Review

An Evaluation of Threatened Species Categorization Systems Used on the American Continent

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Abstract: *Endangered species lists are important tools in conservation. It is essential that these lists be prepared using categorization systems that objectively assess species extinction risk. To determine which threatened species categorization system is the most appropriate and the virtues and limitations of systems used on the American continent, we evaluated 25 categorization systems from 20 countries. These systems included examples of international lists, most national systems used on the American continent, and some systems independently proposed by academics. We based our assessment on 15 characteristics that categorization systems should have, in terms of categories, criteria, and other relevant issues, in order to evaluate species conservation status objectively. Of all evaluated systems, the current World Conservation Union system is the most suitable for assessing species extinction risk. Most categorization systems, but particularly national systems, have serious deficiencies and need to be improved substantially. We recommend governments use three types of lists: (1) threatened species lists constructed following a sound categorization system, (2) lists of species of conservation priority, and (3) lists that serve as normative tools (e.g., Convention on International Trade in Endangered Species of Wild Fauna and Flora). Additionally, the information used to categorize species should be explicit and available to the public. To make the most of threatened species lists in conservation, it is imperative that all countries use the same categorization system.*

Key Words: assessing extinction risk, endangered species, red lists, species conservation status

Resumen: *Las listas de especies amenazadas son importantes herramientas para la conservación. Es esencial que estas listas se preparen utilizando sistemas de categorización que evalúen objetivamente el riesgo de extinción de las especies. Para determinar qué sistema de categorización de especies amenazadas es el más apropiado y cuáles son las virtudes y limitaciones de los sistemas usados en el continente americano, evaluamos 25 sistemas de categorización de 20 países. Estos sistemas incluyen ejemplos de listas internacionales, la mayoría de los sistemas nacionales usados en el continente americano, y algunos sistemas propuestos independientemente por académicos. Basamos nuestra evaluación en 15 características que los sistemas de categorización deben tener en términos de las categorías, criterios y otros temas relevantes, para evaluar objetivamente la situación de conservación de las especies. De los sistemas evaluados, el actual sistema de la Unión Mundial para la Conservación es el más apropiado para determinar el riesgo de extinción de las especies. La mayoría de los sistemas de categorización, pero especialmente los sistemas nacionales, tienen serias deficiencias y deben ser mejorados substancialmente. Recomendamos que los gobiernos usen tres tipos de listados: (1) listas de especies amenazadas preparadas usando un sistema de categorización adecuado; (2) listas de especies prioritarias para la conservación; y (3) listas que sirven como herramientas normativas (v.gr., Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres). Adicionalmente, la información usada para categorizar a las especies debe ser explícita y estar disponible*

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para el público. Para obtener en conservación el máximo provecho de las listas de especies amenazadas, es imperativo que todos los países usen el mismo sistema de categorización.

Palabras Clave: especies en peligro, estatus de conservación de especies, evaluación de riesgo de extinción, listas rojas

Introduction

Evaluating species conservation status is one of the main tools for establishing conservation priorities (Mace & Lande 1991). This information is critical in establishing management policies because in most cases resources for conservation are limited. Thus, conservation policies are generally directed toward protecting a fraction of the biological diversity of the planet: that fraction in greatest danger of extinction. Since 1966 the World Conservation Union (IUCN) has evaluated species' conservation status worldwide, and today the IUCN Red Lists have become a major tool in conservation biology (Colyvan et al. 1999). Since the late 1980s, the IUCN Species Survival Commission has discussed, evaluated, and revised the categories and criteria used in this system so that the assessments reflect with more certainty the conservation status of species. These assessments are based on quantitative analyses of extinction risk in finite time (Fitter & Fitter 1987; Mace & Lande 1991; Mace & Stuart 1994). Also, in response to the need to create comparable national or regional lists, IUCN is developing guidelines for the application of the system on smaller scales (Gärdenfors 1996*a*, 1996*b*; Gärdenfors et al. 2001).

The IUCN system has been widely criticized for its requirement for information that does not exist or that is insufficient for most species (Reca et al. 1994; Cofré & Marquet 1999; Grigera & Rau 2000). This lack of information is especially prevalent in developing countries, where most of the planet's diversity is concentrated (Myers et al. 2000). Consequently, some authors have proposed alternative categorization systems that address this lack of information (e.g., Ceballos & Navarro 1991; Reca et al. 1994; Sánchez 1996; Cofré & Marquet 1999). These systems are based mainly on the biological characteristics associated with species' vulnerability to extinction and on anthropogenic disturbances that place species at risk.

Many countries have created their own official lists of threatened species as a strategy to legislate conservation of their biological diversity (e.g., CONAP 1996; MINAE 1997; SEMARNAT 2002). These lists differ widely in both their risk categories and the criteria used to evaluate the state of species conservation.

We evaluated the categorization systems used on the American continent (both subcontinents, North and South America) to define species conservation status and determined which of these systems is most suitable for assessing species extinction risk. The assessed systems include examples of international lists, most national systems used on the continent, and some systems independently proposed by academics. Our analysis is based on the characteristics that threatened-species categorization systems should have to evaluate species conservation status objectively.

Categories and Criteria in Categorization Systems

Any system of categorization of threatened species must have risk categories. Categories are the names that express the degree to which the species are threatened. Although one could use a system that places each species along a continuum of extinction risk, categorization brings this continuum down to an ordinal scale, which is essential in practice given constraints on the data (Akçakaya et al. 2000). Categories are indispensable because this information is more easily understandable by the general public and decision makers (Mace & Lande 1991). Categories differ among the different categorization systems and although at times the same name is used, it cannot be assumed that the same name confers the same level of extinction risk (i.e., categories may not be comparable or compatible).

