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Proposal on a criteria system for a National Red Data Book of Biotopes

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Abstract

The proposed criteria system should be able to describe the status of biotopes and biotope complexes as exactly as possible and it should provide useful guidelines for nature conservation. The given proposal includes two criteria to estimate the threat of biotopes: 1. threat by destruction (loss of area); 2. threat by qualitative changes (creeping degradation/destruction of certain variants); supplemented by a third criterion: **3.** assessment of regeneration ability.

The categories and their definitions use basically the criteria system developed for the National Red Data Book of Species (Blab *et al.* 1984) but adjusted to the special needs of biotope evaluation. The first steps to realise a National Red Data Book of Biotopes are described and the limitations in the use in nature conservation are discussed.

Introduction

Preparing a Red Data Book of Biotopes requires the development of a coherent system of criteria. These criteria must give a very precise reflection of the actual degree of endangerment of biotopes. They also have to be sufficiently adapted to describe qualitative as well as quantitative tendencies in the development of the particular types of biotopes. In addition, zooecological aspects should be incorporated, as these were neglected in most comparable projects until now.

To balance the net loss of area of biotope types, categories similar to those of the Red Data Books of Animals and Plants can be used (Blab *et al.* 1984, 1986; IUCN 1990). However, for biotopes an additional evaluation of qualitative changes is necessary, including the threat by creeping depreciation (degradation). Thus the criteria have to be suitable also to reflect the consequences of interferences with water and nutrients balance, which may express themselves in changes of species composition or only in changes of abundance of typical species without any loss of biotope area.

Qualitative changes are of special importance with respect to zooecological aspects. Depreciation of a biotope can be determined by the loss of certain structures, typical biotope elements as part of the habitat requirements of characteristic species, by destruction of adjacent (contact) biotopes with influences on functional interactions. A typical example may illustrate this – border lines of forests represent ecotones influenced by adjacent forest use and agricultural landuse. Intensification of agriculture may have double effects: first slow degradation of the forest border biotope by pesticide and fertilizer input with resulting changes in species composition. Second loss of habitat quality for ani-

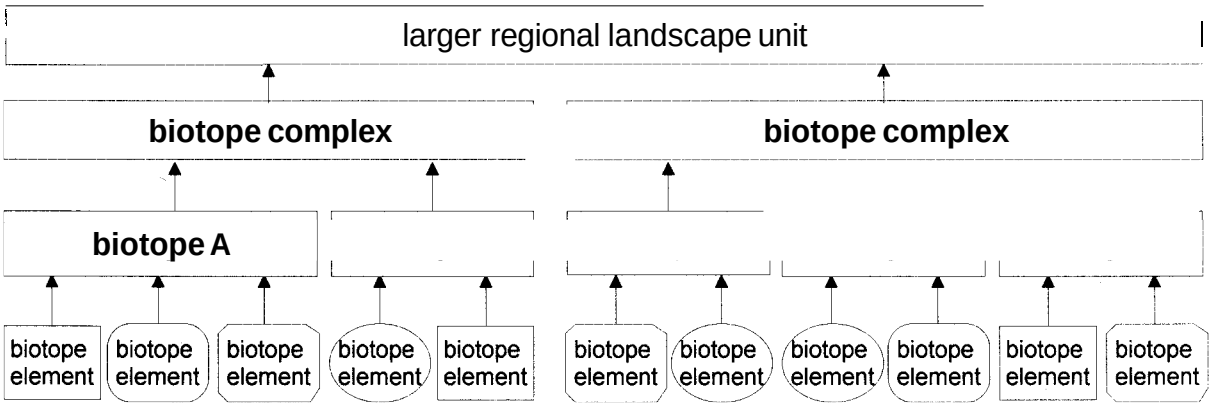

Fig. 1. Overview of the hierarchical structure of spatial units in ecosystems. Within the National Red Data Book of Biotopes the status of threat has been assessed for biotope complexes and biotope types.

mal species living for part of their life in the adjacent field or using it for certain functions only (*e.g.*, hunting prey, warming up in the morning sun). Thus pure approaches of vegetation science, especially floristic approaches and approaches that do not consider neighbouring effects are not adequate to assess the status of biotopes (see Hammer and Völkl 1993; Kratochwil 1987).

