely to be indicative of patterns of relative abundance have distribution maps in which reporting rates are shown in four categories. (a) Grid cells with reporting rates less than 2% were mapped with the symbol X. (b) All remaining grid cells containing records were ranked according to their reporting rates and (c) divided into three equally sized classes. (d) Finally, the class with the highest values of reporting rates was mapped in the darkest shade, the class with the lowest values in the lightest shade, and the intermediate class in the intermediate shade. Where only one or two checklists were available, the cell was automatically put into the intermediate class (see **Arithmetic effects** above). The cut-off reporting rate values for each class are given in the key to the map.

The values of the reporting rate boundaries for the three classes vary greatly between species. The dark shades for species A and species B do not necessarily represent the same range of reporting rate values; the shades represent indices of relative abundance for the particular species being mapped and do not represent similar densities from species to species. Between-species comparisons of maps should be confined to comparisons of the spatial patterns described by the shades; such comparisons may throw light on the ecological similarities and differences between species.

The data for some species did not permit a meaningful mapping of relative abundance, usually because it was rare, inconspicuous or difficulty to identify; this led to a small number of records per grid cell and a weak basis for the calculation of reporting rates. In these cases a smaller map is presented in which relative abundance is not indicated, except that grid cells with reporting rates less than 2% are mapped with the symbol X. Such low values of reporting rate generally indicate marginal presence of the species, although this may not always be true of very inconspicuous, and therefore infrequently recorded, species. Because a reporting rate less than 2% is possible only when there are more than 50 checklists, Xs tend to be clustered in areas with intensive coverage, mainly urban areas and national parks.

Seasonal distribution maps are presented for 51 species. They are similar to the standard distribution maps, except that (1) the grid is a one-degree grid so that each grid cell is equivalent to 16 quarter-degree grid cells, and (2) each map presents the data for a two-month season. The six seasonal distribution maps give an impression of seasonal changes in distribution and provide insight into patterns of movement/migration. The amalgamation of data into larger grid cells ensures that there are sufficient data per unit to allow meaningful reporting rates to be calculated. The 51 species selected for this treatment are those that showed useful information beyond what was apparent in the models of seasonality (see below).

Modelling of seasonality

Seasonality modelling was undertaken for both occurrence and breeding records to throw light on the phenology of migrations and breeding activity, respectively.

Models of occurrence: These models show the seasonal variation in reporting rate through the year. They take two forms: those based on monthly data, and those based on five-day periods, known as 'pentades'; 73 pentades span the 365-day year – the calendar dates for each pentade were defined by Berthold (1973). Models of occurrence based on pentades are preferred, because they have greater precision, and were used whenever a species had adequate data for this approach. Because the decision to model seasonality using pentades was taken after data collection was complete, those checklists which spanned a whole month or which did not specify their exact dates had to be excluded from this analysis. We restricted the analysis to checklists which spanned a period of 10 days or less. These were allocated to the pentade containing the mid-date of the period covered by the checklist. We then calculated the reporting rate per species per pentade and used these data to model seasonal variation in reporting rates by fitting a generalized linear model using the statistical software GENSTAT (McCullagh & Nelder 1989; GENSTAT 5 Committee 1987). A Fourier model using transformations of trigonometric functions was fitted to the pentade reporting rates. These models are circular in the sense that the end of the year is joined continuously to the start, and the fitted models are independent of the choice of year end. Details of the statistical methods were described by Underhill *et al.* (1992b).

For many species the loss of data resulting from the use of a subset of checklists outweighed the additional precision gained from using pentades; for these species the generalized linear model was fitted to all the monthly data. (A small number of checklists, mainly from remote areas in Namibia, which did not specify month, were excluded.)

