Extinction risk assessment for birds through quantitative criteria

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The system used for classifying species according to their risk of extinction in international Red Lists is currently being revised by the International Union for Conservation of Nature. The proposed system is based around a set of quantitative criteria and aims to provide a more explicit and objective method that can be applied across a wide variety of living forms. The first major application has been in the preparation of a new edition of Birds to Watch, a summary of threatened bird species at a global level, by BirdLife International. An analysis of the classification of bird species in this publication indicates that the proportion of birds thought to be threatened varies across regions from about 14% in New Zealand and 12% in Africa down to only 3% in Europe. There are some significant differences among regions in the kinds of criteria that lead to threatened listing, with continuing or expected declines in numbers or habitat being especially significant in Africa and Europe.

Over the last 30 years, the global assessment of threatened status in the International Union for Conservation of Nature’s (IUCN) Red Data Books (e.g. for birds: King 1978–1979, Collar & Stuart 1985, Collar et al. 1992) has been intended to draw attention to the extinction risk faced by many species and to direct conservation action appropriately. However, the process for deriving threatened species lists has continued to evolve both methodologically and practically. In this article we outline proposals for category definitions and for quantitative criteria that are now being considered for general adoption by IUCN. We then present some preliminary results from their application to the bird faunas of Europe, Africa and Australasia.

THE RISE AND FALL OF QUALITATIVE CRITERIA

The first attempts to identify threatened species for IUCN took place soon after the organization was founded in 1948. At IUCN’s Third General Assembly in Caracas in 1952, the Venezuela Section of the International Council for Bird Preservation (ICBP) proposed that the Red Siskin Carduelis cucullata be formally recognized as a threatened species (see Collar et al. 1992), although for the next 10 years the only “list” to which it or any bird could be admitted was the one published in each occasional Bulletin of ICBP (VII: 131–148, VIII: 72–76, IX: 78–101). Moreover, these lists depended on nominations from the constituency of ICBP rather than on any systematic review of candidates around the world.

In the early 1960s, IUCN launched its programme of Red Data Books, beginning with mammals and birds, later adding reptiles and amphibians, flowering plants and freshwater fishes (see Scott et al. 1987). From the outset there were various attempts to discriminate degrees and types of endangerment, although the earliest books used only two categories (Rare and Endangered), with asterisks for emphasis (see Munton 1987). By 1980, when IUCN’s Species Survival Commission (SSC) established its Conservation Monitoring Centre (CMC) in Cambridge, U.K., the situation had largely stabilized with a qualitatively defined set of five categories (Endangered, Vulnerable, Rare, Indeterminate, Insufficiently Known) (see IUCN 1994).

Although several Red Data Books emerged from CMC in the early 1980s, the value and viability of the operation were already in question. The World Conservation Strategy (IUCN/UNEP/WWF 1980) had heavily committed conservation to the service of development, inevitably raising doubts about the relevance of the type of work undertaken by CMC. After 1985, the Red Data Book programme effectively ceased (except for birds, where ICBP maintained the work independently) and persists today mainly with the occasional IUCN Red List (IUCN 1988, 1990, 1994).

With the loss of the Red Data Book compiler, the problem of identifying and categorizing threatened species merely intensified. Compilers had practised in a role akin to doctors or magistrates, interpreting the category definitions and the evidence from individual case histories to arrive at relatively consistent professional judgements. Now the SSC had to turn to its various specialist groups to undertake the identification and classification (though not the documentation) of threatened species that the compilers had previously done.

However, it was quickly realized that the vagueness of the categories, when coupled with the number of people now eligible to apply them, allowed enormous scope for inconsistency (particularly without accompanying documenta-
tion, which essentially justifies the listing to the wider world). The sometimes tautological, tentative and contradictory wording of the definitions represented a liability that could devalue the listings. A new system of categorization was needed, therefore, to keep to a minimum the subjectivity and lack of accountability of the new mode of working.

In 1988, SSC began a review of the ways in which the IUCN categories could be rendered more transparent and objective. This resulted in a proposal to develop numerical criteria that reflect stepwise increases in the probability of extinction based on measured or reasoned rates of decline, population levels and range sizes. After a considerable period as a consultative draft, this first proposal was published by Mace and Lande (1991). Despite clear warnings in the paper that the proposals it contained were intended for further discussion and refinement, they were quickly adopted for standard use by SSC's Captive Breeding Specialist Group in workshops aimed at assessment and conservation planning for whole families or orders (Conservation Assessment and Management Plans [CAMPs]; see Seal et al. 1994). Consequently, this system has achieved almost official status in some sectors of SSC.