The continuous creeping degradation demands clear definitions of biotope types, as in the case of degradation the character of a biotope may change so deeply that a whole series of quite different biotope types develop step by step. Humid extensive meadows for example often were changed to mesophytic extensive meadows, than to intensive meadows and to arable land due to melioration.

On the other hand the assessment of threat by qualitative changes within one biotope type demands a comparison with an idealised optimal type and biotope type related specific threshold setting. The latter should answer questions, which qualitative changes are still within natural variations or only slightly influence the biotope type without representing already a threat.

The characterizations of biotope types should take into consideration main parameters, *e.g.*, abiotic conditions, critical area, typical structures within a biotope or typical biotopes within a biotope complex and include informations on the plant and animal communities as far as possible.

For a biotope type related assessment of threat it is also necessary to define criteria for characterizing those biotope types which occur temporarily in the course of natural or human induced succession series and are usually connected to the pre- or succeeding stages by more or less continuous transitions.

Spatial units

The National Red Data Book of Biotopes will be based on a complete list of all biotope types distributed in Germany (Riecken *et al.* 1993) including those types which are not (actually) threatened. The list is structured hierarchically and based on the following definitions of spatial units (according to Ssymank *et al.* 1993, Fig. 1):

Type of biotope: idealized type, derived from similar biotopes in the field, having specific ecological, unique and more or less constant environmental conditions for animal and plant life. The plant and animal communities living there are themselves a major part of the charactieristic environment and thus play an important role in delimitation of types. Biotopes constitute the spatial compound of an ecosystem.

For practical use the definition is restricted to a certain minimum size, that still can be mapped in the field (*e.g.*, lime-stone beech forest of submontainous zone, extensive humid pastures of the plains). Small 'microsystems' with more or less specific environmental conditions are referred to as

biotope elements (see Fig. 1). Examples are decomposing logs, decaying organic material or parts of living plants. Biotope elements usually occur in several biotope types.

Types of biotope complexes: characteristic, constant mosaic or spatial distribution of certain biotope types. This includes zonations of biotopes along an ecological gradient (*e.g.*, gradient of humidity) and anthropogenous distribution types caused by the historical and cultural development of a certain landscape.

In addition the classification of the threat to *biotope elements* should be realized in future. This will be done related to biotope types within a general framework of analysing qualitative changes. Here it may be necessary to select especially those elements which are relevant to typical animal species.

Also the highest level of the *larger regional landscape units* (*e.g.*, prepared by the IALE-IUCN-CESP Working Group or started for Mediterranean landscapes (see Naveh 1993; Rossi and Vos 1993)) has not been included yet because scientific data on specific regional ecosystems and landscapes as a whole are poor in Germany in several cases.

Criteria and categories of threat

First it is necessary to clarify whether a single system of criteria meets all demands or if a more differentiated concept is necessary.

A Red Data Book of Biotopes should not only balance the status of threat but also give hints to the susceptibilities, preservation and management requirements etc. Therefore, from a scientific viewpoint, a threepronged criteria system seems to be necessary and useful.

The system proposed here differentiates two criteria of threat (I, 11) and one for the regeneration ability (III):

I threat by destruction (loss of area)
II threat by qualitative changes (creeping degradation/destruction of certain variants)
III assessment of regeneration ability

The first two criteria (I, 11) will be combined to one general assessment of threat both on regional and on national level (see Table 1). Criterion III however varies only slightly within different regions and is related directly to the biotope type considered and the local conditions. Examples will be given later (Table 1, Case studies).

Within this classification, anthropogenic changes and development tendencies of the last 100 to 150 years should be assessed because only in this time period valuable information is available. The basis for comparisons is the state of the cultivated landscape between 1840 and 1890 which was before or just at the beginning of industrialization and not the virgin state of nature. This period is in accordance with the temporal reference used for the classification of threats in the German Red Data Book for Animals and Plants (Blab *et al.* 1984). Problems result from types of biotopes that were already largely destroyed before this period (*e.g.*, [semi-]natural forests). For such cases an earlier reference or another concept is necessary.

The evaluation of regeneration ability covers a substantial aspect of biotope susceptibility, thus establishing a conservation priority within similar classification of threats.

