12

Threat descriptors and extinction risk – the Austrian Red List concept

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INTRODUCTION

Red Lists of threatened species are among the most important conservation tools. At the beginning, they were mainly political instruments to raise awareness of the problem of species extinction. Nowadays, they have become indispensable tools for environmental control, in particular on a national scale. Red List categorisations can be decisive for the allotment of financial means for species conservation programmes, they delineate sanctuaries and they substantiate environmental impact studies. With their increased scope, however, national Red Lists face new requirements with regard to consistency, categorisation accuracy, repeatability, data documentation and regional comparability.

When an update of Austrian Red Lists of threatened animals was due in 2000, two series of Red Lists had already appeared (Gepp 1983; 1994). For the new version, it was evident that the progress achieved during the IUCN discussion process (Mace and Lande 1991; IUCN 1994; Gärdenfors 2000) had to be reflected in a new Austrian concept for threat assessment. However, a direct adoption of the IUCN criteria was fraught with difficulties:

1. In 1999, guidelines for the national implementation of the IUCN criteria were still at a preliminary stage (Gärdenfors 2000);
2. Several problems, e. g. the question of grid cell scale for the application of IUCN criterion B, were not solved at that time (Palmer *et al.* 1997);
3. Invertebrate experts expected difficulties when applying the strict numerical threshold criteria, in particular with regard to population decline, in the light of the paucity of existing data. More flexibility with regard to the variety of data types would also have been desirable;
4. A more detailed data documentation system appeared to be necessary (cf. Mrosovsky 1997). On a national scale, explicit reference to existing faunal databases seemed a desirable goal.

During discussion with experts, it became increasingly evident that major inconsistencies in previous Red Lists were consequences of ambiguities in the meaning of 'threat'. Depending on the organism, Red Lists displayed conservation value, rarity, population decrease, priorities, extinction risk or even beauty of an organism, most often a mixture of these properties. Already acknowledged by Mace and Lande (1991), Red List categorisations cannot be objectively achieved as long as value-laden components such as conservation priorities are part of the listing result.

However, even if such components are excluded, threat can be defined at three different logical levels (Harcourt and Parks, 2003; Harcourt, *in litt.*, 3 March 2002): (1) Causes of threat: habitat destruction, habitat fragmentation, hunting or anthropogenic pressure of any other kind. (2) The response to these threat causes, or 'susceptibility to threat' (Harcourt and Parks 2003): a scattered distribution, small and declining populations (cf. Caughley 1994). (3) The final consequence: extinction in the past or increased extinction risk in the future (Fig. 1).

Figure 1 – The logical levels of the meaning of 'threat'.

The IUCN criteria A to D define threat in terms of level 2, in terms of threat correlates. Criterion E, by contrast, defines threat in terms of extinction probability per unit time. The advantage of such a definition is its generality. A probabilistic measure of threat can be compared across organism groups, life forms, old and new lists. It has a clear and unambiguous meaning. Extinction risk is the most relevant information for species conservation programmes. Among the five IUCN criteria, Criterion E assumes a special position, since it integrates information captured by the other criteria. As Keith *et al.* (2000) formulate: 'The attributes in rules A-D serve as surrogates for extinction risk, which is addressed directly in rule E'. However, at present, categorisation using the IUCN criteria A to D frequently disagrees with a numerical analysis using criterion E (Gärdenfors 2000; T. Regan *in litt.*, 17 September 2002).

The main idea behind our Austrian concept is to use the relationship between various threat factors, correlates or threat indicators on the one hand and extinction probability on the other hand to substantiate the Red List categorisation. We use eight quantities, 'abundance', 'abundance trend', 'range trend', 'habitat availability', 'habitat trend', 'direct human influence', 'immigration' and 'other risks' and call them 'threat descriptors' without having to decide whether they are causal factors of extinction risks or just correlates. From a particular combination of these threat indicator values, we infer extinction risk, expressed in terms of extinction probability per unit time (Fig. 2).

