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The value of the IUCN Red List for conservation

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The IUCN Red List of Threatened Species is the most comprehensive resource detailing the global conservation status of plants and animals. The 2004 edition represents a milestone in the four-decade long history of the Red List, including the first Global Amphibian Assessment and a near doubling in assessed species since 2000. Moreover, the Red List assessment process itself has developed substantially over the past decade, extending the value of the Red List far beyond the assignation of threat status. We highlight here how the Red List, in conjunction with the comprehensive data compiled to support it and in spite of several important limitations, has become an increasingly powerful tool for conservation planning, management, monitoring and decision making.

Renowned but misunderstood

The IUCN Red List of Threatened Species (henceforth 'Red List'), produced by the Species Survival Commission (SSC) of the World Conservation Union (IUCN; http://www.iucn.org), highlights species that are at the greatest risk of extinction and promotes their conservation by 'concentrating minds on true priorities' [1]. The evolution of the Red List over the past decade (in response, in part, to previous criticisms; e.g. [2,3]) has been complemented by increased recognition and use (e.g. citations in peer-reviewed journals increased from two in 1994 to 283 in 2004*). Too often, however, real understanding of the advancement of the Red List has lagged behind its increased profile. For example, it is often assumed that Red List classifications are still based solely on expert opinion, that the Red List is simply a classification of species into threat categories, or that too few species have been assessed to make it a useful tool for understanding patterns of, and threats to, biodiversity (e.g. [4]). These impressions have sometimes become obstacles to the use of an extremely valuable conservation tool [5].

Here, we provide an overview of the Red List with the aim of dispelling common misconceptions about it, and highlight some of the important ways in which it is being, and can be in the future, appropriately applied to conservation. This is particularly timely given that the recent World Conservation Congress passed a resolution (RESWCC3.013) mandating the development of uses of the Red List for national legislation, international conventions, conservation planning and scientific research [6].

Beyond subjective expert opinion

The first Red List assessments relied on the experience and common sense of experts, without following a protocol, as it was assumed that 'any competent naturalist would have known the category to place a species in' [7]. Although the idea of having experts assessing the conservation status of a species was revolutionary at the time, the subjectivity of these assessments (open as they were to biases of individual preference or political influence) was subsequently realized (e.g. [2–4,8]).

Over the past decade, the nature of the assessments has changed dramatically, with the implementation of data-driven and objective criteria for estimating extinction risk. The new criteria were introduced after a long phase of development, consultation and validation across a broad range of species [8–10]. Although the opinions of species experts are no longer used to categorize the threatened status of species subjectively, experts retain integral roles through the compilation and review of the primary data required to allocate each species into a category (Table 1). The listing criteria are clear and comprehensive (Table 1), but flexible enough to handle uncertainty [11]. Assessments must be backed up by data, justifications, sources and estimates of uncertainty and data quality. Evaluated species for which insufficient data are available to make an assessment are classified as Data Deficient. Species assessments are compiled from published and unpublished information and typically include expert input by one or more 'assessors'. The assessments are peer reviewed by at least two 'evaluators' assigned by the relevant 'Red List Authority' (established for taxonomic groups; typically the corresponding IUCN-SSC Specialist Group). The results are checked for consistency among regions and taxa by the Red List Programme Office, and all specialists involved are named. An experience-based set of practical guidelines is available [12] and updated regularly, improving the consistency and quality of the assessments.

Increasingly, the Red List receives input from global networks of experts, bringing together the most up-to-date data to make assessments that are as accurate and

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* Based on a total of 1047 citations (Web of Science, http://isiknowledge.com, April 25, 2005) between 1989 and 2004, either on the topic 'Red List'+'IUCN', or citing at least one of the IUCN Red List main publications [10,14,22–24,27,52], or both.