The following proposal considers the concepts of existing Red Data Books of Biotopes of the 'Bundeslander' (German federal states) (overview in Riecken and Ssymank 1993), the criteria of Red Data Books of Plant Associations (*e.g.*, Bohn 1986; Dierssen *et al.* 1988) and the German Red Data Book of Animals and Plants for definition and naming of categories (Blab *et al.* 1984; Blab and Nowak 1986) and recent discussions of the IUCN (Mace and Lande 1991; Naveh 1993). For the Red Data Book of species an universal graduated system of categories of threats has been developed. The individual categories assess the anthropogenic tendencies of decline of populations up to total extinction (category 0 = extinct or presumed extinct). In addition species 'potentially threatened' due to a limited distribution within the considered area are listed in a separate category. These are species which reach their border of distribution in Germany, species with disjunctive distribution like glacial relicts, or which are naturally represented only on a regional

scale and/or in low abundances due to highly specialized demands. These species are in danger to become extinct suddenly due to unpredictable events. This category corresponds to 'rare' of the IUCN criteria (IUCN 1990) (or 'susceptible' of the actual revision of these criteria; see below). It seemed reasonable to transfer this practically proved concept as far as possible into the present proposal.

On the other hand a direct adaption of the IUCN criteria for species was not possible as these criteria are most appropriate for assessment of threats to vertebrate populations which is also the case with recent proposals for its further development (Mace and Lande 1991).

Criterion **Z** *Threat by destruction*

This criterion is supposed to balance the actual loss of area and the decline in number of sites of a given type of biotope. Direct destruction (by demolition, building activities etc.) is not the only reason for loss of area. By negative changes and related creeping degradation one type can quantitatively be transformed, so that the typical biocoenosis is not able to persist. This type has then to be classified as destroyed.

A biotope type related 'ideal typical or historical state' concerning total area and site density has to be used for orientation to classify threats precisely. Actually this 'ideal situation' is rarely present for any biotope type and can be described only approximately. Therefore the present situation and development of total area and site density is of special significance. **As** a rule actual tendencies in development have to be evaluated. In a few well documented cases (*e.g.*, bogs, heathland, ponds, hedges, running waters without technical constructions (see also Case studies)) data for the net loss of area are available over a longer period.

Categories:

0 – *completely destroyed (extinct):*[1]
Types of complexes of biotopes which were previously present in the area considered (Federal Republic of Germany) but today can no longer be proven to exist.

1 – *threatened by complete destruction (critical):*
Types or complexes of biotopes of which only a little part of the original area still exists. With the causes of threat continuing and without any activities for protection and management a complete destruction has to be expected in the near future.

2 – *heavily endangered (endangered):*
Types or complexes of biotopes with a heavy decline of area in nearly the whole region considered or already extinct in several (sub)regions.

3 – *endangered (vulnerable):*
Types or complexes of biotopes with negative development of area over a broad range of the considered region or locally extinct at numerous sites.

P[2] – *potentially endangered (susceptible):*
Types or complexes of biotopes with only regional distribution in the area of interest or occurring naturally within a confined area or with a limited number, thus being potentially threatened by loss of area if not already threatened according to categories 1–3.

* – *presumably not endangered at present*

Criterion ZI: Threat by qualitative changes (creeping degradation)

Apart from a direct loss of total area and decrease in number of sites, biotopes are threatened especially by qualitative changes and deformations. Among others, this means adverse effects to the *abiotic conditions,* to the *typical structural appearance* and to the *typical set of species* including actual ecological interactions.

[1] In parentheses the corresponding terms used in the actual revision of the IUCN criteria system are documented (discussed at the IUCN-meeting, Buenos Aires, Jan. 1994). Differences result from the fact that IUCN criteria have been developed to assess the status of species and not of biotope types.