Ideally, the risk categories should indicate the probability of a species becoming extinct over a given time (Munton 1987; Mace & Lande 1991). This requires explicit definitions that do not include subjective elements. When risk categories do not include definitions or include subjective elements in the definition, the assessments made by different people can differ or the interpretation of the degree of risk can be erroneous.

Categorization systems must also have criteria on which the risk categories and conservation status of species are based. Generally, these criteria refer to the current conditions of the populations (distribution and abundance), population trends, species characteristics that make them vulnerable to extinction, or anthropic factors that endanger them. Like risk categories, criteria should not include ambiguous elements; two authors who evaluate the same species with the same information should arrive at the same risk category.

Some criteria are not useful for evaluating species conservation status; rather, they are related to the designation of conservation priorities. Also, many systems have opted for listing species only because they are included in other

types of lists. This situation is typical of the national systems that include species listed by international systems. A species global conservation status, however, is not necessarily the same as the conservation status on a regional scale (Gärdenfors 1996*a*; Gärdenfors et al. 2001).

Confusing Concepts

Many categorization systems confuse threat categories with factors that put species at risk (e.g., overexploitation), parameters that can be used to measure risk (e.g., rarity), and lack of knowledge of a species (e.g., indeterminate) (Munton 1987). Another common confusion exists in the difference between assessing the "conservation status" and determining the "conservation priority" of species (Munton 1987).

An assessment of conservation status estimates the risk of extinction of a species. This can be done on the basis of, for example, geographic distribution, abundance, habitat availability, or levels of exploitation. This assessment should be conducted using categorization systems that include categories which indicate the probability that a species will become extinct in a given time if the conditions endangering it prevail (Mace & Lande 1991). In contrast, species conservation priorities determine which species should be protected. For this purpose, risk of extinction should be considered (Lamoreux et al. 2003), but other factors may also be included, such as the effectiveness of conservation actions (Balmford et al. 1996); economic, political, and social considerations (Ehrlich & Ehrlich 1992); and the taxonomic singularity of the species or the degree of its endemism. Establishing conservation priorities rather than conducting a scientific analysis is a political or public-opinion task that determines the allotment of resources for conservation (Czech et al. 1998). Nevertheless, although prioritization does reflect societal value, it can still be implemented within an objective framework as long as the goal is clearly defined (e.g., Vane-Wright et al. 1991; Margules & Pressey 2000).

Many authors confuse the lists of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) with lists of threatened species. The CITES lists were developed to support countries in protecting their flora and fauna by regulating their international trade. It regulates the import, export, and re-export of live organisms and their parts, products, and derivatives by including them in a list of protected species. It also regulates and carries out continuous surveillance of other species or similar species that could become threatened (CITES 2000).

Although CITES is a powerful tool in species conservation because it permits the regulation of international trade of threatened species (Jorgenson & Jorgenson 1991), it is important to recognize that it is not a list of threatened species. It includes species that are not of conservation concern, and it does not necessarily include species threatened by factors such as habitat loss, introduction of species, hybridization, or pollution.

Uncertainty in the Evaluation of Species Extinction Risk

Generally, categorization systems evaluate species conservation status based on estimates of parameters such as species abundance and distribution. Because of the very nature of these parameters, however, it is almost impossible to obtain precise information about them (e.g., the number of mature individuals in a given population). Thus, the data used to evaluate species conservation status necessarily have an associated uncertainty. This uncertainty has two origins: error in measurement and the natural variation of populations (Akçakaya et al. 2000). A third type of uncertainty associated with evaluating species conservation status is semantic uncertainty. This type of uncertainty is related to the categorization system per se and is caused by vagueness in the definition of the categories and criteria used by the system (Akçakaya et al. 2000).

It is impossible to eliminate all the uncertainty associated with assessing species extinction risk, so it is important that categorization systems include assessments of the level of uncertainty with which the species are being evaluated (Akçakaya et al. 2000; Regan et al. 2000; Regan & Colyvan 2000). If uncertainty is ignored conclusions on species conservation status may be erroneous and incorrect decisions may be made for allotting resources for conservation (Todd & Burgman 1998).

Global versus Regional Conservation Status

A species' global conservation status does not necessarily coincide with its regional status. Some species that are threatened on a global scale may not be threatened on a regional scale, and species that are not threatened on a global scale might be threatened in some part of their range (Gärdenfors 2001). Some species may be declining fast across their ranges on average but may be locally stable or even increasing (e.g., Cuarón 2000; Carton de Grammont 2002). Therefore, threatened species categorization systems must be applicable at different geographic scales so they can be used at both international and national, or even regional, levels. This is of special importance when the biological diversity of a particular country or region is to be protected.

Knowing the regional status of species is important for several reasons. Loss of population and genetic diversity is a major concern. When a species is protected on a

regional scale, conservation of its genetic diversity is promoted (Hunter & Hutchinson 1994). Moreover, regional-scale extinction of one species can provoke a cascade of extinctions, causing a change in species composition and in ecosystems processes (Borrvall et al. 2000; Lundberg et al. 2000). The extinction of a species is the result of local extinctions of its populations (Ceballos & Ehrlich 2002). Additionally, species conservation requires specific actions, and generally organizations are needed to carry them out. These organizations usually act within political (national, state, regional, or local), not ecological, limits (Hunter & Hutchison 1994; Gärdenfors 2001), although for effective conservation it is essential not to lose a global perspective (Dudley 1995).

