The South African Bird Ringing Unit: 21 years of service and research

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In 1948 the first birds were ringed in South Africa, but it was only in 1971 that the South African Bird Ringing Unit (SAFRING) was established. SAFRING aims to provide a high-quality service to ornithological research, and to undertake extensive and systematic analyses of its substantial data base.

Marking a bird with a ring makes it uniquely identifiable, and provides an effective way of linking points in its life. Some of the quantitative cornerstones of the population dynamics of bird populations, and hence the formulation of strategies to conserve them, are a knowledge of rates of survival, juvenile dispersal, recruitment into the breeding population, immigration and emigration. Bird ringing (bird banding) and related marking techniques are the only cost-effective tool for generating data that enable these quantities to be estimated.

Bird ringing in South Africa started in 1948, when the Southern African Ornithological Society (SAOS) initiated a bird-ringing scheme under the leadership of Dr E.H. Ashton. The first birds were ringed on 1 August 1948. One of these first-day birds, a juvenile Cape Griffon *Gyps coprotheres*, was recovered 14 months later; it had moved 444 km from Kransberg in the Transvaal to the Inziza Tribal Trustland, south-east of Bulawayo in Zimbabwe.[1]

By the late 1960s, the ringing scheme had grown to a point at which the cost and complexity of its administration had exceeded the resources of the SAOS. The Council for Scientific and Industrial Research brokered a deal whereby the provincial conservation departments, whose ornithologists had become major consumers of ringing services, became, in 1971, the major sponsors of the South African Bird Ringing Unit (SAFRING). The Ringing Unit celebrated its 21st anniversary in 1992.

The unit forms part of the Avian Demography Unit in the Department of Statistical Sciences at the University of Cape Town. South Africa must be the only country that has entrusted its bird-ringing unit to statisticians. Yet this makes good academic sense, because statisticians have to devise the methodology to analyse the resulting data. To this end, EURING, the umbrella body for the ringing schemes of Europe, has organized three highly successful conferences that brought together statisticians and ornithologists with a common interest in the data generated by bird ringing.[2–4]

Services

SAFRING provides the following services:

1) It maintains an adequate stock of numbered metal bird rings of 20 sizes, so that all reasonable demands for rings can be met out of stock. Rings are reordered from overseas suppliers, allowing a lead time of up to a year. Plastic colour rings are stocked for studies in which birds need to be visibly identifiable, either as individuals or as members of a cohort.

2) It stocks other specialist ringing equipment, such as mist nets (which can only be supplied to permitted ringers), special pliers to attach rings to the bird, spring scales and wing rules.

3) It keeps records of when, where and on what species each ring was used. This information is currently maintained on schedules, with a microfiche copy for security. Summarized information from each schedule is entered into a computer database to facilitate production of annual reports and other ringing statistics.

4) When a bird is recovered, the finding details are matched with the information at the time of ringing, SAFRING informs both the finder and the ringer, and the record is entered into the computerized recovery data base.

5) It publishes *Safring News*, a biannual publication containing articles on interim ringing results, capture techniques, annual ringing reports and roundups of foreign ringing news. *Safring News* provides both feedback to ringers, and an outlet for ringing-related research results. Papers in the journal are included in *Wildlife Review* and other abstract services.

6) It supplies information to researchers. Requests vary from straightforward queries about survival, movement or body mass, to more complex requests, such as a listing of recoveries of all Southern Ocean seabirds involving movements of at least 100 km, prepared for the recently published first volume of the Handbook of Australian, New Zealand and Antarctic Birds.[5]

7) It runs the Central Data Bank for Antarctic Bird Banding. SAFRING receives copies of schedules or summaries of species ringed by all Scientific Committee for Antarctic Research (SCAR) nations and stores these data, thus providing a secure alternate depository. Reports on ringing totals for all Southern Ocean and Antarctic birds are compiled and published.[6]

There are approximately 120 authorized bird ringers using SAFRING services, many of them amateurs, who have made and continue to make a major contribution to the project's databanks. Few ornithologists in South Africa have not, at some stage, made use of the services of SAFRING, either to provide rings and/or colour rings for the individual marking of birds, or to obtain the data in the recovery data base concerning survival and movement for a species. In fact, at least a few of South Africa's professional ornithologists were attracted into the discipline by being part of amateur ringing groups in their formative years.

