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Recent past and Future Extinctions in Birds

Colin J. Bibby

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Recent past and future extinctions in birds

COLIN J. BIBBY

BirdLife International, Wellbrook Court, Girton Road, Cambridge CD3 0NA, U.K.

SUMMARY

Most recent extinctions of birds have been caused by habitat loss or by human or introduced predators and have been on islands. Local losses of species in habitat patches are particularly prevalent amongst various specialist feeders and species occurring in small numbers. Future candidates for global extinction are hard to pick from lists of species with indicators of susceptibility. Population modelling should help, but data are generally lacking.

A review of threatened birds in the Americas shows that declines and rarity are often inferred from habitat loss and infrequent records, in the absence of quantitative data. The most threatened species often occur in very few places, where their future is likely to be determined. Safeguarding protected areas within centres of endemism offers a pragmatic response for a high proportion of globally threatened birds and probably other taxa as well.

1. INTRODUCTION

As a class, birds are second only to terrestrial molluscs in the number of known extinctions in the past few centuries (Jenkins 1992). If we understood extinction processes, we might be able to predict probabilities of future extinctions and target applied research and conservation work. Knowledge of recent past losses of species, either globally or locally, offers some understanding of extinction. Population modelling may give a more rigorous route to insight.

In this paper, I will examine the extent to which practical guidance for future actions can actually be given on the basis of these approaches.

2. PREDICTING FUTURE EXTINCTIONS

(*a*) *Recent extinctions*

About 100 bird species, or 1% of all birds, are believed to have been lost since 1600 (Temple 1985). Roughly 90% of these were island species (King 1985; Johnson & Stattersfield 1990). As reviewed by Pimm (this symposium), still more species were lost in the earlier history of human settlement before naturalists ever saw or documented them (see also Diamond 1982; Olson 1989). Milberg & Tyrberg (1993) describe over 200 extinct island species known from subfossil remains, despite the large numbers of islands yet to be explored.

Factors salient in the extinction record on islands include human predation (especially of large flightless species), introduced predators (cats, rats, dogs, mongooses, monkeys, etc.), habitat loss due to direct human impact or introduced grazers and browsers (goats, pigs, cattle and rabbits), and introduced diseases. Although many oceanic island species are already extinct, a highly vulnerable class survives on those islands which have not yet been colonized by alien predators (Atkinson 1985; Moors *et al.* 1992).

(*b*) *Local losses from habitat islands*

Comparable losses have yet to occur amongst continental species, although they are widely predicted to be imminent (see, for example, Ehrlich 1986; Myers 1989). Many species have small total ranges (about 27% of all birds have total ranges below 50 000 km^2 (ICBP 1992)). Large areas of natural habitat, most strikingly tropical forests, have been cleared in many countries. As a result, an increasing number of continental species with naturally small ranges are now isolated in shrinking habitat islands (Terborgh 1974). Factors leading to loss of local populations may not be the same as those causing global extinctions (Soulé 1983). However, many currently threatened birds are confined to dwindling numbers of local populations (see, for example, Collar *et al.* 1992). In such cases, global extinction would merely be the last of a series of losses of local populations.

Island biogeographic theory has been used to infer that fragmented habitat patches will lose species. Direct observation of this phenomenon has been made in Brazilian coastal forests (Terborgh & Winter 1980), on the artificial island of Barro Colorado (Karr 1982), and in experimentally created fragments in Brazil (Bierregaard *et al.* 1992).

Salient predictors of extinction in small habitat patches include initially small population size, vulnerability to predators, membership of specialist guilds (such as large predators, army-ant followers or mixed-species flock obligates), dependence on variably avail-

Table 1. *Changes of classification of threatened species in the Americas between 1988 and 1992 and their causes*

	number of species
listed in 1988	360
listed in 1988 but not 1992	−87
listed in 1992 but not 1988	+54
listed in 1992	327

deletions from the 1988 list	
6	species no longer regarded as valid
76	species regarded from new knowledge as 'near threatened'
5	species regarded from new knowledge as 'safe'
additions in the 1992 list	
6	species newly discovered since 1988
20	species newly erected by taxonomic split or clarification
11	species missed from earlier review
18	species reassessed as a result of better knowledge (of which 14 had been listed as 'near threatened')

able diets (such as fruits or nectar), larger members of guilds, and local catastrophes (such as hurricanes).

Vulnerability to predators is often exacerbated by the disappearance of the largest species, which in general do not prey on birds but often kill smaller predators. In their absence, smaller predators with differing diets, including birds, may become more abundant (Soulé 1983; Terborgh 1988).