In order to detect geographical variations in patterns of seasonality, the model of occurrence was fitted for a set of geographical Zones, thus allowing a comparison of seasonality in different parts of the atlas region. For most species, eight terrestrial Zones were used (Figure 7): western and eastern Zones were separated along the 25°E meridian and the 21°, 26° and 31° parallels divided the region into four north–south bands, giving a total of eight Zones. For species with an essentially coastal distribution (most seabirds and some waders), the models of occurrence were fitted to the data from six coastal Zones (Figure 8):

Coastal Zone 1: Northern Benguela coast, Kunene mouth (1711BB) to Lüderitz (2615CA).
Coastal Zone 2: Southern Benguela coast, Lüderitz to St Helena Bay (3218C),
Coastal Zone 3: Southwestern Cape coast, St Helena Bay to Cape Agulhas (3420CC),
Coastal Zone 4: South coast, Cape Agulhas to Kei Mouth (3228CB),
Coastal Zone 5: Transkei coast, Kei Mouth to Port Edward (3130AA), and
Coastal Zone 6: East coast, Port Edward to Kosi Bay (2632DD).

There is no general agreement on biogeographical zones for the southern African coastline, and the choice of boundaries for the coastal Zones was based largely on the suggestions of Hockey *et al.* (1983) and references therein.

The Zones (Figures 7 and 8) are numbered on the distribution map for every species, with corresponding numbers on the seasonality graphic, using the same spatial arrangement. In southern Africa, most species breed in spring/summer, and the overwhelming majority of migrants occur in summer. The seasonality graphs are therefore presented for the period July to June; this division of the year avoids breaking the natural peaks in the annual cycle into components at either end of the calendar year. The numbers of checklists per month and per Zone are shown in Figures 9 and 10. In the graphs, the actual values of reporting rate are indicated by red dots. If the models of occurrence for a species were based on pentade data, the red dots are small; large dots are used when the models were based on monthly data. The fitted models of occurrence are shown as solid red lines. Models of occurrence were fitted provided there were more than 20 records for the Zone; the number of records used per model is given in the legend below the seasonality graphic. (The checklists used in the pentade analyses of seasonality were a subset of the total; thus the total of records in such cases was less than the total given in the summary statistics.)

The primary purpose of the models of occurrence is to reveal the timing of migrations and the existence of local movements; however, because the models are based on reporting rates, they are subject to the biases of this statistic. These general biases are discussed above under **Reporting rates**; the implications of biases for a particular species are discussed in the text for that species under Movements.

Models of breeding: The models of breeding seasonality were fitted using generalized linear models in the same way as those for occurrence. Because

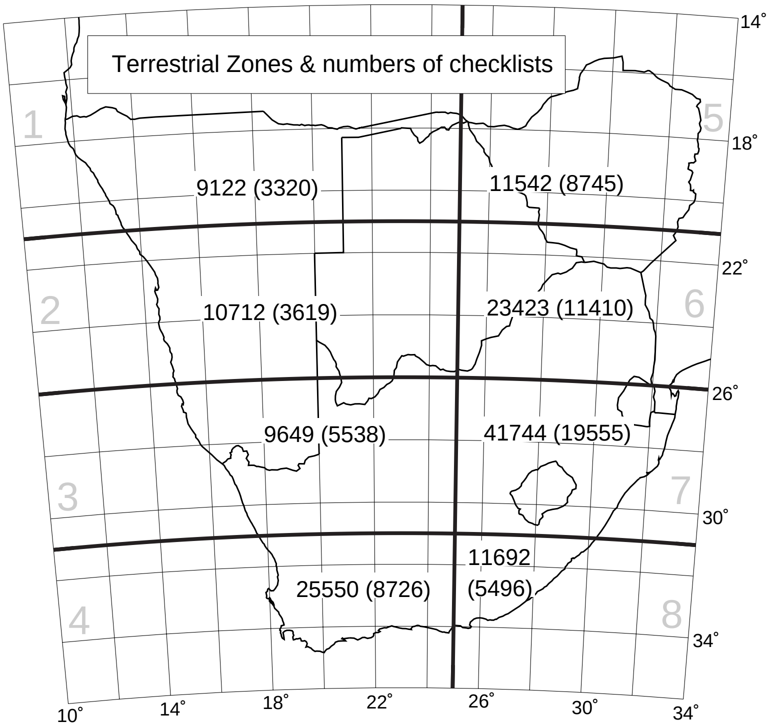


FIGURE 7. Map of the atlas region divided into eight terrestrial Zones,with the total number of checklists, and the number of checklists allocated to pentades (in brackets), indicated for each Zone. These statistics, together with those presented in Figures 9 and 10, should be used in interpreting the models of seasonality.