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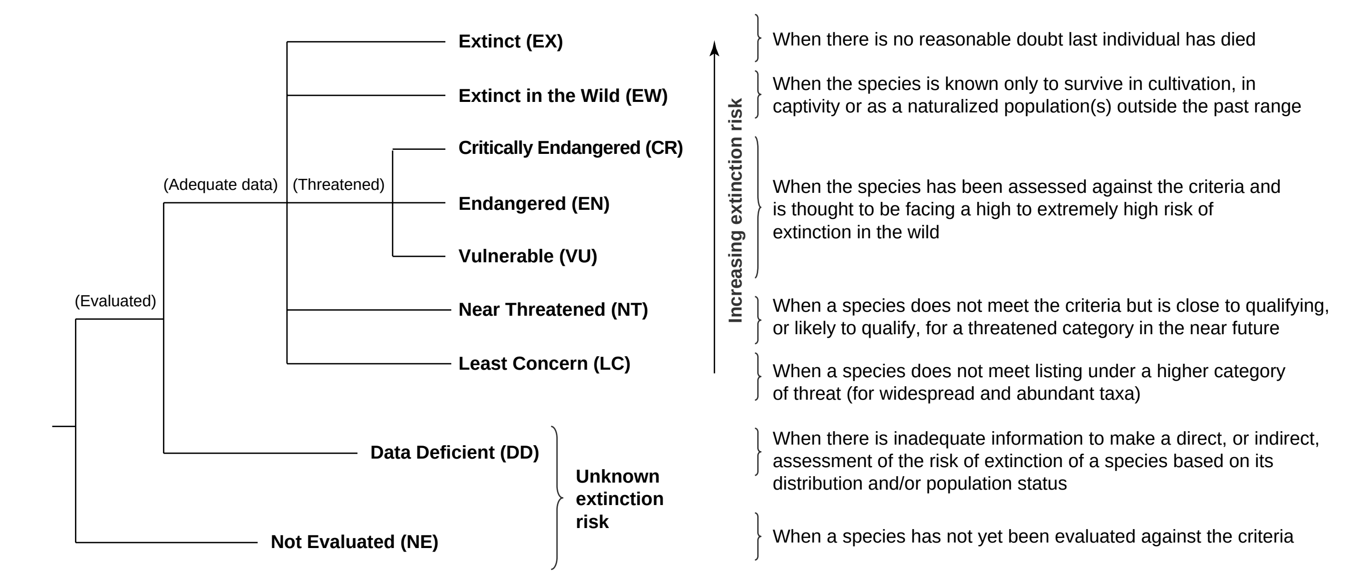
Table 1. The IUCN Red List categories[a] and a simplified overview of the IUCN Red List criteria[b]



Criterion	Critically Endangered	Endangered	Vulnerable	Qualifiers and notes
A1: reduction in population size	≥90%	≥70%	≥50%	Over ten years/three generations[c] in the past, where causes of the reduction are clearly reversible AND understood AND ceased
A2–4: reduction in population size	≥80%	≥50%	≥30%	Over ten years/three generations[c] in past, future or combination
B1: small range (extent of occurrence)	$<100\text{km}^2$	$<5000\text{ km}^2$	$<20\,000\text{ km}^2$	Plus two of (a) severe fragmentation and/or few locations (1, ≤5, ≤10); (b) continuing decline; (c) extreme fluctuation
B2: small range (area of occupancy)	$<10\text{km}^2$	$<500\text{ km}^2$	$<2000\text{ km}^2$	Plus two of (a) severe fragmentation and/or few locations (1, ≤5, ≤10); (b) continuing decline; (c) extreme fluctuation
C: small and declining population	<250	<2500	<10 000	Mature individuals. Continuing decline either: (1) over specified rates and time periods; or (2) with (a) specified population structure or (b) extreme fluctuation
D1: very small population	<50	<250	<1000	Mature individuals
D2: very restricted population	N/A	N/A	$<20\text{ km}^2$ area of occupancy or ≤five locations	Capable of becoming Critically Endangered or even Extinct within a very short time frame
E: quantitative analysis	≥50% in ten years/ three generations[c]	≥20% in 20 years/ five generations[c]	≥10% in 100 years	Estimated extinction risk using quantitative models (e.g. population viability analyses)

[a]Adapted, with permission, from [10].
[b]Adapted, with permission, from [48], see also [10,12].
[c]Whichever is longer.

transparent as possible. The Global Amphibian Assessment, for instance, received contributions from >500 herpetologists (mainly through workshop participation) [13], while almost 1000 ornithologists participated in the Threatened Birds of the World 2004 assessment (largely through web-based discussion forums) [14]. The IUCN follows a model of free, public, electronic access to all data and assessments that invites outside input, and has established an independent process (e.g. [15]) for handling challenges (e.g. [3]).