Assessment of Categorization Systems Used on the American Continent

We compiled information on threatened species categorization systems (henceforth, categorization systems) used in America. We focused on systems representative of those used by international organizations and governments and those proposed by academics. Rather than assemble a complete list of categorization systems used on the continent, we assembled an illustrative group of systems that exemplifies the situation there (and perhaps worldwide).

The search was based on bibliographic references such as conservation biology journals, publications of international organizations, official documents, and unpublished literature (theses, reports) and on information obtained from the Web sites of governments or nongovernmental organizations. We considered 25 categorization systems used in 36 threatened species lists in 20 countries (Table 1). We were unable to obtain information on the systems used by Suriname, Guyana, and French Guiana. The IUCN system has been revised several times, which means there are several versions. We refer to the "original" IUCN system (pre-1994), the 1994 version, and the most recent version (2001). Although between 1994 and 2001 the modifications were few, some of them are important in terms of evaluating the system. When a country uses one of these systems we indicate it.

Mace and Lande (1991) reevaluated the IUCN categorization system and proposed a series of characteristics a categorization system should have to evaluate the extinction risk of a species (taxa, in general, or populations) within a given time. They also proposed that the evaluation be scientifically based to make it as objective as possible. We build on Mace and Lande's (1991) proposal by adding an additional seven characteristics for threatened species categorization systems (Table 2). Although these characteristics could be enriched with other elements, it constitutes a good base for defining criteria from which to establish which categorization system is most suitable to assess the real conservation status of species.

For each categorization system we determined whether it complied with the desirable characteristics of categorization systems (Table 2). If the desirable characteristic was present in the system, it was given one point. The final result for each system was the sum of the points given for the desirable characteristics it possessed. The highest score possible was 13, meaning all the characteristics were present and satisfactory. We did not consider the type of information required by the systems or whether the information used in the assessments is explicitly registered (characteristics 11 and 15 in Table 2) because they were difficult to assess based on the available information.

Categorization Systems Used on the American Continent

At least two categorization systems are used in America to evaluate the international conservation status of a species: that of the IUCN and The Nature Conservancy (TNC). The former is more widely known because of the red books or lists published for more than 30 years, the large number of publications by specialists of the Species Survival Commission (SSC) in international journals, and the many IUCN publications in different languages.

At the country level there are three trends. Some countries have a list of threatened species devised by the government to be used as a tool for legislating the conservation of their biological diversity. Some countries, in addition to the official governmental list, have an unofficial list developed by academic institutions or nongovernmental organizations. Often when two lists are used, the unofficial list is a red list (or several lists with taxonomic groups listed separately) based on some version of the IUCN system. Finally, some countries officially recognize the red lists drawn up by academic institutions (Table 1).

In Paraguay and Uruguay workshops have been held to construct red lists based on the IUCN system. We do not know whether the results have been published or whether the governments of these countries have issued any official lists of threatened species before or after (based on) these workshops.

We found and examined five categorization systems proposed by academics (Burke & Humphrey 1987; Ceballos & Navarro 1991; Reca et al. 1994; Sánchez 1996; Cofré & Marquet 1999).

Virtues and Limitations of Categorization Systems

All the efforts to classify threatened species constitute an important advance in the management of biological

Table 1. Threatened species categorization systems used on the American continent.*

System	*System or threatened species list*	*Type of system*	*Reference*
International			
IUCN pre-1994	IUCN Mammal Red Data Book		Thornback & Jenkins 1982
IUCN 1994	IUCN Red List of Threatened Animals		IUCN 1994*b*; IUCN 1996
IUCN 2001	IUCN Red List of Threatened Animals		IUCN 2001
TNC 1996	Status and Distribution Data on North American Plants		www.nature.org
National			
Argentina	Decreto Nacional 666	own	www.medioambiente.gov.ar
	Mamíferos y Aves Amenazados de la Argentina	IUCN 1994	García-Fernández et al. 1997; Díaz & Ojeda 2000
Belize	Wildlife Protection Act No. 4. 25 November 1981	own	CCAD 1999
Bolivia	Libro Rojo de los Vertebrados de Bolivia	IUCN pre-1994 & 1994	Ergueta & de Morales 1996
Brazil	Portaria Ibama N° 1.522	own	www.ibama.gov.br
	Portaria Ibama N° 06/92	own	www.ibama.gov.br
	Livro Vermelho dos Mamíferos Brasileiros Amenaçados de Extinçao	IUCN 1994	da Fonseca et al. 1994
	Lista Nacional das Espécies da Fauna Brasileira Amenaçadas de Extinçao	IUCN 2001	www.mma.gov.br
Canada	Committee on the Status of Endangered Wildlife in Canada List of Species at Risk	own	www.cosewic.gc.ca
Chile	Ley N° 19.300	own	Marquet 2000
	Red List of Chilean Vertebrates	IUCN pre-1994	Glade 1987
Colombia	Libros Rojos de Colombia	IUCN 2001	e.g., Renjifo et al. 2002
Costa Rica	Lista de Especies de Fauna Silvestre con Poblaciones Reducidas y en Peligro de Extinción para Costa Rica	own	MINAE 1997
Ecuador	Libros Rojos de Ecuador (aves y mamíferos)	IUCN 2001	Tirira 2001
El Salvador	Listado Oficial de Especies de Fauna Vertebrada Amenazada y en Peligro de Extinción en El Salvador	own	MAG 1994
Guatemala	Lista Roja de Fauna Silvestre de Guatemala	own	CONAP 1996
Honduras	Lista de Especies Animales Silvestres de Preocupación Especial de Honduras	own	DAPVS 1998
Mexico	NOM-059-ECOL-1994	own	INE 1994
	NOM-059-SEMARNAT-2001	own	SEMARNAT 2002
Nicaragua	Listado de Especies Nicaragüenses de Fauna Amenazadas o en Peligro de Extinción y que son Objeto de Regulación Especial por parte del Estado (Anexos CITES)	own	MARENA 1996
Panama	Lista de Fauna en Peligro de Extinción de Panamá	own	CCAD 1999
Paraguay	Unknown	IUCN 1994	M. Giménez-Dixon, personal communication.
Peru	Especies de Fauna Amenazada del Perú (Decreto Supremo N° 013-99-AG)	own	www.inrena.gob.pe
	Libro Rojo de Fauna Silvestre del Perú	IUCN pre-1994	Pulido 1991
United States	The Endangered Species Act of 1973	own	www.endangered.fsw.gob
Uruguay	Unknown	IUCN 1994	M. Giménez-Dixon, personal communication
Venezuela	Libro Rojo de la Fauna Venezolana	IUCN 1994	Rodríguez & Rojas-Suárez 1999
Proposals of academics			
United States	Burke & Humphrey	own	Burke & Humphrey 1987
Mexico	Ceballos & Navarro	own	Ceballos & Navarro 1991
Argentina	Reca et al.	own	Reca et al. 1994
Mexico	Modelo de Riesgo de Valores Relativos	own	Sánchez 1996
Chile	Conservation Priority Index	own	Cofré & Marquet 1999