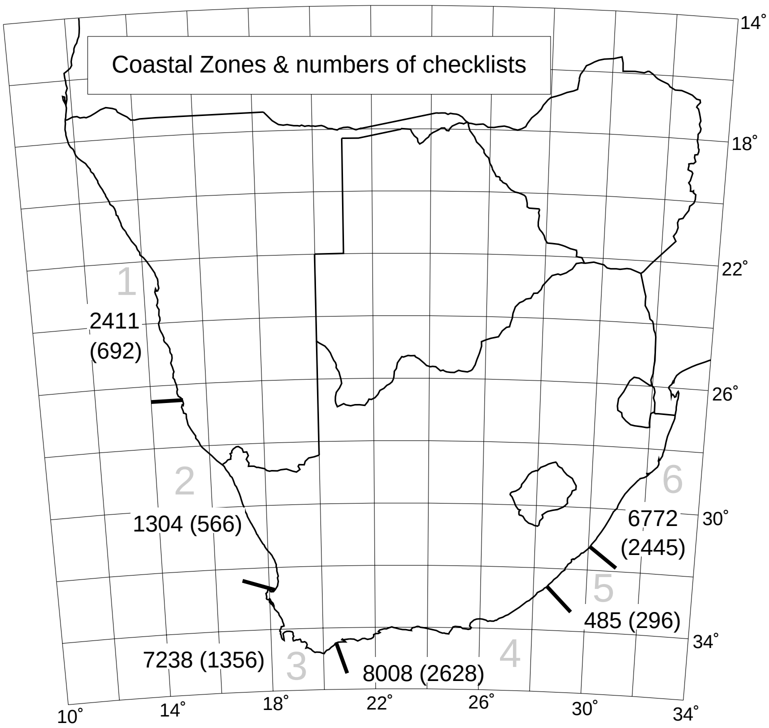


FIGURE 8. Map of the atlas region divided into six coastal Zones,with the total number of checklists, and the number of checklists allocated to pentades (in brackets), indicated for each Zone. These statistics, together with those presented in Figures 9 and 10 should be used in interpreting the models of seasonality.