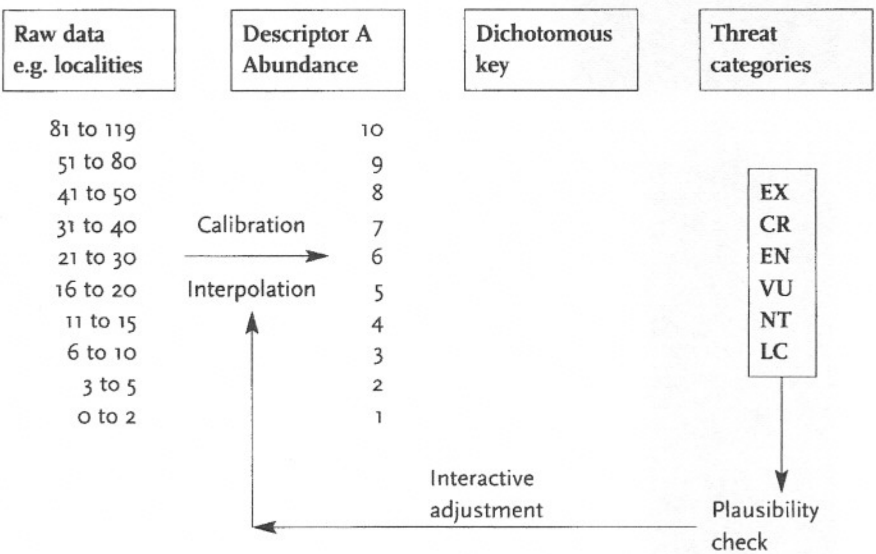

Figure 2 – Calibration of threat descriptor scales and assessment procedure. In the first step, raw data are mapped on a uniform numeric scale. Then, data of eight descriptors are integrated using decision rules in a dichotomous key. The resulting categories are defined as in IUCN criterion E. The calibration can be improved by an iterative trial-and-error process. Well-known organisms or species for which population viability results are available are good starting points, other species can be integrated by interpolation.

The assessment process starts with an Austrian species checklist, which already exists or has to be compiled for the assessment process. For every species, relevant data are collected, e. g. by counting database records, by comparing older and recent record numbers to identify trends, by comparing habitat requirements of the species with the availability of the habitat type. The next step is crucial: The raw data are mapped onto unified tenpartite descriptor scales, which have to be calibrated in an appropriate manner. Well-known species are a good starting point for calibration, e.g. species of which all existing populations including their prospects are known, species for which population viability analyses have been calculated, or species which are so abundant that they can be considered safe without reasonable doubt. These species span the descriptor scale in which other species can be integrated by interpolation according to their raw data values.

The combination of descriptor values then leads to a threat category by a set of decision rules. However, the large set of threat descriptors would make logical AND-OR decision rules very complicated. A dichotomous decision key is a more user-friendly way to integrate the information of various threat descriptors into the single quantity 'threat', which is defined as in IUCN criterion E. This serves two purposes: (1) it limits the infinite ways to calibrate abundance scales to a few meaningful ones, (2) it makes the final statement comparable across regions, organism groups, and Red Lists. Evidently, the scale calibrations need to be optimised in an iterative trial-and-error process. Descriptor scales can be linear or non-linear.

The dichotomous key is based on a simple model (Fig. 3). A monotonic relationship is assumed between abundance values and extinction risk. The key starts to categorise abundance values in a preliminary way. In a second

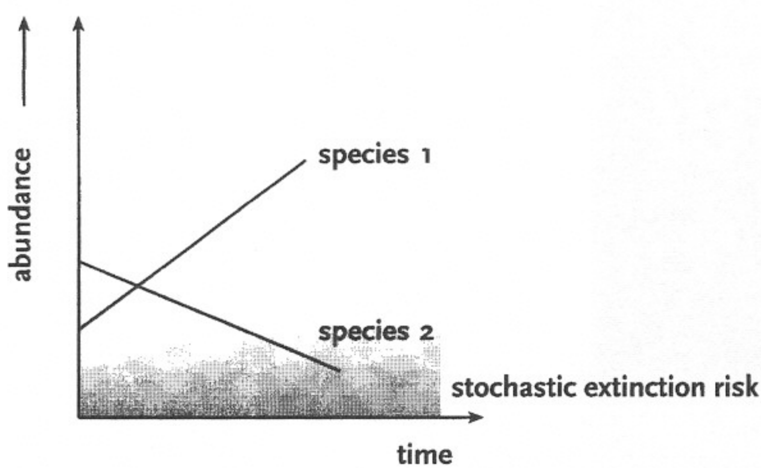

Figure 3 – Model on which the categorisation key is based, integrating abundance and abundance trend (or similarly: habitat availability and habitat trend). A risk zone near small abundance values is assumed. Extinction risk depends on the length of the species' trajectory within the risk zone.

step, trend data modify the preliminary categorisation. The model behind this step assumes a risk zone, where a species will plunge into or emerge from, depending on the trend. Species in the risk zone, but with a positive trend, will have a lower extinction risk than species without a positive trend. A similar consideration can be applied to habitat availability and habitat trend, which means that categorisation can be based on abundance data alone, or habitat data alone, or on both descriptor sets combined.

Other threat descriptors like 'direct human influence', 'range trend' or 'immigration' modify the categorisation obtained by the basic descriptors. A wide range of properties and threat scenarios can thus be incorporated into the assessment process.