(*c*) *Small population models*

Empirical observations are of limited use in making predictions, because so many species share some of the factors known to have been associated with global extinction or local losses (Simberloff 1986). Population viability analysis is a process which might help (Green & Hirons 1991). Indeed, new proposals for categorizing threatened species are based on categories of probability of extinction over given time periods (Mace, this symposium; see also Mace & Lande 1991; Mace *et al.* 1992). The interpretation of model outputs is open to various criticisms (Boyce 1992). The process requires ecological and life-history data, a reasonable model, and insight into the factors which might change in the future, either naturally or within a management régime.

For such models to be of practical use, we usually require data about most of the following processes: reproductive rates and their variances; survival rates and their variances; density-dependent relations for survival and reproduction; frequency of catastrophic events and their impact; carrying capacities of habitats and their variances; and dispersal rates between subpopulations.

There is a serious practical difficulty in obtaining many of these measures, but a move to greater formality would be a great aid in focusing scientific attention on the kinds of data most urgently needed to improve the chances of success of a management plan.

3. RED DATA BOOKS

(*a*) *The basis of red lists for birds*

As discussed in more detail by Mace (this symposium), one approach to predicting which species are at risk of extinction has been the IUCN-promoted red lists. These have reached their greatest elaboration for birds, which are the only class for which all species have been reviewed and classified as 'threatened', 'near threatened' or 'safe' (Collar & Andrew 1988). In the case of Africa (Collar & Stuart 1985) and the Americas (Collar *et al.* 1992), extensive literature reviews have been published. We might ask how accurate these lists are in predicting future candidates for imminent extinction.

Threatened species of the Americas, including the near Pacific islands and the Caribbean, have been listed five times (Anon 1964; Vincent 1966–1971; King 1981; Collar & Andrew 1988; Collar *et al.* 1992). Over the last 30 years, the list has expanded fivefold, with most of the growth being in continental South America.

By 1988 the list for the Americas had grown to 360 species. This list was reviewed in greater depth leading to the 1992 publication (Collar *et al.*). These two most recent reviews differ by 141 species (table 1). Some (24) of the changes were due to taxonomic alterations or discoveries. In general, the consultative process producing the 1988 list tended more towards precautionary listing of species than to omission of candidates found, on fuller study, to be valid (N. J. Collar, personal communication). Of 29 species entering the threatened list for the first time in 1992, 14 had previously been indicated as near threatened, and only 15 had been inappropriately, as revealed by fuller review, omitted or overlooked.

The general similarity of these two most recent listings suggests a convergence of opinion on which the threatened species are. Erroneous judgement is clearly less likely if population parameters of species are adequately documented (King 1987). Despite a huge upsurge of ornithological interest in Latin America, the state of knowledge of many birds remains poor, as shown by Green & Hirons (1991).

Of the three parameters considered, range tends to be best known, but many species have been recorded from rather few localities, and can only be presumed to occur in nearby areas of similar habitat (if there are any surviving). Less than a quarter of threatened species have been subject to any formal counting. The majority are inferred to be rare because they have infrequently been seen within what are often known or inferred to be very limited ranges. Not surprisingly, formal estimates of population trend are still less common because even fewer species were counted 20 years ago. The most frequent pattern of trend is that numbers are inferred to be declining because of habitat loss, which has often been very extensive within known ranges.

There is some relation between quality of knowledge and category of threat (table 2). A slightly higher proportion of endangered species are relatively well known, but this is primarily because of the inclusion of some very thoroughly studied North American species. However, ten endangered species are virtually unknown. Species categorized as rare are often better known, but the causation may be that they have to be reasonably well known before they can be classified as rare rather than insufficiently known.

(*b*) *Recommendations from red data books*

The recommended actions from *Threatened birds of the Americas* are summarized in table 3. Within the divisions made, there are, in total, 1045 recommendations for 327 species. A high proportion (71%) concern a set of four site-specific actions (find new sites, protect sites, manage them, and enumerate populations within them). For only five species do the recommendations include no site-based actions. Species were classified according to degree of threat and reasons for the assessment (see Collar *et al.* 1992). Recommended actions tend to be rather similarly distributed according to threat class ($\chi^2 = 77.0$; d.f. $= 55$).

The cause of such results is that the most frequent pattern for threatened birds in Latin America combines limited distribution, dramatic habitat loss and limited protection of representative areas of the habitat. Minimum conservation measures in such circumstances entail finding populations if the locations of few (or none) are known, followed by protection of viable populations in representative sites. Because numbers are so rarely known, there is a major challenge to survey the threatened species in protected areas as a first step towards establishing whether populations are likely to be viable. Ecological study might assist the management process in protected areas by diagnosing causes of decline and suggesting remedies.

The tropical pattern of risk of extinction differs from that in northern temperate latitudes where, both absolutely and relative to the smaller avifaunas, fewer species are globally at risk. The few that are globally threatened have often been recorded as declining over long periods of time.