**Abbreviations: IUCN, World Conservation Union; TNC, The Nature Conservancy; CCAD, Comisión Centroamericana de Ambiente y Desarrollo; MINAE, Ministerio del Medio Ambiente y Energía; MAG, Ministerio de Agricultura y Ganadería; CONAP, Consejo Nacional de Áreas Protegidas; DAPVS, Departamento de Áreas Protegidas y Vida Silvestre; INE, Instituto Nacional de Ecología; SEMARNAT, Secretaría del Medio Ambiente y Recursos Naturales; MARENA, Ministerio del Ambiente y Recursos Naturales; CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora.*

Table 2. Desirable characteristics of threatened species categorization systems.

System characteristic	*Source*[a]
Risk categories	
1. system establishes risk categories	1
2. categories have an explicit definition	1
3. definitions of categories do not include subjective elements	2
4. categories have clear relationship with each other (i.e., each category delimits different intensities of risk of extinction)	1
5. categories measure species probability of extinction within a given time	1
Criteria	
6. system establishes clear, explicit criteria with which species are assessed to assign them a risk category	1
7. criteria do not include confusing or ambiguous elements	2
8. criteria use information that assesses species conservation status and do not mix this information with that used to evaluate conservation priorities	2
9. system does not use redundant arguments to categorize species (e.g., including species because they are in other lists such as CITES[b] or IUCN[c]) or accumulative characteristics of species intimately related to each other (e.g., award points for both body mass and abundance)	2
Other system characteristics	
10. system is objective and based on science and thus includes evaluations of the level of uncertainty and considerations of risk tolerance	1
11. system is flexible in terms of the required information (i.e., it maximizes the use of the scant information)	1
12. system is flexible so that different taxonomic levels can be assessed (e.g., species, subspecies, or even populations)	1
13. system is applicable at different geographic scales (regional, national, and global)	2
14. system is dynamic so that it can be updated when new information is available or when the species circumstances change	2
15. systems include systematic and explicit records of information used to categorize species, including the details of the assessors, which is available to the public and can be the basis of future reassessments	2

[a] *Key: 1, Mace & Lande 1991; 2, this study.*
[b] *Convention on International Trade in Endangered Species of Wild Fauna and Flora.*
[c] *World Conservation Union.*

diversity. Nevertheless, the categorization systems we analyzed have a number of deficiencies, most of which are related to the definition of the categories and criteria (Appendix).

System Categories

All but six (76%) of the systems evaluated have risk categories (Fig. 1). Fifteen (60%) systems have explicit definitions of their categories, but only seven (28%) exclude subjective elements in the definitions of their categories. One clear example of subjective elements in the definition of risk categories is in Mexican legislation (SEMARNAT 2002), in which the category "endangered species" includes text such as "short or medium term" or "continue operating the factors that negatively affect its viability." In the definition, neither the meaning of "short or medium term" nor the intensity of factors is made explicit. Other examples of subjective elements commonly included in the definitions are "a continuous decrease in populations," "populations reduced to a critical level," and "populations with a drastic reduction."

Ten (40%) of the evaluated systems use categories that have a direct relationship to the species' conservation status (Fig. 1). Text that exemplifies the erroneous use of this type of category include "subject to special protection" (SEMARNAT 2002), "insufficiently known" (IUCN 1994*a*), "rare" (INE 1994; IUCN 1994*a*), "species with reduced populations" (MINAE 1997), and "commercially threatened" (IUCN 1994*a*).