[2] Instead of a category '4' here 'P' is used similar to the planned new edition of the Red Data Book of Animals and Plants (compare Blab and Nowak 1986). The category 'potentially endangered' has not to be interpreted as lowest rank in a linear scale (0–4) of actual threat. Biotopes potentially threatened are those which have been always rare or that exist in a small area without being actually threatened according to categories 1–3.

a. 'Abiotic conditions' means the typical set of abiotic ecological factors (*e.g.*, water and nutrition balance or dynamics). Threat usually is caused by direct changes in these parameters (drainage, eutrophication etc.) as well as by effects of the input of other (toxic) substances. The relevance of these parameters strongly depends on the particular type of biotope, requiring a type related scale for assessment.

b. 'Typical structural appearance' means, in our context, the completeness of structures and habitat elements typical for the biotope type, including typical mosaics or combinations of types within a complex of biotopes or a landscape unit. Threats usually are caused by gradual changes or destructions of particular structures (strata, biotope elements etc.) or of one or more typical biotope types within a complex. The latter are often linked to changes in the spatial-functional set of interrelationships, which could be represented, for example, by animal migration.

c. 'Typical set of species' means the distinct type of vegetation (in a plant sociological sense) as well as occurrence of single biotope- or complex-typical animal and plant species and ecological guilds including the functional connections they are representing. Threat is possible by loss of typical species as well as by immigration of biotope alien species (*e.g.*, neophytes). Affected species include species typically present in a certain biotope type, but also able to colonize other types[3], as well as those occurring exclusively or predominantly in this type. In both cases threat may be valued due to concretely detected negative trends in population numbers as well as due to general trends in the situation of essential portions of the characteristic species (threat according to criteria of Red Data Book of Animals and Plants).

The (regionally) typical or natural variant is supposed to comprise the entirety of the three single parameters previously listed including their interactions. Negative changes in one of the parameters alone or varying combinations of them may be responsible for actual threat. Due to interactions among these factors of threat, a separate evaluation is impossible in most cases.

To support conservation efforts however, the essential causes of threat, as far as they are known, will be named.

Categories for threat by qualitative changes:

0 – *completely destroyed:*
Types or complexes of biotopes with their quality affected so severely that typical or natural variants are completely destroyed.

1 – *threatened by complete destruction:*
Types or complexes of biotopes with their quality being negatively affected nearly in their whole area of interest so that typical or natural variants are only left in one or very few subregions and threatened by complete destruction in a short time.

2 – *heavily endangered*
Types or complexes of biotopes with their quality being negatively affected in a way that
- a decline of typical variants can be stated in nearly the whole area of interest or
- typical variants already became extinct in several (sub)regions.

3 – *endangered:*
Types or complexes of biotopes with their quality being negatively affected in a way that
- a decline of typical variants in several subregions can be stated or
- typical variants already became locally extinct at numerous sites.

* – *not endangered at present*

A category 'potentially endangered' is omitted in this context.

As the distance from a biotope's ideal or (semi)-natural state increases, it is more endangered. A typification of biotope types must be elaborated to serve as a measure in describing the 'ideal state' with regard to all relevant parameters (essential for the value and possible colonisation of the biotope type by typical species) as well as concrete limita-

[3] Including also those species spending only part of their life in this biotope (habitat for larvae, hibernating sites etc.) or using this biotope for certain vital functions (foraging, breeding etc.).

tions beyond which a site no longer corresponds to this type. These characteristics have to be orientated, among other things, to historic conditions, known abiotic requirements and to ecological demands of typical animal or plant species or plant communities.

But this classification and the setting of limits is linked to both scientific and methodic problems. In a number of cases the 'ideal' or 'historic' state is not sufficiently known or can be described only in general terms. However, negative trends and deficits and the resulting threats and changes in habitats, communities and functional relations often are known and documented. In such cases a concrete classification of threat has to reflect these trends.

111: Assessment of regeneration ability

In an overall approach the threat to a biotope type also depends on its unique character, its regeneration ability or its ability to resist negative influences. The term 'restoration ability' is not adequate here as it would suggest a 'technical possibility of creation' which is, strictly speaking, more a wishful thinking than reality. Even if the framework condition could be restored by management measures (even including reestablishing characteristic species), the essential development to a state close to the original natural conditions is often no longer possible. **As** a rule, the ability to regenerate depends on the necessary time for development (or even a necessary historical continuum), on the possibility to recreate appropriate abiotic conditions and on interactions with the surrounding landscape, including the ability of typical species to reach the projected areas during recolonization processes.