4. BIODIVERSITY APPROACHES

The fact that so many threatened species have very limited ranges leads to the obvious priority for identifying and protecting the uniquely important sites where they occur (Terborgh & Winter 1982). In a global study (ICBP 1992), we have shown that 27% of all birds on Earth (2609 species) have breeding ranges of less than 50 000 km^2. There is a high degree of overlap among these ranges which have been classified into 221 distinct areas of endemism, each with at least two unique restricted-range species. By this definition, Endemic Bird Areas (EBAs) embrace about 5% of the Earth's land surface and uniquely accommodate 2484 (95%) restricted-range birds.

In the continental Americas with their nearby islands (the area covered by Collar *et al.* 1992), 81 EBAs occupy just over 3 million km^2 embracing the full range of 999 bird species. Of these restricted-range species, 253 are listed as threatened. This amounts to 77% of the threatened birds of the region.

In addition, a further 52 threatened species with ranges greater than 50 000 km^2 also occur in EBAs (table 4). Thus the future of 90% of the threatened birds of the Americas could largely be determined by the sustained existence of sufficient natural habitat in these EBAs. Of the species not embraced by EBAs, 17 have limited ranges not coincident with other such species, and four are seabirds in need of protection at their limited breeding sites. Thus these 21 species could also largely be safeguarded by appropriate actions in very limited areas. Of just 16 remaining widespread and threatened species, seven occur in U.S.A.

The potential efficiency of managing threatened species by conservation policy in EBAs can be illus-

Table 2. *Distribution of quality of knowledge of threatened species in the Americas (1992) in relation to threat class*

	quality of knowledge					
class of threat	0	1–3	4–6	7–9	mean	*n*
endangered	10	32	36	18	4.1	96
vulnerable	4	24	21	3	3.4	52
vulnerable–rare	1	35	37	6	3.8	79
indeterminate	10	26	12	2	2.6	50
rare	1	4	8	6	5.2	19
insufficiently known	2	20	8	1	2.6	31
total	28	141	122	36	—	327

Table 3. *Frequency of classes of recommendations made for the conservation of 327 threatened bird species in the Americas*

action	number of species
secure sites	241
locate new sites	214
estimate populations in sites	197
study ecology	164
manage sites	91
control taking	49
educate people	44
captive management	23
taxonomic study	8
other	14

Table 4. *Occurrence of threatened birds in the Americas in relation to range and Endemic Bird Areas (EBAs)*

distribution	*n*
restricted range and solely in EBAS	237
restricted range occurring singly	18
range $> 50\,000$ km^2 but occurring in EBAS	52
others (4 seabirds, 7 U.S.A. and 9 South American species)	20
total	327

