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Bird atlases – how useful are they for conservation?

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Summary

In this paper, we argue that bird atlases, and the databases from which they are produced, are becoming increasingly valuable resources – but only in some parts of the world. There is a striking lack of atlases for almost all of the world's species-rich areas, most notably tropical America and tropical Asia. Yet even comparatively modest data sets (we take Uganda as an example) can be used to create an atlas. Further, their data can yield interesting information with clear value for conservation planning. For instance, we can see that Uganda's main savanna parks are quite well-placed in relation to raptor species richness, whilst other species of conservation concern are less well covered. In contrast, the fine-scale data-rich atlas projects in many American and European countries provide detailed information of great value. Taking examples from England, we show some of their uses in planning both for physical developments and for conservation. Repeating atlas projects after an interval of several years highlights changing distributions and, increasingly, changing levels of abundance. We believe that every encouragement should be given to new (and repeat) atlasing projects - but most especially in the tropics.

Introduction

The answer to the question in the title may seem to be self-evident – of course atlases are useful! They are, as Colin Bibby (2004) pointed out, 'a very effective way of documenting the avifauna of a region.' But if that is really the case, why do we see so few references to them in papers on bird conservation? This seems the more surprising since, according to Gibbons *et al.* (2007), there are already more than 400 of them. Further, why did those authors find there to be such a marked decline in new atlases being produced since the peak in the 1980s and 1990s? A favourite phrase in modern papers, particularly in their summaries, concerns '.. the efficient allocation of scarce resources for conservation…' (e.g., Scharlemann *et al.* 2005). So surely atlases have an important role?

The global scene for bird atlases was first reviewed by Donald and Fuller (1998), then by Underhill and Gibbons (2002) and more recently by Gibbons *et al.* (2007) and Dunn and Weston (2008). These authors recognised many different uses for atlases and the databases upon which they depend, including, of course, conservation. Dunn and Weston (2008) derived 15 uses from the 272 atlases that they reviewed (all of which they list) and found that, from five atlases which they describe as 'major', 46 of 97 resulting publications were, as would be expected, about distributions and ecology. But as many as 26 were on planning and land management, clearly aspects of applied conservation.

Atlases can be of several different types: they may be based upon grid cells, or they may depend instead upon point records – that is, records located as georeferenced points. The idea of plotting actual localities is not new – the classic atlases of Hall and Moreau (1970) and Snow (1978) were essentially point records. Since then, the only other atlas in Africa that has used points is that for Uganda (Gibbons *et al.* 2007). Atlases may also vary in the type of information that they offer. Some are seasonal (such as the breeding and winter atlases which we shall discuss later), although in the tropics, breeding seasons are protracted, and effectively spread over the whole year, with different species breeding at different times. Thus African atlases are often of the presence-or-absence type. However, the forthcoming atlas for Tanzania will have 12 monthly symbols within each grid square (Neil Baker, pers comm.). A more recent development is to use symbols of varying types to reflect the numbers of birds.

It is remarkable that those parts of the world with the most birds – tropical South and Central America, South-east Asia and Africa – have the least numbers of atlases. Between them, they have only 14 of the 411 in the global database of Gibbons *et al.* (2007) (Figure 1). There is only one atlas from Asia and one from South America (for the Falkland Islands, which are not very speciose). Of the twelve African atlases, only five are for tropical countries. Countries with few birds but very good, fine-scale atlases, such as Great Britain and Ireland, are finding their atlases increasingly valuable for conservation purposes. But, as we shall also show, atlases and their databases are also beginning to prove useful in the countries with the most birds.

High diversity, low coverage: the example of Uganda

Atlasing in Africa is not new: the classic volumes of Hall and Moreau (1970) and Snow (1978), which covered the whole of Africa, were among the first in the world. Pomeroy and Ssekabiira (1990) used their maps to demonstrate that passerines in Africa have much smaller distributions than non-passerines (and are therefore at greater risk from climate change and other threats),