Beyond a simple list of threat categories

The utility of the Red List as a conservation tool derives not only from the classification of each species into a category of threat (Table 1), but also from the wealth of data, collected to support these assessments, that are published online in a searchable format [16]. Submissions to the Red List now require the rationale for listing, supported by data on range size, population size and trend, distribution, habitat preferences, altitude, threats and conservation actions in place or needed. Many of these parameters are coded in standardized 'authority files' that enable comparative analyses across taxa [16].

A major contribution of the Red List assessments is the compilation of a rapidly increasing number of digital distribution maps of species, for example, of all threatened birds [14] and amphibians [13] (Figure 1). Additionally, point-locality data have been compiled for birds through Red Data Books (e.g. [17]) and the identification of Important Bird Areas (e.g. [18]). Efforts are currently underway to standardize and expand such finer scale geographical data collection to other taxa [19]. The Red List assessments are, therefore, vehicles for the compilation, synthesis and dissemination of a wealth of species-related data that would otherwise remain scattered and inaccessible to decision makers [1].

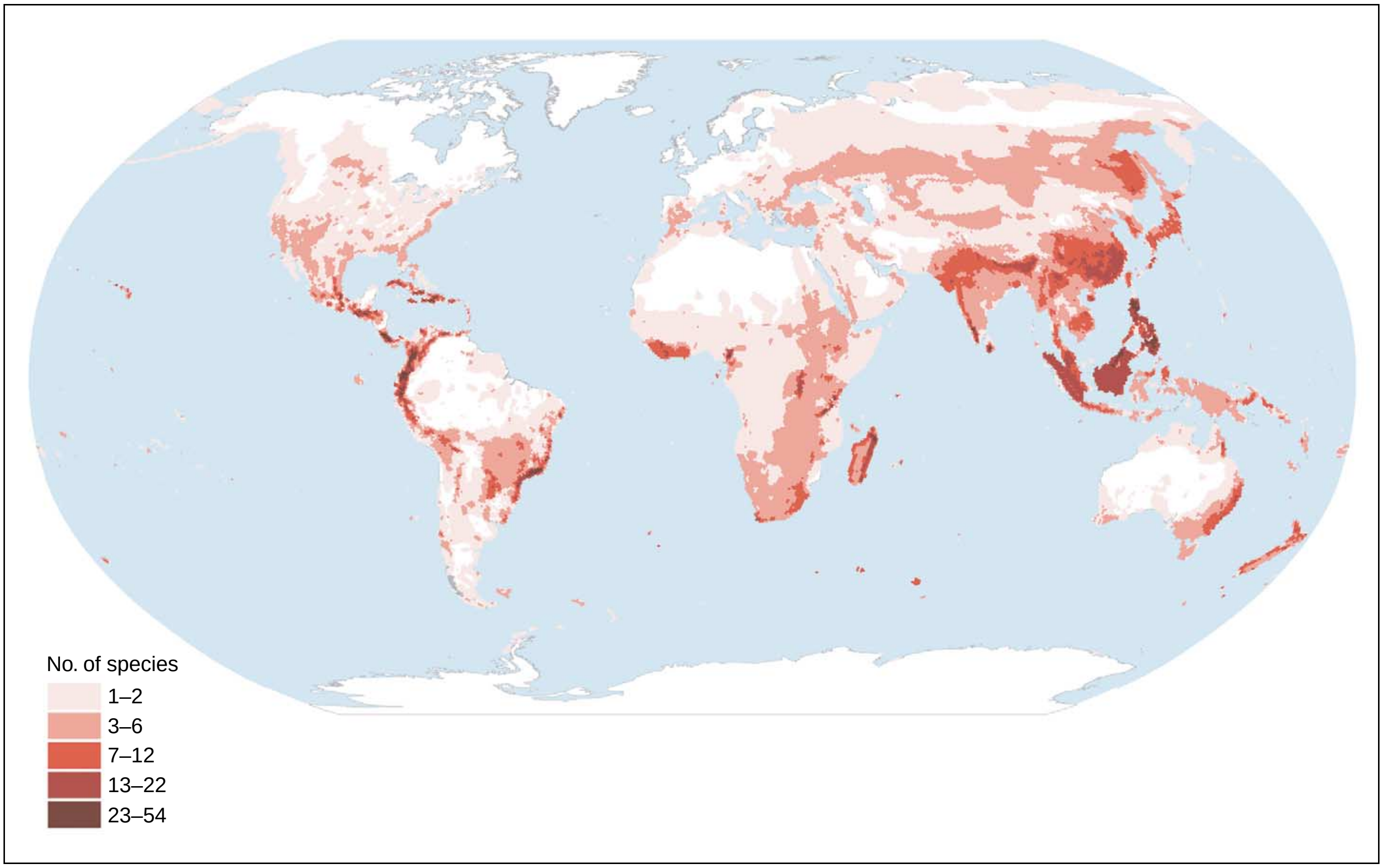


Figure 1. Species richness of globally threatened birds ($n=1208$) and amphibians ($n=1856$), mapped on an equal-area ($\sim$3113 km^2) hexagonal grid. Modified, with permission, from [40].

Beyond 'hand-picked' species assessments

The aim of the first Red List assessments was to draw attention to the conservation needs of select species, typically large and charismatic mammals or birds already known to be under threat [20]. This approach successfully attracted conservation efforts to many such species, but the Red List is now more powerful because it has moved towards documenting entire species clades and regions, including threatened and non-threatened species [16]. Such evaluations are typically carried out by Specialist Groups, the results of which are often incorporated in Action Plans aimed at the recovery of species (e.g. [21]).