Results and research

Scientific results from the SAOS ringing scheme were not slow in coming. By 1961, previously unknown patterns of migration had already emerged for five intra-African migrant species.[7] As another example, before ringing of European Swallows *Hirundo rustica* started in southern Africa, most ringed swallows recovered while spending the northern winter in South Africa bore British rings, and it was assumed that all the European Swallows in the subcontinent were British, or at least west European, in origin. Once the ringing effort in South Africa started earning its share of recoveries, the surprise was to discover that 80% of the recoveries were from Russia, mainly between longitudes 21°E and 91°E. There are few swallow recoveries between southern Africa and central Europe, because these swallows winter mainly in central Africa.[8] McLachlan[7] concluded that the results achieved by the ringing scheme over the first 10 years justified its inception, and predicted that 'patterns of migration will gradually become known in greater and greater detail'. This process has continued and the SAFRING data base still delivers new insights into migration and other aspects of the population dynamics of bird species (for example, refs. 9–15).

Between 1948 and June 1992, approximately 1.37 million birds of 830 species had been banded with SAFRING rings (Table 1). The only species with more than 100 000 individuals ringed in south-

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Table 1. Distribution of ringing effort with SAFRING rings over 824 species ringed up to June 1992.

No. individuals ringed	No. species
1–9	178
10–99	255
100–999	248
1 000–9 999	126
10 000–99 999	22
>100 000	1

ern Africa is the European Swallow; for a further 13 species, between 20 000 and 100 000 individuals have been ringed (Table 2). The SAFRING recovery file contained approximately 23 000 records in June 1992, having increased by an average of 462 records per year during the 1980s. The file includes details of 368 species recovered with SAFRING rings (Table 3). This is less than half the number of species ringed. For only 19 species are there 200 or more recoveries (Table 4). The overall SAFRING recovery rate is 1.01%, less than half the recovery rate of 2.12% of the British ringing scheme.[16]

Since the beginning of the 1980s, the annual ringing total has increased by some 10% per year, to 51 500 birds marked in the 1991/92 ringing year (Fig. 1). The rate of increase could be higher because many birds which are not the species of immediate interest to the ringer are released unringed, and potentially valuable data are lost. At an average price of 37 cents per ring for the smaller ring sizes, ringing these birds would add an unacceptable cost to a ringing project. Larger-size rings, mainly used for seabirds, ducks and raptors, cost over a rand each, and a flipper band for a penguin now costs R2.20. A large component of the costs consists of import taxes, which include special surcharges on ring materials such as stainless steel. Private-sector support for bird-ringing projects would assist greatly in underpinning this important conservation activity.

For example, recovery rates or circumstances of recovery of ringed birds have provided warnings of hazards to birds that might otherwise have gone undetected, and enabled conservation action to be taken. Exceptionally high recovery rates of terns on a short section of the west African coast were the first signal that large-scale trapping of terns by boys and fishermen was occurring.[17–19] Similarly, a series of recoveries of raptors in concrete dams on farms in the northern Cape Province has alerted conservation bodies of the hazard that such dams present.[20]

The Vulture Study Group discontinued the ringing of vultures on the grounds that all that could be learnt about vulture movements had been learnt, and the risks (to both vultures and ringers) were not worth taking. However, it has subsequently been realized that the causes of death reported to SAFRING when ringed vultures are recovered provide the most reliable system so far devised to monitor trends in the causes of death of these endangered species (S.E. Piper pers. commun.).

Table 2. Number of birds ringed for species with more than 20 000 individuals ringed with SAFRING rings up to June 1992.