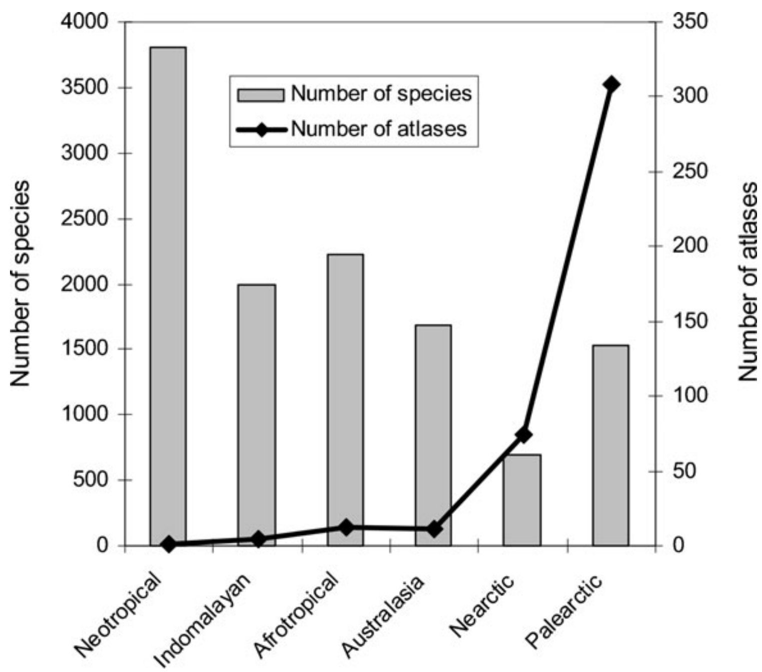

Figure 1: There is a strong negative correlation between the numbers of species of birds and the number of atlases from a region (numbers of species, from Baillie *et al.* 2004, excluding Antarctica and Oceania, for which there are no atlases; and of atlases, slightly modified from Gibbons *et al.* 2007).

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and that – as one would expect – generalists are more widely-distributed than specialists, especially montane forest specialists.

The biodiversity in some eastern African countries is, for their size, almost as rich as that for tropical South America (Pomeroy 1993). But there are few birders in most tropical countries, and this presents a problem for those who would wish to make atlases. Uganda illustrates this well. It is quite small (some 220,000 km^2) but has an above-average number of species – about 1,020 have been recorded, and 80% of these breed there. During the period when data were being assembled, there were few active birders, so two decisions were made which determined the final outcome. Firstly, all historical data were reviewed (some from as long ago as the 1880s); and secondly, new data, although they could only be collected from limited areas, were georeferenced to the nearest 1 km (Carswell *et al.* 2005).

Although the maps in the *Bird atlas of Uganda* (Carswell *et al.* 2005) have many gaps, the data are nevertheless able to support some useful analyses. For example, we can use them to ask how good is the coverage of the existing system of Protected Areas (PAs) and, where different, Important Bird Areas (IBAs; BirdLife International 2004)? Such questions can be applied to specific categories of birds, such as those of conservation concern, in which we include both those of global concern (IUCN 2007) and species in comparable regional categories (Bennun and Njoroge 1996). The region in this case is eastern Africa. Further, since being found in only one area is clearly risky, we also ask whether the species are known from more than one site. Analysis of atlas data shows that National Parks hold, on average, about 55 of these species, but even unprotected IBAs have an average of about 24 and hence their status requires more consideration. Eight of 46 globally threatened or near-threatened species recorded from Uganda are not known from any conservation area (Table 1) and only just over half occur in three or

Table 1: Representation of species of conservation concern at 37 key sites in Uganda. For each species, we summarise their occurrence at one, two and three or more of these sites, or none. The codes represent global (IUCN 2001) and regional (Bennun and Njoroge 1996) threat categories. G-EN = Globally Endangered; G-VU = Globally Vulnerable; G-NT = Globally Near-threatened; R-CR = Regionally Critical; R-EN = Regionally Endangered; R-VU = Regionally Vulnerable; R-NT = Regionally Near-threatened; R-RR = species of Regional Responsibility (being those with the greater part of their range within the region).