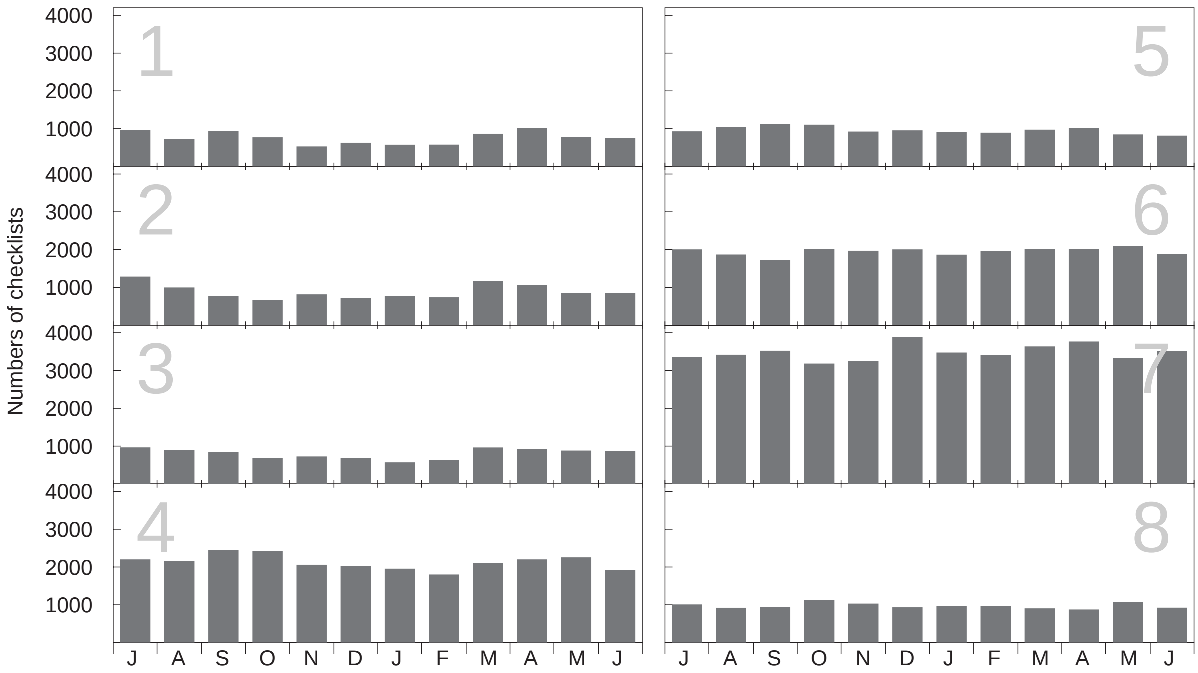


FIGURE 9. Numbers of checklists per Zone per month. Total numbers of checklists in Zones 1–8 are: 9122, 10712, 9649, 25550, 11542, 23423, 41744, 11692, respectively.

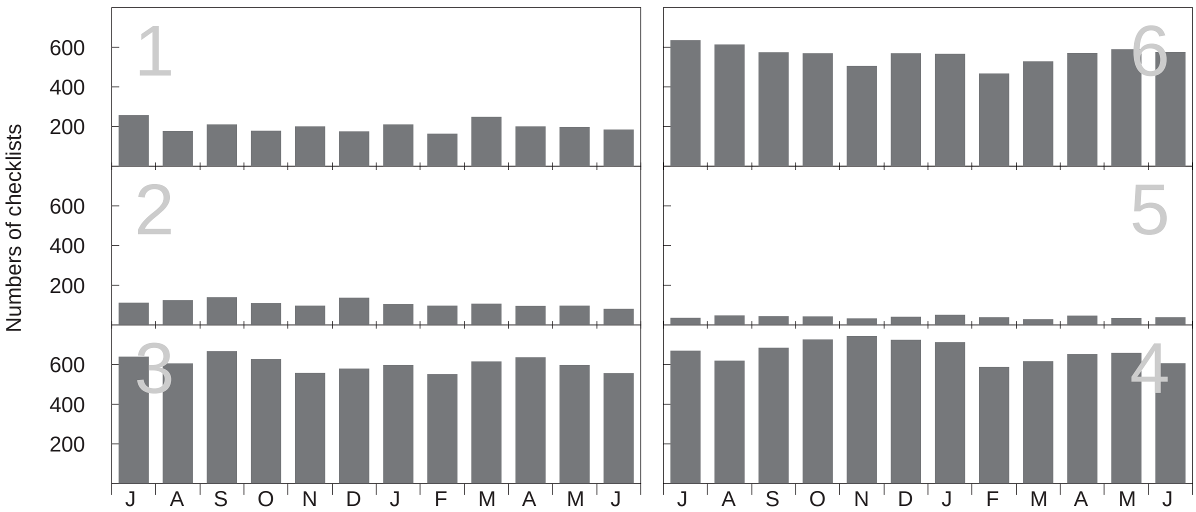


FIGURE 10. Numbers of checklists per coastal Zone per month. Total numbers of checklists in coastal Zones 1–6 are: 2411, 1304, 7238, 8008, 485, 6772, respectively.

of the relatively small amount of breeding data, months were used as the time periods to which all records were allocated. The graphical display of the models of breeding seasonality differs from that of the models of occurrence by showing the percentage of breeding that occurs in each month; in other words, the models display the *seasonality* of breeding within each Zone, and not the *frequency* of breeding. The percentages of breeding records for each month are shown as black circles, and the fitted model as a broken line.

The breeding records with status codes 3, 4, 5, 6 and 7 were used; records with status code 2, ‘suspected breeding’, were excluded. Although the exclusion of status code 2 reduced the number of breeding records, it was felt that ‘suspected breeding’ had been too broadly interpreted to be used with confidence. Consideration was also given to omitting records with status code 7, ‘dependent fledglings’, so as to come closer to the egglaying date (generally used to describe breeding season), but it was decided that the loss of usable data, particularly for species in which this code was important, would be too great. The use of status code 7 had the consequence of extending the length of the breeding period; the breeding data show the total period of *breeding activity* and not only the *egglaying period*; this should be remembered when comparing the atlas breeding data to published egglaying periods.