Nevertheless, other conservationists detected flaws and incompleteness in the system. There was some resistance to numerical thresholds of any kind, but a far commoner concern was that the system was insensitive to various types of extinction risk and various types of biological circumstance affecting diverse taxa. The wave of commentary and criticism that overtook SSC in the year following publication of Mace & Lande (1991) led to a workshop in London, in November 1992, involving 30 conservation biologists and managers from around the world. They attempted to identify every possible problem in classifying extinction probabilities, from the perspective of the largest sea mammals with their massive ranges, long life spans and controversial exploitation potential, through rain-dependent plants that remain undetected for decades between flowerings, down to the humblest invertebrate known only from a single cave in the Alps.

A committee was established following the workshop to weigh up the arguments and counter proposals, and its recommendations were published the following year (Mace et al. 1992). (The date of publication is misleading, as it was only submitted in March 1993 and appeared 2 months later.) This proposal soon generated a new wave of commentary, although this time the feeling was generally more receptive and confident. In the summer of 1993, the SSC committee went over the accumulated response, running to many hundreds of pages, and met repeatedly throughout the autumn to prepare its final recommendations. These were submitted to SSC in November 1993. This proposal was the subject of a resolution passed at the IUCN General Assembly in January 1994, which recommended that, following a period of final review and validation, the new system should be implemented.

The resulting proposals show one clear merit of the system they are intended to replace: its brevity. Where the old categories can be displayed in full in a single short table, the new system, including an outline of certain principles, some definitions and the criteria themselves, runs to 12 pages. This is, however, an inevitable result of any attempt to give structure and form to very general principles, with the incorporation of such difficult concepts as range size, subpopulation, location and generation.

**THE NEW DRAFT IUCN THREATENED SPECIES CRITERIA**

In the new system, the threatened species categories fall within a broader framework that should permit the classification of all species (Fig. 1). This clarifies the position of species that are not listed as threatened by dividing them into those that have simply not been evaluated, those for which there is no information available to assess the degree of threat and those that are not threatened according to the new criteria. Previously, the status of unlisted species had not always been clear.

Three threatened categories are now proposed: Critical, Endangered and Vulnerable. These form a continuum of decreasing likelihood of extinction over increasing time periods. Unlike the current IUCN categories, the new categories describe a single variable, the likelihood of extinction.

The threatened categories are evaluated using a set of quantitative criteria. For each category there are five different criteria, and satisfying any one (or more) qualifies the species for listing at that level. The categories are nested: all Critical species will qualify for Endangered, and all Critical and Endangered species will qualify for Vulnerable.

The five quantitative criteria for each category deploy a
Table 1. Summary of classifications of bird species in four regions. The information in this table is extracted from Collar et al. (1994) and Tucker et al. (1994). The categories in each column are defined in the Appendix.

<table>
<thead>
<tr>
<th>Region</th>
<th>Approximate number of species evaluated</th>
<th>Number Data Deficient</th>
<th>Number threatened (% of total)</th>
<th>Number Conservation Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>1700</td>
<td>6</td>
<td>207 (1.2)</td>
<td>0</td>
</tr>
<tr>
<td>Australia</td>
<td>750</td>
<td>3</td>
<td>51 (7)</td>
<td>7</td>
</tr>
<tr>
<td>New Zealand</td>
<td>290</td>
<td>0</td>
<td>42 (14)</td>
<td>1</td>
</tr>
<tr>
<td>Europe</td>
<td>510</td>
<td>1</td>
<td>20 (4)</td>
<td>3</td>
</tr>
</tbody>
</table>

For extremely poorly known species it may not be possible to make a reliable classification. The category 'Data Deficient' may then be applied. This category falls outside the threatened species classification (Fig. 1), indicating that until further information is forthcoming such species cannot be judged on their conservation status. To be precautionary, such species might be afforded the same kind of protection as threatened forms, at least until their status can be assessed.

Table 2. The global threat status of birds in Europe. The table lists the criteria by which the different species qualified as threatened (see Appendix) as well as their status in terms of category of threat (CR, Critical; EN, Endangered; VU, Vulnerable).