	Code	Number of species	Numbers of species at the main 37 sites recorded at:				% species at ⩾ 3 sites	No of species at other sites [a]
			0 sites	1 site	2 sites	⩾ 3 sites		
Globally threatened	G-EN	6	2	0	2	2		3
	G-VU	12	1	1	3	7		7
	G-NT	28	5	3	4	17		15
	Totals	46	8	4	9	26	57	25
Regionally threatened	R-CR	1	0	0	1	0		1
	R-EN	11	2	5	3	1		1
	R-VU[b]	51	3	3	7	38		30
	R-NT [c]	69	4	9	6	50		51
	Totals	131	9	17	17	89	68	83
Of regional concern	R-RR	53	2	8	5	38	72	35

[a]This refers to other sites in Uganda outside the main 37 sites for which records exist
[b]including R-VU/RR (regional categories as per Bennun and Njoroge 1996)
[c]including R-NT/RR

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more of the 37 areas that we consider (most of which are IBAs). With the 184 species of regional conservation concern, all but 11 occur in at least one such area, and 127 (69%) occur in three or more areas. It seems, therefore, that the species of greatest conservation concern at a regional level are well-represented in conservation areas, but this is less so for species of global concern.

Other ways in which data from the *Bird atlas of Uganda* (Carswell *et al.* 2005) are being used include analyses to compare the effects of coarser and finer scales (Fjeldså and Tushabe, 2005; McPherson *et al.* 2006; Tushabe and Fjeldså 2008) in identifying priority areas for conservation; as well as for predictive purposes. The use of these methods in conservation is being widely explored, especially for areas where resources for exhaustive inventories are scarce (such as most developing countries) and areas that are highly speciose (Gioia and Pigott 2000; Bini *et al.* 2006). Field data were unavailable from large parts of Uganda, which led the National Biodiversity Data Bank at Makerere University to develop an inductive model to predict possible areas of occupancy of a species. By employing knowledge of actual occurrences of species; and with the assumption that ecological conditions within the occupied areas are determinants of species occurrences, one can extrapolate for likely distribution ranges of species for which a substantial amount of records exist. This particular model is based on rainfall patterns and vegetation types (Figure 2). These were chosen as best predictors of bird distributions after rigorous testing of various combinations of different environmental parameters (Tushabe *et al.* 2001, Carswell *et al.* 2005).

Data for individual species can also be 'stacked' to show how whole groups are distributed. For example, Figure 3 shows the numbers of species in the two main groups of raptors that are predicted to occur in various parts of Uganda. The major savanna PAs: Kidepo Valley, Murchison Falls, Queen Elizabeth and Lake Mburo National Parks (Figure 3) are clearly valuable for raptors. Together, these areas cover some 7,000 km^2, but although that is less than half a percent of Uganda's total area, they support 39 of the 54 raptor species recorded from the country – and most of the others are vagrants. Numbers of falcon species are generally higher in areas of moist

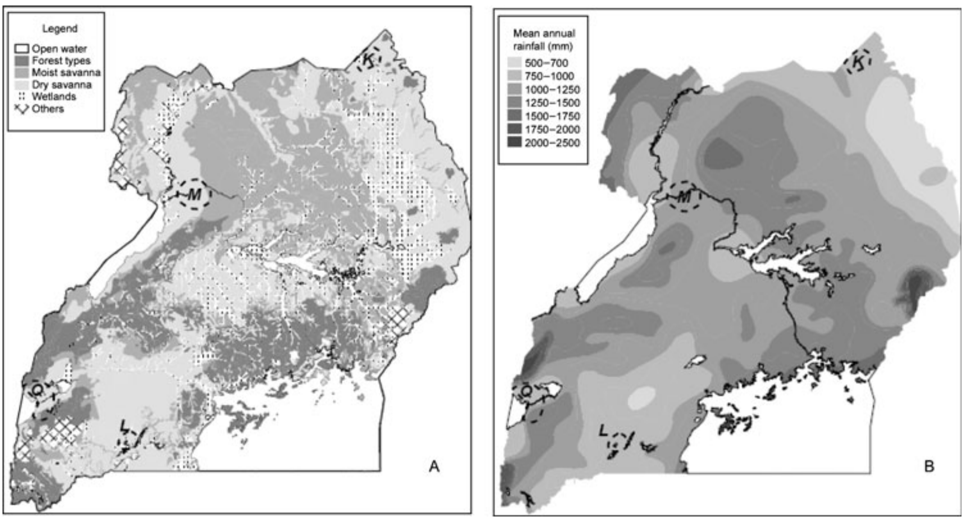

Figure 2: Maps of Uganda showing the two environmental parameters used in the modelling process. (a) Major categories of original natural vegetation according to Langdale-Brown *et al.* (1964). They are grouped to simplify representation. (b) Mean annual rainfall (mm), based on the *Atlas of Uganda* (Government of Uganda 1967). K, L, M and Q show the approximate positions of Kidepo Valley, Lake Mburo, Murchison Falls and Queen Elizabeth National Parks, respectively. These are the main savanna reserves.