BirdLife International (http://www.birdlife.org), the Red List Authority for birds, has led the way in implementing global assessments of all species in a class [14,22–24], and more-detailed reviews at the regional scale have been published in continental Red Data Books [17,25,26]. Comprehensive global assessments have extended to mammals (the first in 1996 [27], with a reassessment ongoing), and have recently been completed for amphibians [13]. Comprehensive assessments will soon include reptiles (the first assessment is underway), marine species (focusing initially on sharks and coral-reef fishes) and freshwater species (e.g. [28]). A few plant groups have been comprehensively assessed (conifers [29] and cycads [30]), and there is a mandate for the assessment of all plant species under the Convention on Biological Diversity 'Global Strategy for Plant Conservation' [31].

The Red List is still highly biased towards well known species, as a result of the biases in the biological knowledge on which it is based [32]. However, the assessments are rapidly becoming more representative geographically (with increasingly global assessments), taxonomically (with the expansion to plant and invertebrate groups), and ecologically (with the expansion to marine and freshwater species). As a result, the Red List contributes to our understanding of the variability in threat status and process, both within and across taxa, providing insights into the nature of extinction (e.g. [33]).

Towards a global standard

Flexibility of the Red List to incorporate data of variable certainty and detail is fundamental in making the best use of limited information to inform conservation decisions. As the wealth of data collected to support species assessments increases in quantity, quality and availability (e.g. [13,14,16]), the Red List is becoming the global standard to ensure consistency in conservation investment across taxa and regions. Such consistency is sorely needed, as conservation investments frequently favour charismatic but common species and regions that are not necessarily those requiring the most urgent attention.

With its standard methodology for evaluating the threat levels of species and collecting baseline data, the Red List is helping to focus priorities for geographically (or taxonomically) flexible global conservation resources. For example, the US$125m Critical Ecosystem Partnership

Fund (http://www.cepf.net) provides grants to projects working on the conservation of globally threatened species, and the sites and landscapes in which they occur. Likewise, the BP Conservation Programme (http://conservation.bp.com/) supports projects focusing on Critically Endangered, Endangered, and Data Deficient species.