<table>
<thead>
<tr>
<th>Species</th>
<th>Criteria met</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fea's Petrel Pterodroma feae</td>
<td></td>
<td>CR</td>
</tr>
<tr>
<td>Zino's Petrel Pterodroma madeira</td>
<td></td>
<td>VU</td>
</tr>
<tr>
<td>Dalmatian Pelican Pelecanus crispus</td>
<td></td>
<td>VU</td>
</tr>
<tr>
<td>Lesser White-fronted Goose Anser erythropus</td>
<td>A1a</td>
<td>VU</td>
</tr>
<tr>
<td>Red-breasted Goose Branta ruficollis</td>
<td>A2b,c</td>
<td>VU</td>
</tr>
<tr>
<td>Marbled Teal Marmaronetta angustirostris</td>
<td>A2b</td>
<td>VU</td>
</tr>
<tr>
<td>Ferruginous Duck Aythya nyroca</td>
<td>A1a,b,c</td>
<td>VU</td>
</tr>
<tr>
<td>White-headed Duck Oxyura leucocephala</td>
<td>A2d</td>
<td>VU</td>
</tr>
<tr>
<td>Steller's Eider Polystica stelleri</td>
<td>A1a</td>
<td>VU</td>
</tr>
<tr>
<td>Greater Spotted Eagle Aquila clanga</td>
<td>C2a</td>
<td>VU</td>
</tr>
<tr>
<td>Spanish Imperial Eagle Aquila adalberti</td>
<td>A2b</td>
<td>VU</td>
</tr>
<tr>
<td>Imperial Eagle Aquila heliaca</td>
<td>C2a</td>
<td>VU</td>
</tr>
<tr>
<td>Lesser Kestrel Falco naumanni</td>
<td>A1a,b,d</td>
<td>VU</td>
</tr>
<tr>
<td>Corncrake Crex crex</td>
<td>A1a,b</td>
<td>VU</td>
</tr>
<tr>
<td>Great Bustard Otis tarda</td>
<td>A2b</td>
<td>VU</td>
</tr>
<tr>
<td>Sociable Plover Chettusia gregaria</td>
<td>A1a,b</td>
<td>VU</td>
</tr>
<tr>
<td>Slender-billed Curlew Numenius tenuirostris</td>
<td>C1,2a</td>
<td>CR</td>
</tr>
<tr>
<td>Dark-tailed Laurel Pigeon Columba bollii</td>
<td>C2a</td>
<td>VU</td>
</tr>
<tr>
<td>White-tailed Laurel Pigeon Columba junoniae</td>
<td>C2a</td>
<td>VU</td>
</tr>
<tr>
<td>Aquatic Warbler Acrocephalus paludicola</td>
<td>A2b</td>
<td>VU</td>
</tr>
</tbody>
</table>

Conservation Dependent species
Audouin's Gull Larus audouinii
Long-toed Pigeon Columba trocaz
Blue Chaffinch Fringilla teydea

Data Deficient species
Scottish Crossbill Loxia scotia
Species that do not qualify for any of the threatened categories (and are not extinct) are classified into one of two categories: Low Risk or Conservation Dependent. The latter is a category for species that would qualify for one of the categories of Critical, Endangered or Vulnerable if continuing conservation measures aimed at their protection were to cease. Commonly, these are species which have declined markedly in the past but are now held at some lower but stable level by specific conservation measures.

Many species will qualify for the Low Risk category, which will include a wide range of possible types. For particular purposes, it may be appropriate to distinguish species within this category that are close to qualifying as threatened from those that are widely distributed and abundant. However, this classification is not formally specified.

APPLICATION OF THE NEW CRITERIA TO BIRDS

In reviewing globally threatened birds for an update of Birds to Watch (Collar & Andrew 1988), BirdLife International (formerly the International Council for Bird Preservation) has been applying the new criteria to bird species at the global level. Birds to Watch is not a classic Red Data Book containing exhaustive reviews of species information. Rather, it is an abbreviated version that relies on a reasonably broad set of standard references and modern sources from which single-paragraph entries on individual species (addressing four variables: range, population, habitat and threats) can be composed.

Methods

The new edition of Birds to Watch (Collar et al. 1994) has to date applied the new criteria with the intention of identifying threatened species. Threatened species are defined as those that (at least) meet the criteria for the lowest category, Vulnerable (see Appendix), and each species entry ends with a list of the (up to five) quantitative criteria (A–E) that are met. Conservation Dependent and Data Dependent species are treated in the same degree of detail but in a separate section. The review of birds being total, the category of Not Evaluated becomes redundant.