The category "rare" species used by the pre-1994 IUCN system (and therefore by the countries that adopted this system) and by the Chilean, Peruvian, and Brazilian systems denotes an intrinsic ecological characteristic of the taxon and not necessarily the level of threat in which it is found. Rarity is an ecological characteristic that defines the relationships among distribution, abundance, and some biological traits of the species (Rabinowitz 1981; Gaston 1994). Rarity is one of the characteristics of species that affects their vulnerability to extinction (Arita et al. 1990) and, therefore, it can be considered in categorization systems as a criterion but not as a risk category. Another category that does not have a direct relationship to the species' conservation status is the category of "species subject to special protection" used in the Mexican norm (INE 1994; SEMARNAT 2002). The species "subject to special protection" may or may not be threatened, and resource managers define which species are given special protection. In other words, designating a species to this category is a management decision (presumably, congruent with some priority criterion), but the category is not indicative of the conservation status of a species. Finally, the category "conservation dependent"

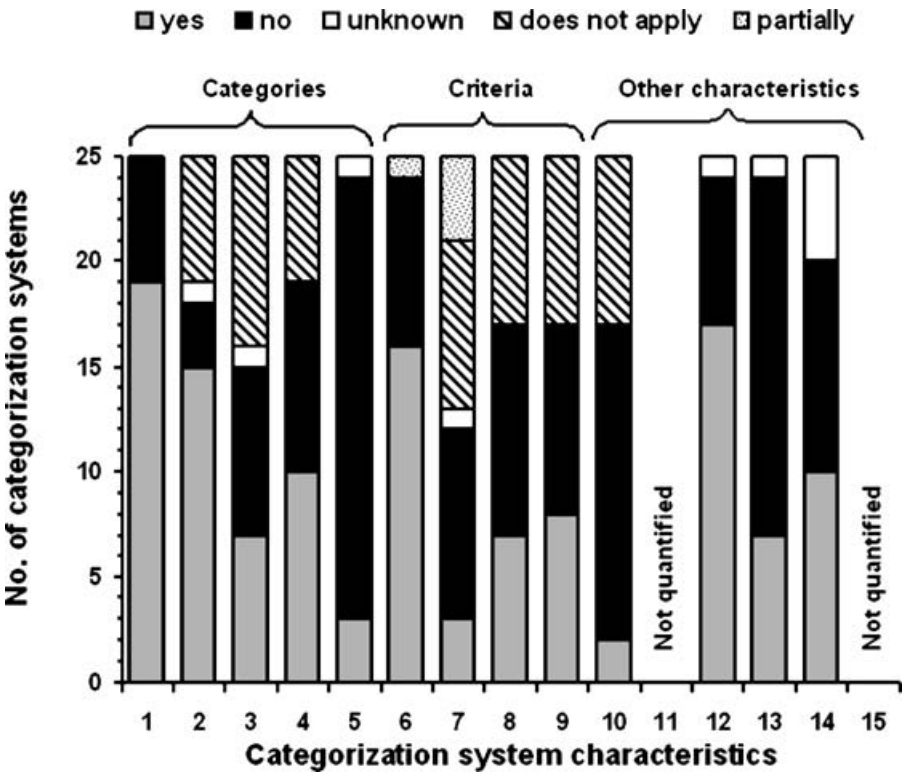

Figure 1. Threatened species categorization systems used on the American continent that include the desirable characteristics of a categorization system. Numbers on x-axis refer to the desirable characteristics listed in Table 2. "Does not apply" means a system does not have a particular element (categories, criteria, or other characteristics) and therefore could not be evaluated.

in the IUCN system (1994*b*) does not indicate the conservation status of a species per se; that is, survival of an endangered or vulnerable species may be dependent on conservation.

Only the categories of the IUCN (1994*b*, 2001) and the newly proposed Chilean system (Marquet 2000) measure risk of species extinction on a finite temporal scale (Fig. 1). This characteristic is important in terms of actions to be implemented to protect the species because it helps people understand the seriousness of the situation and helps managers time conservation programs (Mace & Lande 1991). For example, when a species is defined as being in danger of extinction, such as "species whose distribution or population size have decreased drastically, placing its survival at risk" (SEMARNAT 2002), it can be assumed that the situation of the species is one of concern. The time it will take for a species to become extinct if measures of protection are not taken, however, is not indicated. In contrast, if a species is defined as in danger of extinction, for example, because it has "20% probability of extinction in a period of 20 years or 10 generations, which ever comes first" (IUCN 2001), it is known more precisely how long it will take for a species to become extinct if measures of protection are not taken immediately.

System Criteria

Sixteen systems (64%) contain explicit criteria. The Nicaraguan list gives criteria for only two of its threat categories (Fig. 1). When a categorization system does not consider criteria for the inclusion of species evaluated in different categories, species can be included in the lists in an arbitrary manner, often following political or economic interests rather than those of conservation.

Not only is it necessary to have criteria, but it is also necessary to have clear definitions of them, so that interpretations are always the same. It is advisable that the definitions of the criteria be quantitative. Generally, qualitative criteria can be interpreted in different ways and tend to be subjective, although if there is an adequate definition, qualitative criteria could be objective. For example, it is not enough to consider "species with locally small populations" (CONAP 1996); rather, it is necessary to define what is considered locally small. Some of the subjective elements (or terms) most commonly found in definitions of criteria are "very abundant," "common," "scarce," "very rare," "wide distribution," "limited distribution," and "very localized distribution." Only the IUCN system (1994*b* and 2001) defines all the criteria quantitatively. Only the IUCN (1994*b*, 2001) and TNC (1996) systems include criteria free of subjective elements (12%), four systems (16%) have some criteria free of subjective elements, and the rest do not have criteria or have deficient criteria.