Because only a subset of the data was used to show occurrence by pentades and all the available monthly data were used to show breeding by month, it is possible for a rarely recorded species to be shown breeding in a month for which no pentade occurrence data were available.

Vegetation analysis

The vegetation analyses were also based on reporting rates within divisions of the atlas region, in this case 22 vegetation types (Table 2). The vegetation types were chosen *a priori* for their presumed relevance to bird distributions (described fully in the following chapter) and mapped in a geographic information system. This map was overlaid with the grid used in the atlas, and the areal proportion for each vegetation type in each grid cell was calculated. These proportions were used to calculate, for each vegetation type, the total number of checklists (Table 2) and the total number of records per species; their ratio was the reporting rate per vegetation type, for each species.

The values of reporting rates for each vegetation type are presented as bar charts. In most cases the results provide a good

TABLE 2. Names of vegetation types, numbers of grid cells and percentages, numbers of checklists.

Biome	Number of checklists	Number of grid cells	% of grid cells
Namib	3696	186	3.3
Namibian Escarpment	2870	237	3.9
Succulent Karoo	3838	289	4.5
Nama Karoo	8219	687	11.8
Grassy Karoo	2385	158	2.3
Fynbos	19956	207	2.9
Sweet Grasslands	3322	177	1.9
Sour Grasslands	22389	441	4.8
Mixed Grasslands	12814	421	4.2
Southern Kalahari	2175	283	4.8
Central Kalahari	4593	619	11.3
Northern Kalahari	2250	522	9.3
Arid Woodland	19255	1112	14.0
Moist Woodland	8533	269	3.2
Mopane	7356	680	8.4
Miombo	6029	356	5.0
East Zimbabwe Highlands	212	15	0.1
Okavango	574	76	0.8
Alpine Grasslands	1082	78	0.9
Valley Bushveld	4635	135	0.9
East Coast Littoral	9391	177	1.2
Afromontane Forest	877	203	0.2

representation of the broad habitat preferences of a species, indicating to what extent it can be considered a habitat 'specialist' or 'generalist'. The analysis is best used in conjunction with the distribution map as an interpretive tool in understanding the pattern of distribution.

For species which occupy habitats not catered for in the vegetation types, e.g. waterbirds and montane species, the analysis is less useful. In the case of most seabirds and shorebirds, the analysis is irrelevant and therefore excluded. In a few other species, the small number of records, and/or the species' restriction to a single vegetation type, did not permit a meaningful analysis and the results are therefore not shown.

The vegetation analysis, being based on the reporting rates, was subject to the biases of that statistic (see **Reporting rates** above). In addition, the analysis had some biases of its own:

(1) The categorization of vegetation involved a degree of oversimplification because it was not feasible to include wetland, riverine, montane, agricultural and urban habitats. Associations with particular vegetation types are sometimes related more to these specialized or altered habitats than to the naturally occurring vegetation types.

(2) Because the atlas data were collected by grid cell and not by vegetation type, species may become associated with inappropriate vegetation types. This was particularly true for highly fragmented vegetation types, Afromontane Forest being the foremost among these. For example, a species known to be found only in Afromontane Forest would be shown by the vegetation analysis to be associated also with Sour Grasslands and Fynbos, the vegetation types which usually surround patches of Afromontane Forest and thus occur in the same grid cells. Conversely, a Sour Grassland specialist would be shown to be associated with Afromontane Forest. These spurious associations necessitated a *post hoc* editing of the results of the analysis to remove associations with inappropriate vegetation types. This editing process was based on information, from other sources, of species' habitat associations.

A problem which could not be satisfactorily solved by editing was created when a species does, in fact, occur in both of two interdigitated vegetation types, but much more commonly in one than in the other. If the vegetation type with relatively low densities is also relatively small and shares most of its grid cells with the vegetation type with higher densities, its reporting rate will be artificially boosted. This effect was particularly noticeable in the case of Alpine Grasslands, a vegetation type with a small area and almost surrounded by Sour Grasslands.