The Red List contains the threat category, termed in international IUCN abbreviations, the scientific name, the authority of the species and the German name (Fig. 4). A status column indicates a specific checklist position, e.g. for introduced species or visitors. Then, values of the eight threat descriptors follow. Thus, determinants of threat are visible at a glance: the threat descriptor number sequence tells a short story about the nature of threat impinging on the species. The following column links to a text box in which in-

Threat category	Species	Status	Abundance	Abundance trend	Range trend	Habitat availability	Habitat trend	Direct human influence	Immigration	Other risks	Remarks	Responsibility	Call for action
CR	**Aulacochthebius narentinus (Reitter), Narenta-Zwerguferkäfer**		1	0	0	1	-6	0	0	0	25	!!	!!
LC	**Hydraena alpicola Pretner, Alpen-Zwergwasserkäfer**		6	-1	-1	4	-1	0	0	0	26	!!	
LC	**Hydraena belgica d'Orchymont, Belgischer Zwergwasserkäfer**		4	-2	0	2	-3	0	0	0	27		
LC	**Hydraena britteni Joy, Brittens Zwergwasserkäfer**		4	0	0	2	-1	0	0	0	28	!	
CR	**Hydraena intermedia Rosenhauer, Mittlerer Zwergwasserkäfer**		1	-5	-5	2	-2	0	0	0	29	!!	!!
LC	**Hydraena lapidicola Kiesenwetter, Stein-Zwergwasserkäfer**		7	0	0	6	-1	0	0	0	30		

Figure 4 – Layout of the Red List. For explanation of the columns, see text. Species in the threat categories EX to NT, species in the category DD and species with exclamation marks in the 'responsibility' or 'action' columns are printed in shaded rows.

formation of any kind can be entered to justify the categorisation, to compare current with previous categorisations or to provide biological information.

The last two columns are not part of the threat assessment process. The penultimate column lists national responsibility derived from the percentage of range situated within Austria. The last column, named 'call for action', displays priorities for those species that should receive special care in the future, be it because of high responsibility, flagship- or keystoneness, data deficits, lack of knowledge or a high threat category. Which measures are necessary is detailed in the text box.

DISCUSSION

A first series of Red Lists of threatened animals in Austria compiled according to the new scheme is presently in the press, namely lists on mammals, birds, grasshoppers, water beetles, neuropterids and butterflies. For almost all groups, sufficient data were available to assess the first threat descriptor 'abundance'. In most cases, the number of localities was used to calibrate the descriptor values. However, for birds, breeding pairs (reproduction units) provided a more accurate raw data set to enter the assessment process.

Difficulties were encountered with the second threat descriptor, abundance trend. Except for water beetles, where old collections provided an unbiased reference data set, expert opinion often had to replace trend calculations. Even for birds, trend estimations were only possible at a very crude scale.
Likewise, habitat availability was difficult to determine. CORINE land cover data (Aubrecht 1998) permitted a first estimation, but habitat requirements never matched CORINE land cover types exactly. In most cases, threat assessment using abundance data was more accurate than threat assessment relying solely on habitat data.

However, even if all threat descriptors have to be based on expert opinion and no explicit data are available at all, the system provides a transparent and consistent way of threat categorisation within an group of organisms. Data improvements of any kind can be seamlessly integrated, as soon as they are available. Like in any measuring process, comparability is not so much a question of using precisely the same instruments and methods. This would be desirable, but is difficult to achieve and precludes any methodological improvements over time. Agreement on definitions and quantities to be assessed, by contrast, permits a variety of approaches to be compared within some limits.

Compared to the IUCN criteria, which define strict numerical thresholds to delineate threat categories, the Austrian system is fuzzier. However, the process is transparent and justification of every detail is provided. In particular, the group-specific calibration process has several advantages: (1) Data of any kind can be used. If breeding pair data are more accurate than grid cell occurrence data, there is no obstacle to use them; (2) Incomplete data can be incorporated. Abundance records are never complete, they always constitute an unknown proportion of the true area of occupancy of a species. In invertebrate groups, this proportion can be very low; (3) The relationship between abundance, abundance trend and extinction risk can be fine-tuned according to the size, the trophic position, the survival strategy, and the life form of the organism. For a particular scale calibration, the IUCN criteria appear as a special case in the system; (4) A close connection between raw data and final categorisation result is an inevitable consequence of the calibration process. If necessary, any risk categorisation can be traced back to the original data, of which the source is indicated in a methods section.

In summary, the Austrian Red List assessment scheme can be regarded as a generalisation of the IUCN criteria A to D, aiming at a better correspondence between surrogate criteria (mainly based on abundance and abundance trend) and extinction risk. Alternatively, the categorisation system may be viewed as a very broad interpretation of the term 'numerical analysis' in IUCN criterion E, collecting data on various threat factors, quantifying them and integrating them into a single statement. In any case, the system is intended to produce categorisations that are compatible with IUCN standards while providing extensive documentation of the data sources available on a national scale

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