Ten of the systems that include criteria (59%) contain information that relates more to designating conservation priorities than to defining conservation status (Fig. 1). The most common are the use of endemism and the taxonomic singularity of the species, but criteria related to cultural importance and the species' importance for

ecotourism and science are also common. El Salvador's system also uses criteria related to the form in which information to evaluate species conservation status is obtained, for example, "use of bibliographic information and number of existing recordings."

Of the systems that include criteria, nine (53%) have redundant arguments because they include species previously listed by IUCN or CITES or because they include in their criteria species characteristics that are intimately related (Fig. 1). For example, Nicaragua's system includes only the species listed in the CITES appendixes. Another example is that of the Ceballos and Navarro system (1991) in which "trophic level" and being a "carnivorous species" are criteria. In this case the same characteristic (diet) of the species is measured twice. Sánchez (1996) uses species characteristics such as "body mass," "size," "gestation period," and "average number of offspring," which are closely related (Peters 1983). Other correlated variables are distribution, abundance, and body mass (Robinson & Redford 1986; Arita et al. 1990).

Other System Characteristics

Only the IUCN system (1994*b*, 2001) considers evaluations of the level of uncertainty associated with the data used to assess species conservation status and contemplates risk tolerance. Most of the systems we examined do not state explicitly whether they can be applied at different taxonomic levels or geographic scales. Most of these systems (68%) could be applied to species, subspecies, and populations, although this has generated heated debates in some countries (e.g., O'Brien & Mayr 1991; Losos 1993). Only the IUCN system (1994*b*, 2001) and those proposed by Reca et al. (1994), Sánchez (1996), and Cofré and Marquet (1999) specify national, regional, or local application. Nevertheless, at least two other systems may be applicable to different geographic scales. Ten of the systems (40%) seem to be dynamic; categorizations can be updated as new or better information becomes available (Fig. 1).

There are two main trends in the type of information used to evaluate species conservation status in the 25 systems we analyzed. The first trend, exemplified by the IUCN system (1994*b*, 2001), is to use information on population characteristics. This system requires information on past and present distribution and abundance of the populations. Some authors (e.g., Reca et al. 1994; Cofré & Marquet 1999; Grigera & Rau 2000; Grigera & Ubeda 2000) argue that this type of information is difficult to obtain and not available or nonexistent for most of the species, especially in developing countries.

The second trend, exemplified by Ceballos and Navarro (1991), Reca et al. (1994), Cofré and Marquet (1999), and SEMARNAT (2002), is to use species' intrinsic characteristics that are related to vulnerability to extinction and information about human activities that put the survival of species at risk. In general, this type of information is more accessible, but not always. Some of the characteristics used in these systems—for example, reproductive characteristics (number of offspring per year or age at first reproduction)—are not easily obtained. The effect of human activity is also difficult to obtain because the same activity can affect different species in different ways (Carrillo et al. 2000; Cuarón 2000). This type of systems tends to evaluate the potential vulnerability of a species rather than its actual conservation status.

The Most Adequate System

Our results show that every system has defects and virtues. Some systems, however, are more appropriate for determining species conservation status. The system that had the highest number of desirable characteristics was IUCN (2001), followed by IUCN (1994*b*), TNC (1996), Burke and Humphrey (1987), Ceballos and Navarro (1991), and Cofré and Marquet (1999). These systems have more than 60% of the characteristics we recommend for evaluating species conservation status as objectively as possible (Fig. 2).

All country categorization systems we considered have serious deficiencies (Fig. 2; Appendix). Canada's system scored the highest but contained only half the desirable characteristics of a categorization system. Some countries' systems have only the rudiments of a threatened species list. A repeated pattern is the inclusion of both criteria that help determine the species conservation status and criteria used to define conservation priorities. This defect is largely because the lists are used as normative tools and not exclusively as lists of threatened species. More important, it is evident that there is much confusion over the concepts related to categorization systems and their characteristics.

The Ceballos and Navarro (1991) system has both threat categories and explicit criteria but also some deficiencies. It contains redundant arguments because it includes species that were listed previously by IUCN and uses criteria that measure the same characteristic ("trophic level" and "being a carnivorous species"). It also mixes criteria that are useful for evaluating species conservation status with those that determine conservation priorities. The model they propose is an index that helps evaluate the potential conservation status of a species but not the species' real situation, a characteristic shared by other, similar systems (e.g., Reca et al. 1994; Cofré & Marquet 1999).

Virtues of the Cofré and Marquet (1999) proposal are that it is flexible in terms of the information necessary to apply the system and has criteria for evaluating species conservation status. Also, although risk categories are not explicitly defined in terms of probability of extinction of the species, there is a clear relationship among categories.