Species	No. individuals ringed	Recovery rate (%)
European Swallow *Hirundo rustica*	172 859	0.40
Cape Gannet *Morus capensis*	97 267	1.27
Redbilled Quelea *Quelea quelea*	96 612	0.25
Yellowbilled Duck *Anas undulata*	58 467	1.67
Masked Weaver *Ploceus velatus*	49 674	0.79
Cattle Egret *Bubulcus ibis*	46 015	0.94
Laughing Dove *Streptopelia senegalensis*	40 817	1.49
Red Bishop *Euplectes orix*	37 913	0.31
South African Cliff Swallow *Hirundo spilodera*	36 934	0.24
Cape Sparrow *Passer melanurus*	36 794	0.68
African Penguin *Spheniscus demersus*	35 170	1.97
Redknobbed Coot *Fulica cristata*	25 962	3.08
Curlew Sandpiper *Calidris ferruginea*	24 308	0.40
Cape White Eye *Zosterops pallidus*	22 218	0.28

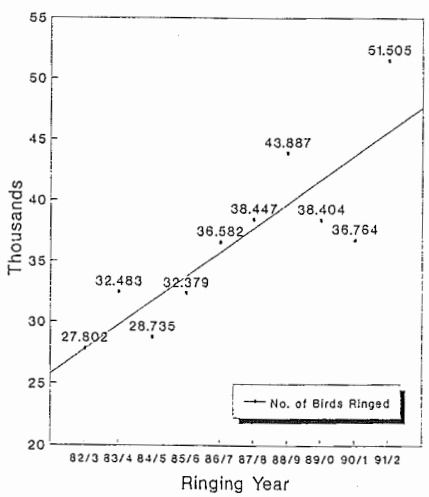

Fig. 1. Numbers of birds ringed annually with SAFRING rings, 1982/83–1991/92.

Table 3. Numbers of birds with SAFRING rings recovered, up to June 1992.

No. of recoveries	No. species
0	462
1–9	247
10–99	93
100–999	27
>1 000	1

SAFRING therefore currently holds major information resources of scientific and conservation importance, gathered as a result of the efforts of bird ringers throughout southern Africa over a period of more than 40 years. This is one of the main strengths of bird ringing. Whereas an individual ornithologist can do detailed research in a small area for a short period of time, SAFRING's data have the potential to produce results on a subcontinental scale over decades. New statistical tools for handling bird-ringing data are rapidly becoming available, both as theoretical methodology and as user-friendly computer software.[2–4,21] This provides fresh incentives and opportunities for the analysis of the SAFRING data base.

Looking ahead

Is there a justification for continuing the ringing of birds, especially species

Table 4. Species with more than 200 recoveries of birds with SAFRING rings, up to June 1992.

Species	No. recoveries
Cape Gannet *Morus capensis*	1 234
Yellowbilled Duck *Anas undulata*	974
Redknobbed Coot *Fulica cristata*	800
European Swallow *Hirundo rustica*	693
African Penguin *Spheniscus demersus*	693
Laughing Dove *Streptopelia senegalensis*	609
Cattle Egret *Bubulcus ibis*	431
Egyptian Goose *Alopochen aegyptiacus*	392
Masked Weaver *Ploceus velatus*	393
South African Shelduck *Tadorna cana*	364
Whitebreasted Cormorant *Phalacrocorax carbo*	342
Redbilled Teal *Anas erythroryncha*	332
Hartlaub's Gull *Larus hartlaubii*	323
Swift Tern *Sterna bergii*	278
Cape Cormorant *Phalacrocorax capensis*	253
Sacred Ibis *Threskiornis aethiopicus*	252
Cape Sparrow *Passer melanurus*	250
Redbilled Quelea *Quelea quelea*	239
Cape Griffon *Gyps coprotheres*	239

for which large numbers of recoveries have already accumulated? Surely the 700 European Swallow recoveries from southern Africa's most ringed species are adequate to give a full picture of their movements and their survival rates? No, and there are at least four reasons for urging ringers to continue ringing all species in the largest numbers feasible, and for providing them with financial support to enable them to do this.