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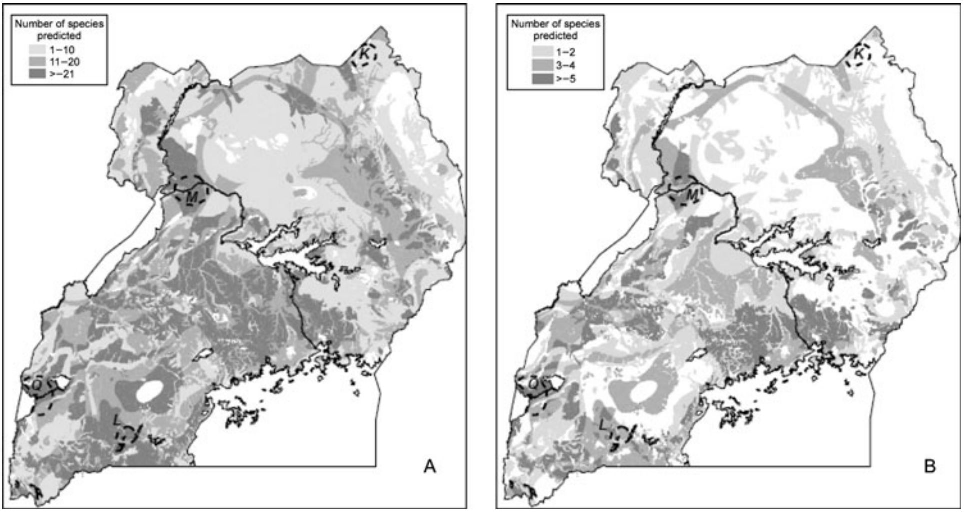

Figure 3: Numbers of raptor species predicted over Uganda, based upon a model that takes into account known distributions and environmental parameters. (a) Accipitridae, for which 2,204 records of 51 species exist. Only 46 species (with 2,192 records) qualified for the predictions due to model restrictions that require a threshold of five records per species. (b) Falconidae with 192 records of 11 species. Eight species with 183 records were used due to similar restrictions. The dotted ellipses indicate the locations of four major savanna National Parks, as in Figure 2.

savanna and forest (nowadays, typically former forest), whilst other raptors seem to prefer dry savannas, except in the north-east. The three western savanna parks (Figure 3) all correspond to areas of higher raptor densities.

There is a rapidly-growing literature on the likely changes in bird distributions as temperature and, probably more importantly for Africa, rainfall patterns change (e.g. Huntley *et al.* 2007). Several studies have already used the data from the Uganda atlas (Fjeldså and Tushabe 2005; McPherson *et al.* 2006; Tushabe *et al.* 2006)); and data georeferenced to a finer resolution are much better suited to this than grid data (Araújo *et al.* 2005; Fjeldså and Tushabe 2005; Tushabe and Fjeldså 2008).

Grid data can also be analysed, of course, as a number of papers following the South African atlases (Harrison *et al.* 1997) have shown (e.g. Fairbanks *et al.* 2001; Githaiga-Mwhicigi *et al.* 2002; Evans *et al.* 2006). Elsewhere, the relatively fine-scale mapping of birds in Britain and Ireland has been extensively analysed in relation to land-use and other factors likely to be useful in explaining observed distributions (see, for example, Atkinson *et al.* 2002; Chamberlain and Fuller 2000, 2001).

McPherson (2005) found that models, including those of Carswell *et al.* (2005) can generate good predictive maps of the distributions of African birds. But, as one might expect, the coarse-grained data of larger grids are more difficult to use than fine-grained data, particularly georeferenced points (McPherson *et al.* 2006); though the large-grid data have been shown to be useful in pinpointing areas within which conservation efforts can be concentrated (Tushabe and Fjeldså 2008). The widespread use of GIS will increasingly allow more sophisticated modelling – and more useful pointers to where interventions are most likely to benefit conservation (Burgess *et al.* 2002). Uganda is not atypical of many developing countries in having many birds but few birders, and the use of predictive models is likely to increase in importance.