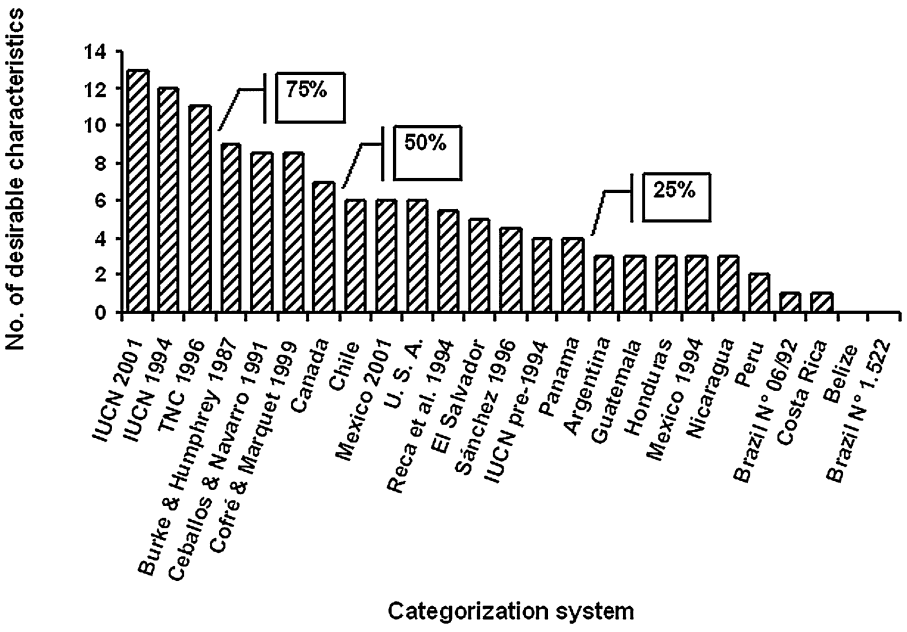

Figure 2. Number of desirable characteristics presented by each threatened species categorization system used on the American continent. Refer to Table 1 and the Appendix for details on each of the categorization systems.

Nevertheless, this system, like that of Reca et al. (1994) and Sánchez (1996), is limited by the use of statistical criteria to delimit threat categories. This means that the intervals used to define the categories can vary depending on the species being evaluated. The degree of danger a species is in is not relative; that is, there is not a relative proportion of threatened species. Moreover, this system mixes conservation priorities with the evaluation of extinction risk and includes redundant elements in its categories. Finally, the model they propose is a vulnerability index that does not necessarily reflect the actual state of species conservation.

The TNC (1996) system obtained a high score; the system is designed only for plants, however, and uses only the number of occurrences of specimens to classify the species. Although the Burke and Humphrey (1987) proposal had a high score, it is based only on rarity as the criterion for determining the degree a species is endangered, leaving out of the list those species that are not considered rare but may be facing extinction. Although the criteria are explicit and quantitative, they are not yet well established. In fact, the authors suggest use of different criteria for each taxonomic group. This is a serious limitation to its general applicability.

The IUCN (2001) system also has some details that need to be improved. For example, it is important to define locations quantitatively (the number of locations in which a species is found is a subcriterion of criteria B and D) or to omit subjective words such as "typically." Even with these details, the IUCN system (2001) is the method that has the most potential because it clearly defines categories and criteria. Also, it is the only system that considers uncertainty in the assessment, and there is software available to calculate species categories and uncertainty (Akçakaya et al. 2000; Akçakaya & Ferson 2001). Moreover, the application of the IUCN 2001 system at a national or regional level has apparently been successful (e.g., da Fonseca et al. 1994; Ergueta & de Morales 1996; Rivera 1996; García Fernández et al. 1997; Rodríguez & Rojas-Suárez 1999; Lavilla et al. 2000; Dollar 2000; Tirira 2001; Carton de Grammont 2002, 2005), although the proposed guidelines for regional assessments (Gärdenfors et al. 2001) have not been applied yet. Even if there are authors who argue that the information required by this system is difficult to obtain, there are methods for obtaining or generating this information with relatively little effort and low cost (Carton de Grammont 2002, 2005; A.D.C. & P.C.G., unpublished data). Nevertheless, there are still important deficiencies in its application. Training workshops in different parts of the world have been organized to solve this limitation. So it may be only a matter of time before this problem is solved.

The many categorization systems and lists and the incompatibility and incongruence among them (Cuarón 1993; Rodríguez et al. 2000) limit the effectiveness of conservation planning and action. There is a need for a unified categorization system and effort. Why, after the seminal paper by Mace and Lande (1991), are there still so many different categorization systems? This is difficult to assess, but in our opinion, the most likely reasons are ignorance of what constitutes a categorization system (in large part because of the lack of access to scientific literature in many parts of the world) and a good bit of nationalistic chauvinism.

Recommendations

On the basis of our analysis, we recommend two courses of action relative to country lists of threatened species.

First, governments should use three types of lists. The first is the list of threatened species, which should be constructed following a categorization system that has the desirable characteristics we present here. We recommend the IUCN (2001) system as the most suitable. A second list should contain species of conservation priority and consider information relative to threats to the species, level of endemism, taxonomic singularity, and economic, political, cultural, or scientific importance. It will be necessary to propose specific guidelines (categories and criteria) to construct this list. The third list (or lists) should include normative tools such as hunting calendars or the CITES list that, for example, indicate which species are usable and which are banned from use.

Second, threatened species lists should report species conservation status (i.e., the category of risk a species faces) and include the criteria with which each species was classified. So, the criteria with which the species was evaluated are reported (IUCN [2001] system), as is the information used to categorize species and the name of the assessors. This information is useful when updating the categorization of a species, constructing the other two types of lists, and preparing and implementing management plans. The 2003 IUCN Red List (www.redlist.org) includes this type of information for some species (although the quality of these accounts is uneven).

Conclusions

To be efficient conservation tools, threatened species lists should be prepared based on categorization systems that objectively assess species extinction risk. To do so these systems should comply with the 15 characteristics we propose for a threatened species categorization system.