Firstly, Mead[22] considered that at least 500 recoveries for a species were needed before an analysis of movements and survival rates could be attempted, and that once 10 000 recoveries had accumulated, it was possible to examine both regional and annual differences in these key demographic parameters. The 1 000 Cape Gannet *Morus capensis* recoveries revealed that the pattern of winter movement had changed over a period of four decades; there were virtually no recoveries of gannets on the west coast of Africa north of 17°S after 1979, whereas, between 1951 and 1959, 34% of recoveries came from this region.[12]

Secondly, for more than half the species ringed there are no recoveries at all. Even a few recoveries can radically change our perceptions about the dispersal abilities of species that are generally considered resident breeders. Recently, there have been recoveries of some adult raptors that have surprised the raptor specialists: Forest Buzzards *Buteo trizonatus* from both Natal and the northern Transvaal to the southern Cape Province,[23] Lanners *Falco biarmicus* from the Kalahari to Zambia and Malawi, a Black-shouldered Kite *Elanus caeruleus* from the Transvaal to Uganda, and a Wahlberg's Eagle *Aquila wahlbergi* from the Transvaal to northern Sudan.

Thirdly, ongoing ringing on an annual basis has an important role in monitoring. Oatley *et al.*[24] showed that the continuing project of the Port Elizabeth Museum, in which 3 000 gannet fledglings are ringed each year at Bird Island in Algoa Bay, has the potential to give rapid warning of warm-water events, phenomena which occur once or twice a decade, and which are frequently diagnosed retrospectively. Immediately after ringing, SAFRING keeps a running total of the number of recoveries reported, and if the recovery rate exceeds certain limits, a warning is sounded. The British Trust for Ornithology has an Integrated Population Monitoring Programme, one strand of which is provided through ringing sufficient birds of a suite of species each year so that the number of recoveries generated is adequate to estimate annual survival rates for each of these species.[25]

Fourthly, we are entering a period of threatened global warming. Birds, and especially long-distance migrants, might well have their movement patterns disrupted, and their survival rates altered.[26] It is only for those species for which we already have a good body of data to provide a baseline that we have any possibility of detecting changes. Amongst Berthold's[26] predictions is that, in Europe, warming will favour resident species over migrants, and that many species of long-distance migrants will decline or become extinct. SAFRING ringers have a key contribution to play in collecting the data to test these and other predictions, and to monitor changes in the demographic parameters of the region's avifauna. Therefore the 700 European Swallow recoveries may provide a baseline against which future change will be detected.

On the subject of stopping or discouraging the continued ringing of a species, there is an important lesson from a British experience. Starting in 1961, a 'Sand Martin Enquiry' was undertaken in Britain.[27,28] By 1968 it was considered that 'enough' Sand Martins *Riparia riparia* had been ringed, and the active promotion of Sand Martin ringing was ended, in order 'to assimilate the data already in hand'.[28] In that year the Sand Martin population crashed, possibly in association with a drought in the Sahel to the south of the Sahara Desert, to where these birds migrate for the northern winter.[28] The lack of data for this exceptional year meant that an opportunity to make observations in an extreme year, and to develop a fuller understanding of the population dynamics of this species, was lost. When a further Sahelian drought occurred in 1984, precipitating another population crash, the fascinating result was that smaller Sand Martins had higher survival rates during the period of environmental stress.[29]

It is now appropriate to renew the vision for AFRING, the African analogue of EURING, which co-ordinates ringing schemes in Europe. The concept of AFRING was proposed in 1969, at the Third Pan-African Ornithological Congress, where a resolution that 'co-operation between ringing schemes in Africa and between African schemes and European schemes is highly desirable' was passed unanimously at a meeting of delegates to the congress interested in bird ringing.[30] Besides South Africa, SAFRING provides services to ringers in Namibia, Botswana, Mozambique, Zimbabwe, Malawi and Mauritius.[31] South of the Sahara Desert, there is currently an active ringing scheme in East Africa covering mainly Kenya, Tanzania, Uganda and the Sudan,[32] and a newly launched scheme in Ghana;[33] earlier schemes in Nigeria[34] and Zambia[35] are defunct, but since 1990 large numbers of migrant birds have been ringed in Senegal by volunteer expeditions of European ringers using British rings.[36]

SAFRING, as part of the world-wide network of ringing schemes, has a decisive contribution to make to ornithology, with opportunities to promote projects involving bird ringing that will increase our understanding of bird population dynamics.[37] In turn, this will enable conservation strategies for bird species, based on sound quantitative analyses, to be developed.