High coverage, low diversity: the example of Great Britain and Ireland

Atlasing in Europe goes back to the 1950s (Gibbons *et al.* 2007), and there are now atlases for most countries, and for many smaller areas, as well as one – Hagemeijer and Blair (1997) - for the whole continent. Atlasing in Great Britain and Ireland is as advanced as anywhere in the world, with three national atlases and over 50 regional ones. A new national atlas is being developed by the British Trust for Ornithology (BTO), Scottish Ornithologists' Club and BirdWatch Ireland (Balmer 2007), and 32 English regions are also producing new local atlases, often their second. Between 1968 and 1972 field work for the first British and Irish atlas (a breeding bird atlas) was carried out, with the Atlas being published four years later (Sharrock 1976). This was the first comprehensive attempt to map the distributions of British and Irish birds, and it was based on dividing England, Ireland, Scotland and Wales into 10-km squares and recording the presence or absence of breeding species. Despite initial fears that coverage in Scotland would be no better than 25% and in Ireland even less, in the event every one of the 3,862 10-km squares in Britain and Ireland was surveyed, and the end product far exceeded the wildest dreams of the organisers. This Atlas truly set a new benchmark in the level of detail for bird maps.

In 1981–84, field work for a second British and Irish bird atlas was carried out, this time of wintering birds (Lack 1986), and mapping not only their distributions, but also their relative abundance. This was followed in 1988–91 with fieldwork for a second breeding bird atlas (Gibbons *et al.* 1993). The results were based on a fixed effort method of surveying a minimum of eight out of every 25 tetrads within a 10-km square, rather than carrying out variable effort surveys across the 10-km square as a whole. Moreover, because it was a second breeding atlas, changes in distribution from the previous atlas could be mapped and analysed (Gates and Donald 2000). The results were quite dramatic. For example, they showed that Wryneck *Jynx torquilla* and Red-backed Shrike *Lanius collurio* were nearly extinct as breeding species in Britain and Ireland, that Corncrake's *Crex crex* range was severely reduced, but that Hobby *Falco subbuteo* and Peregrine *F. peregrinus* were markedly expanding their ranges. They also showed some quite notable changes in the distributions of certain species within the four countries, e.g. Goldfinch *Carduelis carduelis* range extension into north-east Scotland, Nuthatch *Sitta europaea* colonisation of Cumbria and Northumberland, Goosander's *Mergus merganser* southward spread to Wales and south-west England. As noted in the preface ''bird distribution patterns are dynamic, changing more rapidly than was previously thought. Therefore they should be monitored more closely in future. ….perhaps (by) some kind of rolling sample survey with a selection of grid squares being monitored more often'' (Gibbons *et al.* 1993). This last suggestion was quickly acted upon, with the setting up by the BTO in 1994 of the Breeding Bird Survey (BBS), an annual breeding season survey which now extends to over 3,000 1-km squares, and which enables distribution and population trends of some 106 species to be monitored nationally (Raven *et al.* 2007)

Probably the most dramatic thing to come out of this second breeding atlas was an understanding of the full extent of the contraction in the distribution of farmland birds (such as Grey Partridge *Perdix perdix*, Corn Bunting *Emberiza calandra*, and Yellowhammer *E. citronella*; Fuller *et al.* 1995; Chamberlain and Fuller 2001). Since then BBS data indicate that the decline in farmland birds has continued, with other species, such as House Sparrow *Passer domesticus*, Starling *Sturnus vulgaris* and Dunnock *Prunella modularis*, also now seen to be in decline. Indeed so serious is the situation that agri-environment schemes have now been introduced to encourage farmers to make their habitats more wildlife friendly. (Who would have thought twenty years ago that UK farmers would be paid by their government to be good stewards of the countryside environment? Yet they now can be – which surely is one of the prime outcomes of the first two British and Irish breeding bird atlases, to which much of the credit goes).

Using the data from the second Breeding Bird Atlas, and from later surveys, action has been taken to improve the fortunes of individual species. In 1995, 26 bird species were identified as priorities in the UK Biodiversity Action Plan (UK-BAP). These species were either globally

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threatened, and/or had experienced a population decline in the UK of at least 50% in the last 25 years; 15 of them are farmland birds. Eleven years later there is definite progress on only four species, partial progress on another 11 and no progress on 10 species (the trend on Scottish Crossbill *Loxia scotica* is unknown; Eaton *et al.* 2006).