Therefore the ability of regeneration is strongly dependent on regional and local conditions. Correspondingly, difficulties arise in making an assessment on a typological level so that here only rough approaches to the real situation can be achieved and described. However, a complete restoration cannot be expected even for 'pioneer biotopes' because ecosystems are to be considered more or less unique with concrete variants depending upon, among other things, regularly unique constellations and upon long-term evolutionary processes.

Classifications:

N – *regeneration impossible:*
Types or complexes of biotope types whose regeneration is not possible in historical times. This includes, for example, biotope types with extremely long development periods (*e.g.*, ancient or virgin woods, raised bogs), biotope types where abiotic conditions cannot be restored and such types being populated by relictic populations or essential portions of characteristic species threatened by extinction.

K – *regeneration hardly possible:*
Types or complexes of biotope types whose regeneration is possible only in historical times (> 150 years) and if regeneration takes place it is expected to happen only in an imperfect manner due to low number and high isolation of single sites (possible starting points for (re-) colonization of typical species).

S – *regeneration difficult:*
Types or complexes of biotopes whose regeneration is probable only in very long periods of time (15–150 years). For (re-)colonization of some typical plant and animal species longer periods may be expected.

B – *regeneration conditionally possible:*
Types of complexes of biotopes whose regeneration is probable in periods of time up to 15 years. For (re-)colonization of some of the characteristic plant and animal species longer periods of time may be expected.

X – *classification not meaningful:*
Types or biotopes that are undesirable from a nature conservation point of view (*e.g.*, forests of exotic trees, areas of arable land with intensive farming) or biotopes representing short intermediate stages in natural succession.

Overall evaluation of threat

Both criteria (direct destruction and qualitative change) are combined to an overall classification of threat. This has at least the same level as the highest rank in one of the criteria I and 11. This can be achieved without a new definition for the categories as the evaluation corresponds to the summary of definitions of the already discussed criteria.