SAFRING is mainly supported by a long-term contract with the South African Department of Environment Affairs. The University of Cape Town provides facilities and services. Further support is given by the Southern African Ornithological Association and the Namibian Ministry of Wildlife, Conservation and Tourism. In 1992, a special grant was received from the Southern African Nature Foundation. Bird ringing in southern Africa is carried out by some 120 ringers, most of whom conduct their activities at their own expense.

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The tonsillar evacuation hypothesis of yawning behaviour

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We do not know why we and other animals yawn. Yet because this behaviour is so commonplace, we are obliged to accept either that yawning has no physiological function or that, because it involves gaping of the mouth, it has some obscure respiratory function. It is suggested that yawning is a powerful reflex to evacuate the palatine tonsillar fossae. As this strong reflex does not have any immediate urgency, it has become allocated to times of minimal inconvenience. This is reflected in the circadian pattern of yawning in our own species, and explains why we have come to associate yawning with drowsiness and boredom, even though this association is not a causal one. If yawning does indeed have this function, then by our social sanctions against it we may be supressing its effectiveness, leading to endemic tonsillitis in our species.

The familiar reflex known as yawning has been defined as 'the involuntary act of opening the mouth widely, accompanied by deep inspiration, and frequently stretching of the arms, shoulders and chest to assist in the inspiratory act, followed by relaxation of the muscles involved, usually performed when sleepy or bored'.[1] This definition incorporates, without formal statement, the conventional wisdom, as yet unproven, that yawning has an inspiratory function. It is a remarkable fact that to this day the cause, physiological function and, most intriguing of all, the contagiousness of this everyday habit remain unexplained.[2–5] This article explores an alternative function for yawning behaviour, by looking laterally — not straight down the throat but slightly to the side.

Yawning, as in the act of opening the mouth widely, has been recorded in all vertebrate classes with the exception of the Agnatha.[6–8] Among mammals this stereotyped[2] behaviour is most obvious in the carnivores and primates.[6–8] Several authors have cautioned that resemblances between taxa may be superficial only, and that the role of yawning may not be the same in all groups of animals.[2,3,6,7,9] This discussion will be limited to mammals, yet even within this group it is recognized[2,3,10] that yawning serves two discrete purposes: the first is the as yet unsatisfactorily defined physiological/homeostatic function, and the second is a communication function. Provine and Hamernik[2] have appropriately labelled the signalling function in humans as 'a paralinguistic signal for boredom', emphasizing the strong relationship between yawning and fatigue or drowsiness.[6,8,11,12]

The mystery surrounding the function of yawning has intrigued us for centuries: Hippocrates is recorded as having been fascinated by its role.[8] Numerous hypotheses have been proposed to fill this rather worrisome gap in our knowledge about ourselves — none of which has adequately explained all the observed features of this complex behaviour. The hypothesis proposed by Russel,[13] that yawning is an 'automatic impulse' caused by 'bad air in the lungs' intended to 'awaken the respiratory organs into activity' and to 'effect a stimulation of the brain through increased activity of the circulation', seems to form the basis of present-day conventional wisdom on yawning.

However, Provine *et al.*[14] have demonstrated that anoxia does not play a role in the regulation of yawning. This can be confirmed by the reader by holding his or her breath for as long as possible — this does not result in a yawn! We may therefore bury the old ideas about yawning and take a look at some of the alternative explanations: yawning is an integrated discharge in a bulbo-reticular motor structure occurring at a particular level of activity of the reticular formation corresponding to a decrease of wakefulness preceding sleep;[8] yawning has no physiological role;[15] yawning stretches the facial and neck muscles;[2,10,12] yawning prevents a loss of lung compliance during normal breathing;[16] yawning synchronizes sleep in group-living animals;[17] yawning provides a pulse of thyroid hormones by squeezing the thyroid gland (unknown source in ref. 6); yawning is an attempt of the body to delay onset of sleep and reinforce wakefulness after sleep;[18] yawning is a means of increasing attention when sleep is pressing in the face of a danger or social circumstance;[19] yawning is an arousal defence reflex.[20]

The following conclusions can be drawn from current knowledge on the subject.

Yawning is a reflex act which may be

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