The global Red List has inspired the development of many national and regional red lists (e.g. [34]), even though many of these have a history pre-dating the Red List itself. However, because these assessments might not follow the IUCN Categories and Criteria [10], they are not endorsed by, and do not automatically feed into, the global Red List. To improve standardization, the IUCN has developed guidelines for the application of the criteria at national and regional levels [35]. Such standardized national red-listing efforts have great value in national legislation and implementation, improve the comprehensiveness of the Red List, and act as vehicles for data collection [36]. These are particularly important in cases where national endemic species have been assessed as nationally threatened, but have not been assessed globally (e.g. for Ecuadorian plants [37]).

Informing the conservation of species

The Red List data are a source of information that is essential to guide conservation efforts focused on species. Threat categorizations themselves are key to guiding priorities for conservation investment among species [1], albeit necessarily along with other information, such as cost and feasibility [4,8]. The assessments also produce a series of recommendations for conservation action, such as the 5500 key actions identified for 1186 globally threatened birds during 2000 [24]. These provide a baseline to measure conservation responses: by 2004, two-thirds of threatened bird species have had some of these actions implemented [14,38].

The recommended conservation measures address threats affecting each species: for example, fisheries management for marine species threatened by overfishing [39], or captive breeding to provide insurance populations for amphibians threatened by chytridiomycosis [13]. Habitat loss and degradation is by far the most common threat to species [40], and, hence, habitat- and site-based conservation actions are deemed necessary for most species (e.g. 73% of amphibians [13] and 76% of threatened birds [14]). The Red List also identifies species that would benefit from site-level interventions, such as protected areas, and provides data that are useful to prioritize candidate areas for protection.

Identifying sites for conservation action

Vulnerability and irreplaceability are two key principles guiding systematic conservation planning [41]. Vulnerability is the likelihood that biodiversity values in a site will be lost, and the Red List contributes valuable information that can be used to measure it (e.g. [42]). Irreplaceability is the extent to which spatial options for conservation targets are reduced if the site is lost. Measurement of site irreplaceability is thus dependent on information about population size, dynamics and distribution of species, all of which are being collected in increasing detail to support Red List assessments.

Accordingly, Red List data are used in conservation planning at scales ranging from local (e.g. [18,19]), to regional (e.g. [43]), to global (e.g. [44]). This planning leads directly to implementation; for example, Important Bird Areas, mostly identified for globally threatened birds, have been officially recognized as sites of public interest for conservation in Ecuador, the European Union, Mexico, and the USA, resulting in the designation of new protected areas.

Informing broader policy and management

Red List data can be, and are being, used to guide management of natural resources at multiple scales, including at individual sites (e.g. in Environmental Impact Assessments [45]), and in national development policies and legislation (e.g. transport, energy, National Biodiversity Strategies and Action Plans), and multilateral agreements [e.g. the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)]. Again, we emphasize that the full set of data provided by the Red List should be applied, not only the threat rankings. Failure to do so can result in misuse of the Red List; for example, blanket restrictions imposed by governments on access to threatened species carry the harmful side-effect of impeding the scientific study of those species that need it most.

Evaluating the state of biodiversity

The comprehensiveness of Red List assessments has yielded a better picture of the state and distribution of global biodiversity [40]. For instance, because amphibians and birds have been assessed comprehensively [13,14], we now know that amphibians are proportionately more threatened than are birds, with 32% and 12% threatened species, respectively. This difference is only marginally influenced by the fact that amphibians have smaller range sizes than birds, with just 9% and 8% of threatened species, respectively, triggering the Vulnerable D2 criterion as having tiny ranges of $<20\,km^2$ area of occupancy. Likewise, we know that, within a class such as birds, species in Colombia are proportionately more threatened than those in Bolivia (4.8% and 2.2% of species threatened, respectively). The standardization of the data compiled also enables geographical and taxonomic comparisons regarding threats to, and habitat associations and range sizes of, species. For example, rapid declines of amphibians are caused mainly by overexploitation in Asia, habitat loss in Africa and probably disease in Mesoamerica and the Andes [46].

