EQUID
GLOBAL CAPTIVE ACTION RECOMMENDATIONS WORKSHOP

FIRST REVIEW DRAFT

Report from the workshop held
8-11 March 1994

Edited by
Cheryl Asa, Mary Rowen, Ann Oakenfull, Simon Wakefield, and Onnie Byers

Compiled by the Workshop Participants

SPECIES SURVIVAL COMMISSION

Equid Specialist Group

A Collaborative Workshop

SSC Equid Specialist Group

AZA Equid Taxon Advisory Group

IUCN/SSC Conservation Breeding Specialist Group

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GLOBAL CAPTIVE ACTION RECOMMENDATION
WORKSHOP

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EXECUTIVE SUMMARY

Of the 20 distinct equid taxa considered by participants during the Equid Conservation Assessment and Management Plan workshop, 8 species/subspecies (in various categories of threat according to Mace-Lande criteria) were assigned to one of 3 levels of captive programs:

Level 1	5 taxa (4 Critical, 1 Endangered)
Level 2	2 taxa (Vulnerable)
Level 3	1 taxon (Critical)

Captive programs for eight taxa were listed as "pending", meaning that recommendations for these taxa would be postponed until further information was available, either from survey, a PHVA, or other sources. Two taxa were considered extinct and the remaining two taxa were identified as not requiring captive programs.

Target populations were computed for seven taxa during the Global Captive Action Recommendations workshop. Global captive population targets ranged from 175 to 600 individuals. In two cases (28.6%), the target population is lower than the current global captive population indicating a recommendation to manage the captive population toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority. In the remaining 5 taxa (71.4%), the recommended target population constitutes a considerable increase in the current captive populations.

Regional information has been obtained from North America, Europe, Australasia and Africa. Each region currently maintains captive programs for several taxa:

North America	7 taxa
Europe	7 taxa
Australasia	5 taxa
Africa	4 taxa

In these four regions, captive programs currently exist for 10 (50%) of the 20 equid taxa. All of the 8 taxa recommended for captive management, have 5 or more individuals currently in captivity in one or more of these regions.

All calculations of Mace-Lande criteria and all recommendations are based on estimates of wild population numbers and trends and on estimates of habitat area and conditions. As with all CBSG programs, the GCAR process is continually evolving as additional workshops are held and as reports from completed workshops are reviewed. Similarly, the GCAR document is a "living" set of guidelines, meaning that it will be reassessed and revised continually based upon new information and shifting needs. As additional regional information regarding current and planned population sizes becomes available, it will be incorporated into this document and made available to the various regions of the zoo world to serve as a guide when planning or revising regional collections.

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SECTION 1

WORKSHOP SUMMARY AND RECOMMENDATIONS
GLOBAL CAPTIVE ACTION RECOMMENDATIONS (GCAR)
FOR EQUIDS

Introduction

Reduction and fragmentation of wildlife populations and habitat are occurring at a rapid and accelerating rate. For an increasing number of taxa, the results are small and isolated populations at risk of extinction. A rapidly expanding human population, now estimated at 5.25 billion, is expected to increase to 8 billion by the year 2025. This expansion and concomitant utilization of resources has momentum that cannot be stopped, the result being a decreased capacity for all other species to simultaneously exist on the planet.

As wildlife populations diminish in their natural habitat, wildlife managers realize that management strategies must be adopted that will reduce the risk of extinction. These strategies will be global in nature and will include habitat preservation, intensified information gathering, and in some cases, scientifically managed captive populations that can interact genetically and demographically with wild populations.

Within the Species Survival Commission (SSC) of IUCN-The World Conservation Union, the primary goal of the Conservation Breeding Specialist Group (CBSG) is to contribute to the development of holistic and viable conservation strategies and management action plans. Toward this goal, CBSG is collaborating with agencies and other Specialist Groups worldwide in developing scientifically-based processes, on both a global and regional basis, with the goal of facilitating an integrated approach to species management for conservation.

In addition to managing the natural habitat, conservation programs leading to viable populations may sometimes require a captive component. In general, captive populations and programs, or the use of captive technologies, can serve several roles in holistic conservation: 1) as genetic and demographic reservoirs that can be used to reinforce wild populations either by revitalizing populations that are languishing in natural habitats or by re-establishing by translocating populations that have become depleted or extinct; 2) providing scientific resources for information and technology that can be used to protect and manage wild populations; and 3) as living ambassadors that can educate the public and generate funds for *in situ* conservation.