(3) Uneven geographical coverage biased the reporting rates in some vegetation types. The worst example of this is the Central Kalahari vegetation type which falls largely within the borders of Botswana, but has an extensive portion in South Africa. Coverage of this vegetation type in South Africa was more intensive than in Botswana, with the result that a relatively large proportion of checklists for the Central Kalahari came from South Africa although most of the vegetation type lies in Botswana. This would not necessarily adversely affect the results, unless the two portions had differing avifaunas. This appears to be the case for the Central Kalahari vegetation type, as defined here. This is partially due to real differences in vegetation and partially due to important differences in patterns of land use, particularly the availability of water. The result is that the Central Kalahari has high reporting rates for many species which occur only on the periphery of the vegetation type. A similar bias occurs in the Southern Kalahari vegetation type in which many checklists were made in the tree-lined Nossob and Auob rivers in the Kalahari Gemsbok Park; most of this vegetation type is actually virtually treeless. A large proportion of the checklists for the Namib vegetation type were made in Walvis Bay and Swakopmund, resulting in atypically high reporting rates for waterbirds at sewage works and saltworks, and for species commensal with man.

The delineation of the vegetation types was based on authoritative vegetation maps (see following chapter). With hindsight, various refinements were possible, including the splitting of the Central Kalahari into 'deep sand' and 'shallow sand' types. However, such *a posteriori* fine tuning of the vegetation analysis had the potential to become an iterative process, which would have degraded the integrity of the analysis. That there now appear to be some striking discrepancies between bird distributions and vegetation maps is a major result of the atlas which will allow a more precise definition of southern Africa's 'avi-vegetational zones' (or aviomes) to be achieved in future.

Anomalies such as those described above do reduce the value and validity of the analysis for some species, and the results should, in all cases, be critically evaluated. Nevertheless, for most species the vegetation analysis does provide a useful summary of their biogeographical distributions and a clear indication of their ecological relationships to vegetation.

THE BOOK

Objectives

The objective of this book is to present the results of the atlas survey, but also to go beyond distribution maps and to present analyses of distribution in terms of vegetation, relative abundance within ranges, and seasonality of occurrence and breeding. This attempt to enhance the value of the data has been carried further by the species texts which aim to interpret the atlas data and analyses, but also try to place the results in a broader ecological, historical and conservation context. It is particularly hoped that this information will be useful in efforts to conserve and manage the subcontinent's avifauna.

A subsidiary objective is to bring together the relevant literature for the subcontinent and, through well-referenced text, to provide a 'voice' for publications which are not widely known.

A motivating factor in producing this book has been the strong desire to do justice to the efforts of the volunteer partici-

FIGURE 11. Map of southern Africa showing national boundaries, and the pre-1994 boundaries of South African provinces, and the Transkei. In addition, the positions of some frequently mentioned regions and localities are indicated. Large protected areas are shown as numbered polygons (named below); the positions of smaller protected areas in South Africa are indicated with dots. (Polygons as per map of southern Africa: 1: 2 500 000. 1993. Chief Directorate, Surveys and Land Information, Mowbray, 7700.) (This map should not be used as an authoritative reference on political or land-use boundaries.)

1. Etosha National Park
2. Skeleton Coast Park
3. Namib-Naukluft Park
4. Ai-Ais Hot Springs and Fish River Canyon
5. Kaudom Game Reserve
6. Mahango Game Reserve
7. Chobe National Park
8. Moremi Wildlife Reserve
9. Nxai Pan National Park
10. Makgadikgadi Pans Game Reserve
11. Central Kalahari Game Reserve
12. Khutse Game Reserve
13. Mabuasehube Game Reserve
14. Gemsbok National Park
15. Hwange National Park
16. Chizarira Game Reserve
17. Mana Pools Park
18. Chewore Park
19. Gona-re-zhou National Park
20. Kruger National Park
21. Kalahari Gemsbok National Park
22. Richtersveld National Park

pants in the project. Continuing the ‘community involvement’ approach to the project, it was decided to recruit as many authors and artists as possible in order to make the atlas representative of southern African ornithology at this point in its history.

Taxonomy, common names, and ordering of species texts

The taxonomic order followed here is the traditional one and the scientific names used are those accepted by the South African List Committee of BirdLife South Africa (Clancey 1980b; Clancey *et al.* 1987, 1991). English and Afrikaans common names were taken from Maclean (1993b), except where recent taxonomic developments have necessitated the use of other names. The order of presentation of species follows Maclean (1993b) closely, with deviations to accommodate the varying number of pages used for each species; the species texts for vagrant, marginal and escaped species are grouped together at the end of each volume. The systematic lists, near the beginning of each volume, provide a list of all species in the order used by Clancey (1980b).