The 1988–91 Breeding Atlas also had another lasting legacy. Data collection was organised through some 143 regional co-ordinators and the amount of data collected led to most county bird clubs computerising their own records in subsequent years. In recent years this has led to the electronic interchange of some data between national organisations such as the BTO and county bird clubs, of which there are more than 50 in Britain. One particular example is the Bird Conservation Targeting Project (BCTP), led by the Royal Society for the Protection of Birds (RSPB) and comprising the BTO, Natural England, Forestry Commission, Department of Agriculture and Rural Development, and the Environment and Heritage Service. It is collecting records from county bird clubs of 28 farmland species, 21 of which also now have an individual Species Action Plan (SAP) under the UK-BAP, with a view to targeting the landowners where these species have been recorded to enter an agri-environmental scheme in order to conserve and improve the fortunes of such species. This is a powerful example of using Atlas and other national data to identify species in trouble, and then using local data to target specific conservation measures at the local level.

At a finer scale, most English counties, which are typically a few thousand square kilometres in size, have produced atlases of their own – and many are now making repeats of those. For instance, the Sussex Ornithological Society (SOS) has a database that currently holds nearly a million records of 388 bird species. This was used for the *Birds of Sussex* (James 1996) which mapped breeding species at the level of 2 x 2 km 'tetrads', rather than the 10 km level of the national atlases. It is now collecting nearly 100,000 records a year, although a majority are coming from the better birding spots in the county. As a consequence, Sussex has good records for the less common and rare species (as that is what every birder wants to see and record). But its records do not currently provide a good picture as to what is happening to some of the commoner species, several of which are now the subject of new SAPs (see above). Sussex is very conscious that despite the large number of records it receives each year it will not have a complete picture of what is happening to the distribution and abundance of each species until it completes its next major project, an atlas for 2007–11.

In 2005, the SOS decided to share most of its records with the Sussex Biodiversity Records Centre, which currently fulfils over 500 requests for data a year, mostly from developers (carrying out environmental assessments in connection with planning applications). These records are also shared with local authorities and such government agencies as the Environment Agency and Natural England. However, particularly sensitive records (such as those for some breeding raptors) have not been shared, although the SOS has indicated the general areas where such records are withheld. The result of this is that the SOS's bird records are now being used much more widely for conservation purposes than was previously possible.

Returning to the national scale, field work for a second wintering and third breeding bird atlas for Great Britain and Ireland started in November 2007 and will continue through to July 2011. This will be the first time that the distribution of winter birds will be compared with a previous atlas (the 1981–84 Atlas of Wintering Birds, *op. cit.*). Annual sample surveys such as the BBS are already indicating some of the trends in distribution that these new atlases are expected to show, but the true scale of changes in both distribution and breeding abundance will probably only be fully revealed when these atlases are completed. These data will no doubt have an important role in establishing up-to-date datasets against which the expanded UK bird BAPs can be monitored.

Discussion

One of the most useful ways of finding out how every bird species is doing, wherever it occurs, is by making and consulting atlases. Atlases therefore underpin conservation activity, highlighting the species and habitats that need special conservation attention (because you cannot conserve something unless you know where it is, how many there are, what it needs and what the threats to it are). As yet, however, many countries have still to produce their first atlas, including almost all of the high-diversity countries of the tropics. Repeat atlases are rare too: only 12% have been systematically repeated (Gibbons *et al.* 2007), although the rate of repeats in the current decade has increased markedly: Dunn and Weston (2008) report that as many as 68% of atlases in the 2000s are repeats or ongoing. The value of repeats is that they allow changes to be documented for the elapsed period. Thus, the second atlas of birds in Britain and Ireland (Gibbons *et al.* 1993) has maps of change for a large number of species over a period of about 20 years. The first repeat atlas for Africa is expected to be for southern Africa. Such atlases can be said to have a monitoring function, giving a broader perspective than the more conventional forms of monitoring and further helping to identify priorities