It is proposed that, when captive populations or captive technology can assist species conservation, captive and wild populations should, and can be, intensively and interactively managed with feasible interchanges of animals occurring as needed. Captive populations should be a support, not a substitute, for wild populations. There may be problems with respect to disease, logistics and financial limitations. In the face of the immense extinction crisis facing many taxa, these issues must be addressed and resolved immediately.

Captive breeding programs have limited resources. Priorities must be developed cooperatively among all regions of the world for program development and resource allocation, the purpose of the Global Captive Action Recommendation process. Once global priorities are known, regional captive propagation programs can be developed to assist in practical conservation.

Global Captive Action Recommendations (GCARs)
A Global Captive Action Recommendations (GCAR) Workshop was held on 8-12 March 1994. Ten individuals met in San Diego, California to begin establishment of global priorities that, in turn, can be used by all regional taxon advisory groups to formulate, coordinate, and implement effective Regional Collection Plans that together will have a true global conservation impact. GCARs are derived from the Conservation Assessment and Management Plan (CAMP) process. The CAMP recommends which species/subspecies deserve attention, and the GCAR determines which region(s) are responsible for propagating a target number of animals to sustain a healthy world population. This system assumes that captive populations be treated as an integral part of the metapopulations being managed by conservation strategies and action plans. Viable metapopulations may need to include captive components. The IUCN Policy Statement on Captive Breeding recommends, in general, that captive propagation programs be a component of conservation strategies for taxa in which the wild population is below 1,000 individuals. Captive and wild populations should and can be intensively and interactively managed with interchanges of animals occurring as needed and as feasible, after appropriate analysis. There may be problems with interchanges including epidemiologic risks, logistic difficulties, and financial limitations. However, limited but growing experience suggests that these problems can be resolved. Strategies and priorities should maximize options while minimizing regrets for species conservation.

Captive populations are a support and a reservoir, not a substitute, for wild populations. A primary focus of the GCAR is on captive propagation programs that can serve as genetic and demographic reservoirs to support survival and recovery of wild populations in the future. The purpose of the GCAR workshop is to provide strategic guidance for captive programs at both the global and regional level in terms of captive breeding. GCAR workshop activities include considering how the various regional programs for each group of taxa might interact and combine to catalyze a truly effective global effort. An important aspect is establishing global target population size goals (i.e., how many individuals ultimately to maintain). More specifically, GCARs recommend which taxa are most in need of captive propagation and thus:

1) which taxa in captivity should remain there,
2) which taxa not yet in captivity should be there, and
3) which taxa currently in captivity should no longer be maintained there.

There are multiple genetic and demographic objectives affecting the captive population target: some taxa require large population sizes for a long time, where others need small nuclei or reduced gene pools that can be expanded later, if needed. One result of the GCAR will be an ability to logically adjust current captive population sizes in various regions, hopefully to better sustain threatened taxa as well as to identify new space available for conserving other species/subspecies receiving insufficient attention.

In summary, the GCAR provides the strategic framework for establishing global priorities that, in turn, can be used by all regional taxon advisory groups to formulate, coordinate, and implement effective Regional Collection Plans that together will have a true global conservation impact.

GCAR Workshop Goals

The goals of the GCAR are:

1) to review CAMP data and discuss required changes;
2) to prioritize taxa in need of captive management and to identify global target population sizes; and
3) to evaluate the direction of regional collection plans on the basis of global conservation priorities identified by the GCAR process.

The GCAR Process

A major consideration in establishing priority species for captive management is the category of threat assigned to the taxon. Mace-Lande criteria (Mace & Lande, 1991) and the Draft IUCN Red List criteria, were applied to each taxon during the CAMP process. The Mace-Lande process assesses threat in terms of the likelihood of extinction within a specified time period and defines three categories:

Critical	50% probability of extinction within 5 years or two generations, whichever is longer
Endangered	20% probability of extinction within 20 years or 10 generations, whichever is longer
Vulnerable	10% probability of extinction within 100 years

In assessing threat according to Mace-Lande criteria, workshop participants also use information on the status and interaction of habitat and other characteristics (Table 1). Information about population trends, fragmentation, range, and stochastic environmental events, real and potential, also are considered. The number of equid taxa in the wild by range country or region and by Mace-Lande category of threat is presented in Table 3. All Mace-Lande category assignments and all recommendations are based on estimates of wild population numbers and trends and on estimates of habitat area and conditions.