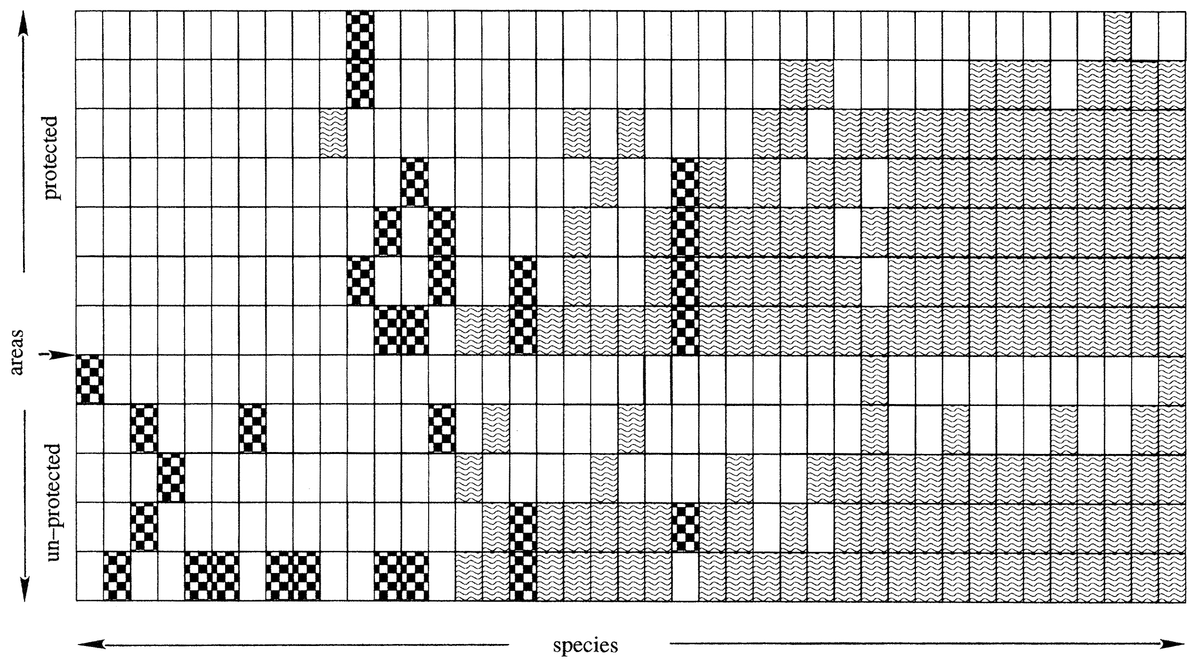

Figure 1. Occurrence of 41 species endemic to the Albertine Rift Mountains in relation to 12 subdivisions of the region. Threatened species are hatched in bold.

trated by the areas involved. If attention was given to threatened species, all 253 are confined to 2.2 million km^2, but 209 to only 1 million km^2.

The extent to which individual threatened species with restricted ranges are found in protected areas is one measure of the degree to which their poor conservation status has been recognized and acted upon. However, if such species do not occur in protected areas, it is very likely that other elements of biodiversity, both species and communities, will also be unprotected. Knowledge of the distribution of threatened species can thus be used to assess the degree to which they are threatened, and also the adequacy of existing networks of protected areas.

An example is shown in figure 1. The Albertine Rift Mountains in central Africa have 41 endemic birds and can be divided into 12 separate areas of surviving forest, of which seven enjoy some formal protection. Not surprisingly, the 15 threatened species are still less widespread than the other local endemics, occurring, on average, in only two areas each. At the moment, nine threatened species do not occur in a protected area at all. Had the protected areas been chosen differently, a set of five would have been sufficient to secure at least one place of occurrence for all the threatened species. Four of these five are the unique locations for one threatened species each and are not currently protected.

5. DISCUSSION

Evidence from previous extinctions, losses from habitat fragments, and population modelling all point to small populations and losses of habitat as recurring themes on the road to extinction. Birds with these features can be identified fairly readily and include about 10% of all the world's species. The impact of stochastic variation on extinction risk is clear from modelling and from observed losses from habitat fragments. It is rather unclear how vulnerable most particular species or habitats are to stochastic variation beyond the observation that fruit and nectar feeders are vulnerable. Both modelling and observation point to the devastating potential of catastrophic events. With the exception of hurricanes, it is difficult to see how to anticipate the identity of most possible catastrophes, let alone their probability. This is most evident in the case of islands. If the predator-vulnerable species still survive, there is a perpetual risk of accidental introductions. The impact of an alien snake on Guam (Savidge 1987) shows how steep the slope to extinction can be. Only perpetual precaution and vigilance can lower the chances of such disaster and warn of the need for urgent action should it occur. Clearly, the warning time can be very brief.

The coincidence in range of many rare species argues strongly for the identification, designation and adequate protection of representative areas. Systematic review of the threatened birds of the Americas (Collar *et al.* 1992) provides very clear indication of priority species and places to start such a search. A further analysis (Wege & Long 1994) portrays these priorities with a clearer geographic rather than species-based emphasis.

Evidence reviewed by Thirgood & Heath (1994) points to the strong likelihood that centres of endemism for birds will be centres of endemism for other taxa at a broad scale. There is a striking, but not complete, similarity between the formally identified Endemic Bird Areas and centres of plant diversity which have been identified semi-formally (Anon 1992; Davis & Heywood 1994). Although we might aspire to a great increase in knowledge of bird species in the next few years, this is optimistic for the majority of the world's other species which may not be identified for a few hundred years. The use of indicator species from other taxa would be a prudent approach to identifying gaps in protected area coverage missed by ornithologists.

Although the majority of species which have so far been driven to extinction would always have been relatively rare by virtue of limited range, and particularly vulnerable because threats could have operated throughout their small ranges, some spectacularly abundant species (e.g. passenger pigeon *Ectopistes migratorius*, Carolina parakeet *Conuropsis carolinensis*) have also been exterminated. Concentration on species at risk of extinction also ignores the progressive erosion of biodiversity represented by the reduction of range and numbers of many species. Imboden (1987) and Diamond (1987) have therefore proposed the green listing of those species which are ubiquitous and tolerant of habitat modification. Greater attention to the factors causing the unfavourable conservation status of many species not yet globally threatened would potentially prevent inexorable growth of the globally threatened list. Such an approach has been taken in Europe, where nearly half of all species have an unfavourable conservation status, although rather few of them are currently at risk of global extinction (Tucker *et al.* 1994). It would be wise to review the conservation status of all the world's birds, and draw attention to widespread declines as well as risk of extinction.

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