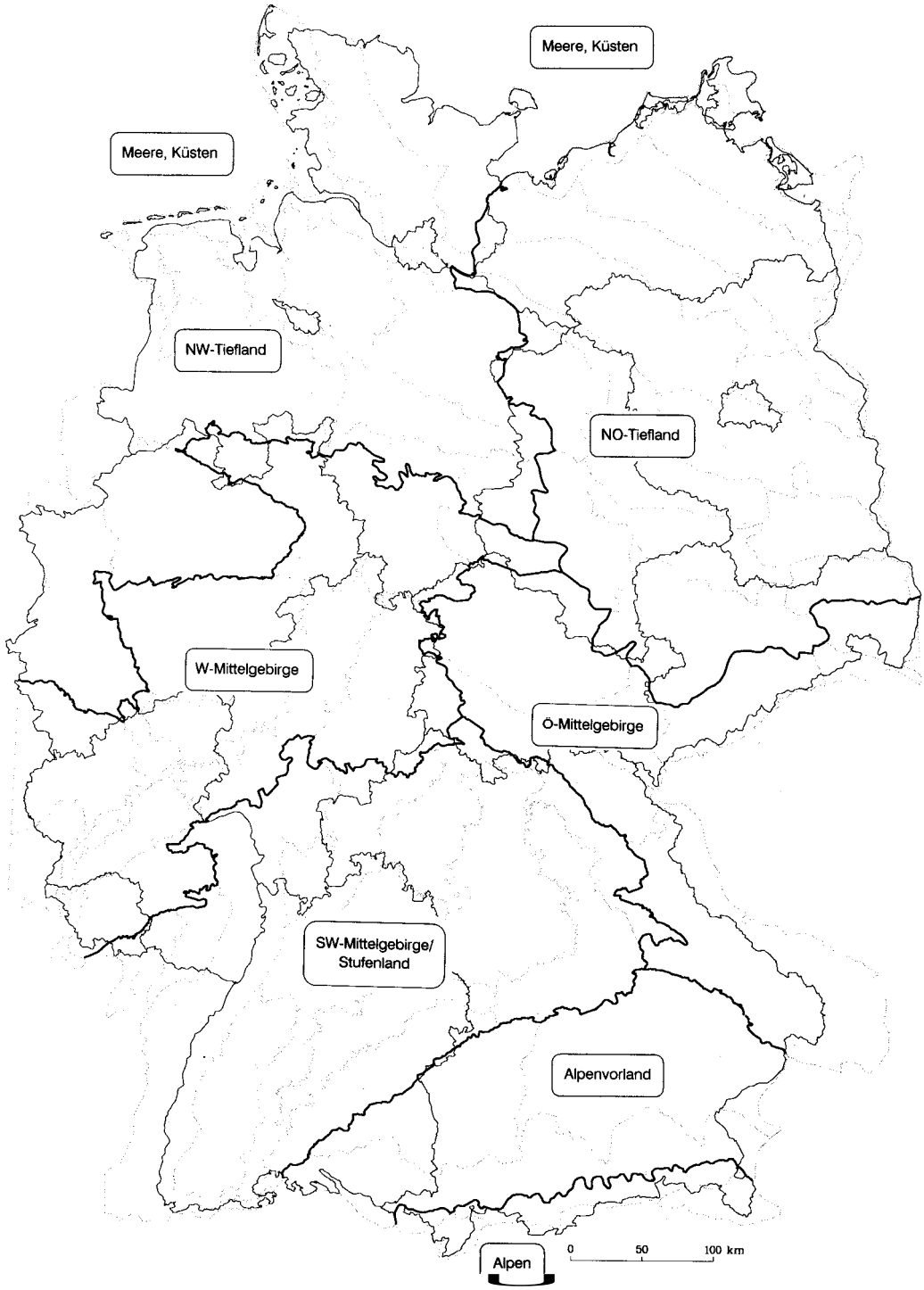

Fig. 2. Overview map of Germany documenting the borders of eight distinctive regions. These are the large landscape units for which the regional assessment values of threat are given (see Table 1).
Meere, Küsten = North Sea, Baltic Sea and coasts; NW-Tiefland = northwestern lowlands; NO-Tiefland = northeastern lowlands; W-Mittelgebirge = western highlands; Ö-Mittelgebirge = eastern highlands; SW-Mittelgebirge = southwestern highlands; Alpenvorland = prealpine region; Alpen = Alps.

The dotted lines represent natural regions as subunits **(n = 69)** referred to as 'subregions' within the definitions of the categories of threat.

Due to the great heterogeneity of landscapes in Germany and due to the strong gradient of certain ecological parameters (*e.g.*, climate, geology, elevation, historic development of land use), the situation of threat for many biotope types is also often strongly dependent on regional conditions (Ringler 1993). Therefore it was necessary to assess the status of threat for eight 'regions' (Fig. 2, Table 1) as well as for Germany in total.

Practical implementation

To implement this concept, all types of biotopes considered to be endangered from a federal point of view were marked within a complete list of all existing and predefined biotope types (Riecken et *al.* 1993). A pre-assessment was made by the authors based on regional or local data and on literature studies.

This pre-assessment has been elaborated and refined by extensive consultation of experts including all authorities for nature conservation of the 'Bundeslander' (German federal states). With this step, missing types considered to be endangered and especially complexes typical on a regional scale were added. At last the results were compiled by the BfN *(Bundesamt fur Naturschutz* = Federal Authority for Nature Conservation). An extensive expert consultation as described seemed to be the only way to achieve sufficient precise and proven results in a reasonable time frame. In contrast directly balancing development of number and area of all biotope types to serve as a basis for classification of threat on the national level is not possible at present as the necessary basic data either do not exist or are not available for the majority of biotope types.

Regarding the urgent need to act, from the point of view of nature conservation, one should not wait until precise data (which could be taken from biotope mapping projects of the 'Bundeslander' for instance) have been raised to a scientifically satisfactory level to enable quantitative evaluations. However, to improve this situation in the future, it is necessary to take into account the following proposals for new data collecting projects:

- increased consideration of zooecological aspects, functional interrelations between biotope types and the whole landscape context,
- evaluation of the surroundings of each mapped biotope,
- evaluation of each biotope according to criterion II (qualitative changes),
- balanced interpretation of data considering evaluations according to criterion 11,
- improvement of transfer and standardisation of data

Case studies

To explain how the criteria have been used with in the Red Data Book (Riecken et *al.* 1994) we will present a few case studies for the assessment of the status of biotope types which cover natural and seminatural types and also some typical combinations of threat (see Table 1).