By far the greatest use of biodiversity databases, in addition to the production of atlases, relates to conservation planning. It has to be said that these data are used much more by conservationists than by planners, who often seem reluctant to consult them, but they are helping conservationists to add weight to their advocacy efforts. We are well aware, of course, that the scope for creating new PAs is already limited in most parts of the world, and may soon be almost finished in the more densely-populated areas. Areas of high biodiversity coincide rather well to places with dense human populations (Fjeldså and Burgess 2008; Moore *et al.* 2002), and hence to areas with reduced opportunities for creating new PAs. But even there, some scope remains for improving boundary alignments and for creating corridors. And existing PAs – especially the many unprotected IBAs – are increasingly under pressure, so that it is inevitable that some will be lost and many will suffer from degradation. Consequently, choices will have to be made as to which cases to fight – another form of prioritisation.

Analysis of the existing 'system' of PAs features in many papers (the parentheses are there because in many countries, perhaps most, PAs are where they are more by chance than by rational planning) – for example, Brooks *et al.* (2004) and Rodrigues *et al.* (2004). The latter show, rather alarmingly, that more than 105 of terrestrial vertebrate species globally are not known from any PA, and many of the rest are poorly covered. However, in Africa and many other parts of the world, survey work for atlases is patchy. Consequently, the real distributions of many species are poorly known – let alone their numbers. This is why the Uganda atlas (Carswell *et al.* 2005) has maps that show predicted distributions, believing that these give a more realistic idea of species' distributions than the actual records by themselves (although those are also shown). Predicted distributions are, of course, hypotheses, which can be tested by collecting more data and thus improving the models.

Analyses of species' distributions require data other than the presence of the species themselves. Many different variables have been used by different authors, for example rainfall, vegetation, land use, altitude and human population density (Carswell *et al.* 2005, Scharlemann *et al.* 2005). As would be expected, combinations of data from various sources can be highly beneficial (Chamberlain and Fuller 2001). From a practical point-of-view, mapping habitat suitability of target species (or communities) would seem to be desirable too, but it turns out to be harder to achieve than the mapping of species' distributions (Burgess *et al.* 2005, Rondinini *et al.* 2005). Nevertheless, as more species are modelled in more countries, the chances of filling the gaps left by those without atlases are improved. Added to this, birders are being encouraged to put their observations onto the internet when they travel the world, providing more data for poorly-recorded areas. At present, these records are generally coarse-grained, in the sense that they often consist of lists from such-and-such national park, which may cover several thousand square kilometres. We should like to suggest that travelling birders be encouraged to carry a GPS, and thus georeference their records at a finer scale.

Europe has had a continent-wide programme for monitoring and atlasing birds for many years, encouraging the use of standard, tested methods, both in the field and for analyses. Perhaps their experience could help other parts of the world to develop in comparable ways.

Some relatively recent developments can be expected to gain greater importance in the next few years. Firstly, data for groups of species, as in Figure 3 in this paper, can carry stronger messages than maps of individual species; this parallels the grouping of birds as 'farmland', 'woodland' and so on in the analysis of trends in Europe, for example, although the development of the necessary composite indices is complex (Buckland *et al.* 2005). Secondly, some atlases are now attempting to show a measure of the relative abundance of species. This appears to be a growing trend, and Gibbons *et al.* (2007) find that it is no more costly than mapping simple distributions, whilst adding much useful information.

Birds are commonly considered to be suitable surrogates for biodiversity as a whole (e.g., ICBP 1992, BirdLife International 2004), and the similarities in distributions of 'hotspots' for birds often resemble those of other taxa, as shown by congruence analyses (Burgess *et al.* 2002, 2005; Tushabe *et al.* 2006) – but not always (Araújo 2004). It is certainly the case, however, that there are far more data, and more atlases, for birds than any other group of plants or animals, and they are therefore going to be the most useful source of data for planning and many other uses for years to come. Gibbons *et al.* (2007) reported that the rate at which new atlas schemes were being initiated declined after the 1990s. However, many new local atlases are being started in the UK and we can only hope that this trend will become more widespread. Land use planning the world over is accelerating, and the need for such processes to take account of conservation concerns, based upon sound data, is obvious, even were the climate not changing. Colin Bibby would have applauded that – but he, like us, would probably have been less happy about the lack of atlases from the tropics. So we end, as we began, with a question – what can be done about that?

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