Analyses such as these will become possible for other groups when they have been assessed comprehensively. Meanwhile, the overall proportions (or numbers) of threatened species across taxonomic groups or regions need to be interpreted carefully [4]. It means little, for example, that only 0.06% of ~950 000 described insect species are listed as threatened compared with 20% of 5416 mammals, because <0.1% of all insects have been assessed compared with 90% of mammals [40].

Monitoring the changing state of biodiversity

The Red List systematically records the reasons for a change in category between assessments, distinguishing changes as a result of genuine improvement or deterioration in status from those as a result of improved knowledge (e.g. of population sizes) or taxonomy (e.g. newly split species). The Red List Index (RLI) uses this information to evaluate net changes in overall conservation status (i.e. extinction risk) across entire taxonomic groups [47], and is being tested as an indicator to evaluate progress towards meeting the '2010 biodiversity target' of the Convention on Biological Diversity (http://www.biodiv.org) [48,49]. The RLI can also be disaggregated to compare trends for suites of species in different biogeographical regions, ecosystems and habitats, for different taxonomic sub-groups, or for species that are relevant to different international treaties (e.g. the Ramsar Convention; http://www.ramsar.org [47,48]).

Furthermore, where repeated Red Lists exist, these can provide valuable warning and monitoring of emerging conservation issues. This has already been the case with the devastating global amphibian declines associated with an infectious disease, probably chytridiomycosis [46], and the declines of albatrosses as a consequence of increases in commercial long-line fisheries [47], and is likely to become the case with global climate change [50].

Limitations and directions

The Red List is at a crucial juncture. Over the past two decades, there have been long debates regarding the Red List criteria, as a result of which the Red List structure is now remarkably sound. These disputes have now largely subsided, and future debate is less likely to be concerned with the criteria than it is with Red List process and implementation.

Three major issues are related to the Red List process. First, the taxonomic expansion of Red List assessments has a long way to go. The Red List currently spans $<2\%$ of known species [40] and increasing this coverage through comprehensive assessments is rightly the highest priority of the programme. To achieve this, the Red List must enlist many additional taxonomic and geographic experts. Thus, the IUCN will have to be more diligent than ever to ensure its commitments to grass-roots participation and to its open-access data policies. Second, the capacity and funding of the IUCN-SSC Red List programme urgently needs boosting to handle increasing amounts of data and to better support standardization (e.g. between the Red List and national red lists). Third, the rigour of the process (e.g. in ensuring the correct application of the Data Deficient criterion) must be further increased through, for example, training workshops. Two further limitations that the Red List faces mirror those of organismal biology generally, namely the unstable application of species concepts, and lack of knowledge of most species [51]. Although both of these are beyond the scope of the Red List to remedy, its transparent categories and criteria (and increasingly replicable assessments) offer lessons for a consistent and stable taxonomic framework.

Beyond these limitations, the potential uses of the Red List require further development, as mandated by the World Conservation Congress [6]. For instance, the Red List must work to harmonize the linkages between national lists and the global Red List, and to ensure that it informs national species conservation policies in appropriate ways. The Red List process will also need to make a greater effort to compile point locality data enabling the identification of priority sites for conservation, as well as to repeat comprehensive assessments to enable calculations of Red List Indices. The future of the Red List will depend on its utility; thus, addressing these issues is an important new direction for the programme.

Conclusions

Although the IUCN Red List of Threatened Species is far from perfect or complete, it remains faithful to its original aim of providing the most comprehensive and scientifically rigorous information about the conservation status of species. In the 40 years since it was conceived, the Red List has evolved to become a key tool in conservation, with applications ranging from local to global scales. Its value derives from the implementation of a data-driven protocol, which leads to consistent classifications, as well as the compilation of a wealth of supporting data. Although the Red List is not prescriptive, we have outlined here some of the ways in which it enables users to make informed decisions concerning practical conservation and sustainable development. The immense achievement that is the Red List is still primarily fuelled by the enthusiasm and combined efforts of the thousands of dedicated experts worldwide who, in spite of severely limited resources, go beyond the call of duty to prevent global biodiversity loss.

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