Bogs

Raised bogs originally covered substantial surfaces in the northern lowlands and smaller bogs were typical for both highland regions and the alps. Peat cutting, drainage and degeneration are the main reasons for their decline. In the lowlands only 3–5% of the original surface are in a natural state (Ringler 1993; Niedersachsischer Minister fur Ernahrung, Landwirtschaft und Forsten 1981). In the prealpine region and the alps the situation is only slightly better with 5 to *25%* of the sites left (Ringler 1993). Caused by atmospheric deposition of nutrients all sites suffer ongoing qualitative changes. As a result raised bogs are threatened by complete destruction in all regions (Table 1).

Hedges on man-made ridges

Hedges on man-made ridges represent a specific regional type of hedges occurring traditionally only in the northwestern lowlands and in few areas of northeastern lowlands on the border lines of pas-

Table 1. Examples for the assessment of the status of biotope types (taken from Riecken *et al.* 1994; marine and coastal biotope types have been listed in a separate table).

code	biotope type	NW lowlands			NE lowlands			W highlands			E highlands			SW highlands			prealpine reg.			alps			FRG	
		DE	QU	RT	DE	QU	RT	DE	QU	RT	DE	QU	RT	DE	QU	RT	DE	QU	RT	DE	QU	RT	OT	RA
...																								
	Running water																							
23.01.01.01	calcareous epi-/metarhithral (natural or seminatural)	1	1	1	2	1	1	3	2	2	3	3	3	3	3	3	2	2	2	3	3	3	2	K
...																								
	Bogs																							
36.01	raised bog (undisturbed, active)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	N
36.01.01	raised bog, planar to submontane	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	N
36.01.02	raised bog, montane			-			-	2	2	2	1	1	1	2	2	2	1	1	1	2	1	1	1-2	N
...																								
	Hedges																							
41.03.01	hedge on man-made rigdes	2	2	2	p	2	2			-			-			-			-			-	2	S
...																								
	Alluvial forests																							
43.04.05.01	mixed oak-elm-ash forests of great rivers, inundated periodically	1	1	1	2	2	2	1	1	1	1	2	1	1	2	1	1-2	2	1-2			-	1	K-N
...																								

Explanations: code – hierarchical coding for database-applications; DE – threat by destruction; QU – threat by qualitative changes; RT – regional assessment of threat; OT – overall assessment of threat; RA – assessment for regeneration ability.

tures, roads, paths etc. Direct losses of this biotope type are documented for the whole region and have been *e.g.*, 46% since 1935in Lower Saxony (Schupp and Dahl 1992) (DE = 2, heavily endangered). The reasons for this decline are direct losses by enlargement and rearrangement of pastures in the western lowlands. On the other hand, degradation because traditional wood-cutting is missing or intensive pasturing dramatically increased, can be found nearly in every subregion (QU = 2, heavily endangered).

Limitations in the use of a Red Data Book of Biotopes

For the elaboration of a Red Data Book of Biotopes, categorizing natural diversity into a proper system according to pragmatic scientifically-based but often somewhat anthropocentric criteria is inevitable. Reality, however, is not a static system but a continuous process of change. The objects therefore are parts of a system in space and time with many biotopes more or less in a process of transition with all the resulting problems for a classification.

Biotope types cannot be regarded as isolated as they form integral parts of a complex network of functional relations in a whole landscape context. This network is not only represented by biomass and energy fluxes but also by animal species and their links to certain habitats and space. Species groups of interest in this context are those living in different biotope types during different stages of their lives (*e.g.*, dragonflies, mayflies, amphibians) or living permanently in complex biotope networks (solitary bees, different birds of prey etc.). The analysis of this functional network is an essential basis for biotope protection and management based on differentiated conservation plans.

At least the evaluation of a site for nature conservation and the development of appropriate management plans cannot be based only on biotope types and their degree of endangerment. Therefore, it is absolutely necessary to include further conservation aims such as the protection of water balance, soil, fauna, flora, *i.e.*, the whole ecosystem balance.

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