Although the new edition has (at April 1994) the species accounts largely unchecked and unreviewed, and any analysis must remain extremely preliminary and tentative, it is possible to search for some general trends. Using the first drafts for three regions (Europe, Africa and related islands, and Australia with New Zealand), we analysed the distribution of threatened species and those qualifying for Conservation Dependent and Data Deficient. We also examined the contribution of the different criteria (A–E) to threatened classifications among the different regions. Information on European species used in Birds to Watch and included in this analysis has been derived partly from parallel research by BirdLife International (Tucker & Heath 1994).

Results

Over 3000 species have been considered in this analysis, but only eight are Data Deficient (i.e. unclassifiable because of a lack of information) (Table 1). Of the remainder, the proportion classified as threatened varies across the different regions from a maximum of 14% in New Zealand down to 4% in Europe. There is a small change (about 8%) in birds classified as threatened from compilations made using the existing criteria. There are no Conservation Dependent species in Africa, only eight in total in Australia and New Zealand and three in Europe (Table 1).

In the African and the Australasian threatened lists, just over 50% of species qualifying for Vulnerable did so by meeting just one criterion, about 30% met two criteria and 15–20% met three. In the African set of species, six species (3%) met four criteria. The criterion E (see Appendix) was applied very rarely and has been omitted in this analysis. With the exception of three species which qualified on two criteria, all the European threatened species met just one criterion for Vulnerable (or a higher threat category) (see Table 2).

In Africa, Australia and New Zealand, the commonest criterion met was C (small population size associated with decline, fragmentation or single location) (Fig. 2). Qualification through restricted range or habitat area associated with continuing decline (criterion B) was also common. The distribution of criteria is similar across these regions except that a very rapid observed or projected decline (criterion A) was significantly commoner in the African region than in Australia and New Zealand (12% v 4%; \( \chi^2 = 6.55, P < 0.01 \)).

In contrast, most (11 out of 18) European threatened species were classified as threatened on the basis of observed or projected decline rates, eight of them on this criterion only. The restricted range size criterion for Vulnerable (criterion B) was met in only one case.

Discussion

Birds are a relatively well-known group because of their high detectability, and, as Table 1 shows, a comprehensive analysis can be undertaken. Very few are so poorly known that they cannot be classified, at least in the subset of regions discussed in this paper, and the low number classified as Data Deficient is not surprising. The overall proportion classified as threatened (320 out of approximately 3250; Table 1), about 10%, is similar to the 11% reported under the IUCN (1990) category definitions (Collar & Andrew 1988). The species listed as threatened are generally the same as those in Birds to Watch (Collar & Andrew 1988), with some being de-listed and others added. For the most part, the changes result from changing circumstances and not from the application of new criteria. This has not always been the case, and for some higher taxonomic groups the application of the new criteria has both increased the number listed as threatened and resulted in more substantial changes in the set of species listed (Mace 1994). The levels set for the new
Figure 2. The number of species within four geographical regions which qualified for threatened status by each of the criteria A-D (see Appendix and text for details). In many cases species qualified by meeting more than one criterion.

criteria therefore appear comparable to more subjective interpretations of threatened status under the existing system. Across the different regions threat levels vary, and in particular there are relatively few globally threatened birds in Europe (Table 1).

The different criteria for threatened status all play a role. For birds it is not surprising that the criteria including estimates of population size (C and D) are commonly invoked. It was anticipated in the drafting of the criteria that C and D would be especially appropriate for vertebrates and that distribution-based criteria would be more applicable to taxa, such as some plants and invertebrates, where available habitat is a more practical and reliable measure of extinction risk (Mace 1994). In the bird species examined here, qualifications under criteria B and C were closely correlated, though this will not always be the case in other taxa.

The differences in criteria among regions are also perhaps not surprising, but they may convey important conservation messages. For example, the fact that African species are more commonly threatened through observed or projected rapid declines in either numbers or range than are the Australasian species (criterion A; Fig. 2) is undoubtedly a result of habitat changes—most importantly, deforestation—resulting from human population pressures on that continent. Many tropical species of birds have generation times of close to 10 years (some even longer); hence, over five generations they can easily be expected to lose 50% of their total population or habitat (see Vulnerable criteria in the Appendix).