Citations and references

There has been a trend in southern African bird books to omit citations. Although this may make the text more readable, it degrades its scientific value, because statements of fact or opinion cannot be distinguished or traced to source. In this atlas an attempt has been made to reference the text fully, except for statements on the world distribution and basic habitat requirements of species. In such cases the references were generally one or more of the following frequently used references: Maclean (1985c, 1993b); Cramp *et al.* (1977, 1980, 1983, 1985, 1988, 1992, 1993, 1994); Del Hoyo *et al.* (1992, 1994, 1996); Brown *et al.* (1982); Urban *et al.* (1986); Fry *et al.* (1988); Keith *et al.* (1992); Hall & Moreau (1970).

FIGURE 12. Map of southern Africa showing national boundaries, and the post-1994 names and boundaries of South African provinces. The locations of some major towns and cities, and the principal offshore islands, are indicated. (This map should not be used as an authoritative reference on political boundaries.)

The reference list is valuable in that it draws together a significant part of the literature for southern Africa, including many little-known publications. It also provides readers with the means of finding out more about a point that interests them, enabling them to find a full account of an issue that may have been summarized down to a single sentence in a species text.

Authors and artists

Names of artists and authors are listed under the relevant family headings in the systematic lists near the beginning of each volume. Authors' names also appear as bylines at the bottom of each species account and the drawings bear the artists' signatures.

Editors

All species texts were edited by all seven editors. Special responsibility for particular states was borne by David Allan (South Africa and Lesotho), Chris Brown (Namibia), Marc Herremans (Botswana), Vincent Parker (Swaziland) and Tony Tree (Zimbabwe). These 'national editors' attempted to ensure that the species texts were accurate and balanced for their respective countries; their contributions to a text are frequently acknowledged as personal communications ('pers. comm.') Other particular responsibilities were allocated to Les Underhill (statistical design and presentation) and James Harrison (stylistic consistency). The analysis of data was made possible by the computer programmers, namely Dr David Holgate, Peter Martinez, René Navarro and Les Underhill. Important contributions to the layout and presentation of the atlas were made by René Navarro and Felicia Stoch.

Introductory chapter

Essential descriptions of the database and explanations of methods of analysis are given. It is strongly recommended that it be perused, particularly by scientific users.

Geography chapter

The chapter on southern African geography is designed to be an aid in the interpretation of the distribution maps and the recurring patterns they show. It is not a comprehensive discussion of southern African geography or biogeography, but it refers copiously to the distribution maps in these volumes, and thus should enrich the reader's understanding of the atlas data.

Species accounts

It was decided not to try to present the results for all species in one standard format because that would mean losing the opportunity to present additional interesting information for some, and also having to present meaningless and potentially misleading information for others. With four different formats for species accounts all species found an appropriate level. The four formats are described in the ***Guide to Species Accounts*** in each volume.

The results of the analyses are presented in the distribution maps, models of seasonality, vegetation graphs and the summary statistics. These are explained under **Analyses** above, and in the ***Guide to Species Accounts***. Although the graphics may appear self-explanatory, it is unwise to attempt interpretation of the results without first familiarizing yourself with the background and methods.

Place names

Place names are usually followed by grid references to aid location on the maps. The names of the provinces of South Africa follow the old usage, except for KwaZulu-Natal and the Free State, which essentially retained their original boundaries (see Figures 12 and 13). Most texts were written prior to renaming, and were edited during a period when the names were unstable, as is still the case at the time of going to press. In addition, loosely described areas in species texts do not translate simply into post-1994 terminology; e.g. 'southwestern Cape Province' does not translate into 'Western Cape', and 'southern Cape Province' would have had to be translated into the 'southern Eastern and Western Cape', which is almost unintelligible. It is a pity that unimaginative compass directions have been incorporated into the names of so many of the new provinces.

Glossary and index

The glossary presents definitions of technical terms used in the text. The index is for species names only; English and scientific names are indexed. Page numbers in bold indicate the page on which the main text for the species occurs; other page numbers point to references to a species in the text for another species (or in the preliminary chapters).