Of the 25 categorization systems of threatened species we evaluated, the IUCN (2001) system is the most adequate in terms of its categories, criteria, and other characteristics. It is important to recognize, however, that much of the information required by this system may not be available, and so it is important to develop methods to obtain the necessary information directly or indirectly. The country categorization systems we evaluated have serious defects and must be substantially improved and complemented with lists of species of conservation priority and lists that serve as normative tools. To make the most of threatened species lists in conservation, it is imperative that all countries use the same categorization system or, at least, compatible systems.

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Appendix . Characteristics of 25 threatened species categorization systems used on the American continent.*

	Category characteristic					*Criterium characteristic*			
System	*(1) includes risk categories*	*(2) has an explicit definition*	*(3) definition does not include subjective elements*	*(4) has a clear relationship with other categories*	*(5) measures species probability of extinction within a given time*	*(6) explicit*	*(7) no confusing or ambiguous elements*	*(8) no information that does not serve to assess species conservation status*	*(9) no redundant arguments*
IUCN pre-1994	yes	yes	no	no	no	no	na	na	na
IUCN 1994	yes	yes	yes	no	yes	yes	yes	yes	yes
IUCN 2001	yes	yes	yes	yes	yes	yes	yes	yes	yes
TNC 1996	yes	yes	yes	yes	no	yes	yes	yes	yes
Argentina	yes	yes	no	yes	no	no	na	na	na
Belize	no	na	na	na	no	no	na	na	na
Brazil N° 1.522	no	na	na	na	no	no	na	na	na
Brazil N° 06/92	yes	no	na	no	no	no	na	na	na
Canada	yes	yes	no	yes	no	yes	no	yes	yes
Chile	yes	yes	yes	no	yes	yes	no	no	no
Costa Rica	yes	no	na	no	no	no	na	na	na
El Salvador	yes	yes	no	yes	no	yes	no	no	no
Guatemala	no	na	na	na	no	yes	no	no	no
Honduras	no	na	na	na	no	yes	no	no	no
Mexico 1994	yes	yes	no	no	no	no	na	na	na
Mexico 2001	yes	yes	no	no	no	yes	no	yes	yes
Nicaragua	yes	no	INA	no	no	yes	no	no	no
Panama	yes	INA	INA	yes	INA	yes	INA	no	yes
Peru	yes	yes	no	no	no	no	na	na	na
United States	yes	yes	no	yes	no	yes	no	no	yes
Burke & Humphrey 1987	yes	yes	yes	yes	no	yes	no	yes	no
Ceballos & Navarro 1991	yes	yes	yes	yes	no	yes	2 of 10	no	no
Reca et al. 1994	no	na	na	na	no	yes	4 of 12	no	yes
Sánchez 1996	no	na	na	na	no	yes	6 of 10	yes	no
Cofré & Marquet 1999	yes	yes	yes	yes	no	yes	7 of 9	no	no

continued

Appendix . (continued)

System	Other characteristics				Type of information required by system
	(10) includes evaluations of the level of uncertainty and considerations of risk tolerance	*(12) applicable at different taxonomic levels*	*(13) applicable at different geographic scales*	*(14) dynamic*	
IUCN pre-1994	na	yes	no	yes	na
IUCN 1994	yes	yes	yes	yes	quantitative analysis of extinction risk (e.g., PVA); population and distribution size and trends
IUCN 2001	yes	yes	yes	yes	quantitative analysis of extinction risk (e.g., PVA); population and distribution size and trends
TNC 1996	no	yes	no	no	number of occurrences of specimens or individuals
Argentina	na	no	no	INA	INA
Belize	na	no	no	no	na
Brazil N° 1.522	na	no	no	INA	INA
Brazil N° 06/92	na	no	no	INA	INA
Chile	no	no	no	yes	quantitative analysis of extinction risk (e.g., PVA); population size and trends; distribution size and trends
Costa Rica	na	no	no	INA	INA
El Salvador	no	yes	no	no	population size, distribution, anthropic factors that place species at risk, habitat specificity
Honduras	no	yes	no	yes	distribution, importance to humans
Guatemala	no	yes	no	yes	anthropic factors that place species at risk, endemism, rarity (distribution, abundance, habitat specificity)
Mexico 1994	na	yes	no	no	na
Mexico 2001	no	yes	no	no	distribution, anthropic factors, biological characteristics that place species at risk
Nicaragua	no	yes	no	no	international trade and hunting
Panama	no	INA	INA	INA	INA
Peru	na	no	no	no	INA
Canada	no	yes	no	no	population size, distribution, natural and anthropic factors that place species at risk
United States	no	yes	no	no	population size, distribution, natural and anthropic factors that place species at risk
Burke & Humphrey 1987	no	yes	yes	yes	rarity (distribution, abundance, body size)
Ceballos & Navarro 1991	no	yes	yes	yes	anthropic factors and biological characteristics that place species at risk
Reca et al. 1994	no	yes	yes	yes	distribution, abundance, biological characteristics that place species at risk, extractive actions, and protection degree
Sánchez 1996	no	yes	yes	no	biological characteristics that place species at risk, effect of human activities, historical environmental factors
Cofré & Marquet 1999	no	yes	yes	yes	distribution, abundance, body size, effect of human activities, and protection degree

**Abbreviations: na, not applicable; INA, information not available; IUCN, World Conservation Union; TNC, The Nature Conservancy; PVA, population viability analysis.*