Of the 11 European species classified as threatened on the basis of criterion A (rapid observed or projected decline rate), seven showed an observed decline, yet often no obvious cause can be identified. The high frequency of rapid declines in European species seems likely to reflect the activities of man in temperate latitudes. It seems still more likely, however, that similar declines are occurring in the tropics but go undetected owing to lower monitoring levels. Two species (Corncrake Crex crex and Sociable Plover Chettusia gregaria) are included in the threatened lists because transect work done in the U.S.S.R. in the 1960s compares very unfavourably with the results of similar work undertaken in recent years (Collar et al. 1994; Tucker & Heath 1994). There is also a high proportion of migratory species in the threatened list. Only three (Spanish Imperial Eagle Aquila adalberti, Dark-tailed Laurel Pigeon Columba bolii and White-tailed Laurel Pigeon C. junoniæ) are year-round residents, while seven are partial migrants and ten are full migrants. Two of the three Conservation Dependent species are resident, the other is a partial migrant and all owe their status to conservation measures enacted in Spain and Portugal. Finally, only one of the 20 threatened species and only one of the three Con-


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servation. Dependent species is a passerine. This is quite different from the proportion in Africa where over two-thirds of the threatened species are passerines. This finding may be associated with the low representation of restricted-range endemics in Europe (ICBP 1992) and the fact that many smaller temperate species, such as passerines, tend to have large ranges.

CONCLUSIONS

One of the main aims in the development of new threatened species criteria was to make the listings of species more objective and transparent. The analysis by Collar et al. (1994) represents one of the first large-scale applications of the proposed system, facilitating comparisons across higher taxa and across regions. Moreover, the listing of criteria as shown in Table 2 indicates clearly the reasons for including particular species; therefore the categories allocated are open to discussion and to further refinement. For birds, at least, the system appears to be relatively robust and practical.

Apart from facilitating the systematic collection and comparison of information on conservation status across species from widely differing taxonomic groups, use of the new criteria will have other consequences. In particular, the emphasis on quantitative information should stimulate the collection and dissemination of basic information on threats, status, distribution and population size and structure. All of these are important for conservation planning and not just for documenting threat levels.

We particularly thank A. J. Stattersfield for comments and ideas that clarified points in this review. We are also grateful to contributors for BirdLife International’s forthcoming publication Birds in Europe: Their conservation status, especially authors O. M. Tucker and M. F. Heath, for access to their information and the preparation of Table 2. G.M.M. is grateful to the Pew Scholars Program in Conservation and the Environment for financial support.

REFERENCES


APPENDIX

Criteria for the category Vulnerable used to identify threatened status by Collar et al. (1994), the lowest of the threat categories defined in the new draft IUCN threatened species classification. Note that the definitions and criteria presented here are for general information only and should not be applied without reference to the accompanying notes and definitions.

Vulnerable

A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the following criteria (A–E):

(A) Population reduction in the form of either of the following:

(1) An observed, estimated, inferred or suspected severe decline of at least 50% during the last 20 years or five generations for which data are available, based on (and specifying) any of the following:

(a) direct observation;

(b) a decline in area of occupancy, extent of occurrence and/or quality of habitat;

(c) actual or potential levels of exploitation;
(d) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

(2) A severe decline, of at least the rate specified in A1, that is projected, observed, inferred or suspected to be likely to occur in the near future, based on (and specifying) any of (b), (c) or (d) above.

(B) Extent of occurrence estimated to be less than 20,000 km² or area of occupancy estimated to be less than 2000 km², and estimates indicating any two of the following:

(1) Severely fragmented or found at no more than ten locations.

(2) Continuing decline, inferred, observed or projected, in any of the following:
   (a) extent of occurrence;
   (b) area of occupancy;
   (c) area, extent and/or quality of habitat;
   (d) number of locations or subpopulations;
   (e) number of mature individuals.

(3) Extreme fluctuations in any of the following:
   (a) extent of occurrence;
   (b) area of occupancy;
   (c) number of locations or subpopulations.

(C) Population estimated to number less than 10,000 mature individuals and either

(1) An estimated continuing decline of at least 20% within 10 years or three generations, whichever is longer, or

(2) A continuing decline, observed, projected or inferred, in numbers of mature individuals and population structure in the form of either
   (a) severely fragmented (i.e. no population estimated to contain more than 1000 mature individuals);
   (b) all individuals are in a single sub-population.

(D) Population very small or restricted in the form of either of the following:

(1) Population estimated to number less than 1000 mature individuals.

(2) Population is characterized by an acute restriction in its area of occupancy (typically less than 100 km²) or in the number of locations (typically less than five). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

(E) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.