THE FUTURE

Uses of the data

The large number of requests for atlas data received by the Avian Demography Unit demonstrate the variety of uses to which the data can be put. These include academic ornithological studies of individual species, including their ecology, biogeography and phenology; conservation biology studies of endemism, conservation status and biodiversity patterns; applied studies of community structure and breeding seasonality for resource management purposes; environmental consultancy surveys on local species occurrence and abundance; and ecotourism and hobbyist surveys on local species occurrence and abundance (Harrison 1989; Underhill *et al.* 1993; Donald & Fuller in press). The atlas database has demonstrable usefulness in all of these areas, but it is particularly in the fields of theoretical and applied conservation biology that we hope that the atlas will have a positive influence.

Access to data

The grid distribution maps presented here are subject to copyright held by BirdLife South Africa. Because of the multinational nature of the raw atlas data, arrangements for access to them are complex. Subject to arrangements with each state, atlas data in various formats are available from the Avian Demography Unit, University of Cape Town, Rondebosch 7701, South Africa. Fees are charged for data extraction and processing and for any special computer programming which may be necessary. It is anticipated that summary data, in checklist format, will be published in book form, at least for South Africa. More comprehensive information is likely to become available on CD-ROM in due course.

Lessons learnt and the next atlas

In conjunction with earlier published information, this atlas clearly shows that bird distributions in southern Africa are changing, slowly for some species, rapidly and sometimes catastrophically for others. There can be no doubt that a similar survey of distributions should be carried out in the not-too-distant future. The value of updates lies in their clarification of the direction of trends, and of the rates at which change is happening. Already there is a Mozambique Atlas Project underway at the initiative of Vincent Parker, one of the editors of this atlas. In addition, a joint ADU–BirdLife South Africa project, the Birds in Reserves Project (BIRP) – essentially an atlas project limited to protected areas – is in progress. These two projects will allow for a significant update of the atlas database within a few years. We would urge that the planning of the next full-scale atlas project begin with the appearance of this book.

Of course the next atlas project need not be exactly like SABAP; in fact there are several aspects which, depending on the exact objectives of a future project, could be improved upon and are worth highlighting here. Aspects of project design worth considering are:

- ❑ **A finer grid:** A finer grid is a feasible option, particularly in South Africa; also the development of the hand-held global positioning system (GPS) makes a point-data approach possible. These options are desirable for analyses of habitat specificity and the impacts of habitat alterations and land-use patterns, but must be weighed carefully against practical considerations.
- ❑ **A finer temporal resolution:** If a future atlas project aims to describe patterns of seasonality, it should be restricted to checklists compiled on single days.
- ❑ **Measurement of inter-year variation:** If minimum annual coverage standards were set for geographical units within the atlas region, analyses of year-on-year differences in reporting rates for particular species could be possible (e.g. Underhill & Hockey 1988). Measures of inter-year variation would greatly aid the interpretation of putative trends.
- ❑ **Standardization of effort per checklist:** For example, a minimum of three, and a maximum of 24 hours per checklist, would greatly improve the comparability of checklists with regard to effort and would help to stabilize reporting rates in relation to effort.

There are also organizational aspects which might benefit from revision:

- ❑ The use of electronic mail and optical mark readers has the potential to speed up data capture and thus also the feedback to observers.
- ❑ The SABAP database could be used to automate vetting procedures and generate 'out-of-range' queries quickly, thus providing meaningful interaction with observers.
- ❑ A greater degree of personal contact with volunteers, and more training, could contribute to higher levels of participation. On the other hand, SABAP has demonstrated that success can be achieved with a relatively small number of enthusiastic participants.
- ❑ With exceptions, SABAP volunteers came from the white population group. This suggests that support was good in one minority sector of southern Africa's population but negligible amongst the majority. This presents a major challenge to the future development of birding and bird-oriented projects in the region.
- ❑ In retrospect, it is clear that insufficient cognizance was taken of national and personal interests in the planning stages of the project. SABAP would have benefited from more thorough and formal negotiations between interested parties at the earliest stages of the project, prior to the commencement of data collection.

J.A. Harrison and L.G. Underhill