Table 1. MACE-LANDE CATEGORIES AND CRITERIA FOR THREAT

POPULATION TRAIT	CRITICAL	ENDANGERED	VULNERABLE
Probability of extinction	50% within 5 years or 2 generations, whichever is longer	20% within 20 years or 10 generations, whichever is longer	10% within 100 years
	OR	**OR**	**OR**
	Any 2 of the following criteria:	Any 2 of following criteria or any 1 CRITICAL criterion	Any 2 of following criteria or any 1 ENDANGERED criterion
Effective population N_e	$N_e < 50$	$N_e < 500$	$N_e < 2,000$
Total population N	$N < 250$	$N < 2,500$	$N < 10,000$
Subpopulations	≤ 2 with $N_e > 25$, $N > 125$ with immigration < 1/generation	≤ 5 with $N_e > 100$, $N > 500$ or ≤ 2 with $N_e > 250$, $N > 1,250$ with immigration < 1/gen.	≤ 5 with $N_e > 500$, $N > 2,500$ or ≤ 2 with $N_e > 1,000$, $N > 5,000$ with immigration < 1/gen.
Population Decline	> 20%/yr. for last 2 yrs. or > 50% in last generation	> 5%/yr. for last 5 years or > 10%/gen. for last 2 years	> 1%/yr. for last 10 years
Catastrophe: rate and effect	> 50% decline per 5-10 yrs. or 2-4 generations; subpops. highly correlated	> 20% decline/5-10 yrs, 2-4 gen > 50% decline/10-20 yrs, 5-10 gen with subpops. highly correlated	> 10% decline/5-10 yrs. > 20% decline/10-20 yrs. or > 50% decline/50 yrs. with subpops. correlated
OR			
Habitat Change	resulting in above pop. effects	resulting in above pop. effects	resulting in above pop. effects
OR			
Commercial exploitation or Interaction/introduced taxa	resulting in above pop. effects	resulting in above pop. effects	resulting in above pop. effects

Draft IUCN Red List Categories.
The threatened species categories now used in IUCN Red Data Books and Red Lists have been in place, with some modification, for almost 30 years (see Mace and Stuart, 1994, in Section 4). The Mace-Lande criteria were one developmental step in an attempt to make those categories more explicit. These criteria subsequently have been revised and formulated into new Draft IUCN Red List Categories, which also are being tested in the CAMP process.

The Draft IUCN Red List Categories (Table 2) provide a system which facilitates comparisons across widely different taxa, and is based both on population and distribution criteria. Like the Mace-Lande criteria, the new criteria can be applied to any taxonomic unit at or below the species level, with sufficient range among the different criteria to enable the appropriate listing of taxa from the complete spectrum of taxa, with the exception of micro-organisms (Mace and Stuart, 1994).

The categories of Critical, Endangered, and Vulnerable are all nested (i.e., if a taxa qualifies for Critical, it also qualifies for Endangered and Vulnerable). This system introduces a new category of threat "Susceptible." The Draft IUCN Red List Categories are:

EXTINCT (EX)
A taxon is **Extinct** when there is no reasonable doubt that its last individual has died.

EXTINCT IN THE WILD (EW)
A taxon is **Extinct in the Wild** when it is known only to survive in cultivation, in captivity, or as a naturalized population (or population) well outside the past range.

CRITICAL (CR)
A taxon is **Critical** when it is facing an extremely high risk of extinction in the wild in the immediate future as defined by the criteria listed in Table 4.

ENDANGERED (EN)
A taxon is **Endangered** when it is not Critical but is facing a very high risk of extinction in the wild in the near future, as defined by the criteria listed in Table 4.

VULNERABLE (VU)
A taxon is **Vulnerable** when it is not Critical or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by the criteria listed in Table 4.

CONSERVATION DEPENDENT (CD)
Taxa which do not currently qualify under any of the categories above may be classified as **Conservation Dependent**. To be considered **Conservation Dependent**, a taxon must be the focus of a continuing taxon-specific or habitat-specific conservation program which directly affects the taxon in question. The cessation of this program would result in the taxon

qualifying for one of the threatened categories above.

SUSCEPTIBLE (SU)
A taxon is **Susceptible** when it does not qualify as Critical, Endangered, or Vulnerable, nor is it Conservation Dependent, but it is of serious concern because of acute restriction in its area of occupancy (typically < 100 km^2) or in the number of locations (typically <5). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critical or even Extinct in a very short period.

LOW RISK (LR)
A taxon is **Low Risk** when it has been evaluated and does not qualify for any of the categories Critical, Endangered, Vulnerable, Susceptible, Conservation Dependent, or Data Deficient.

DATA DEFICIENT (DD)
A taxon is **Data Deficient** when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.

NOT EVALUATED (NE)
A taxon is **Not Evaluated** when it has not yet been assessed against the criteria.

Table 2. DRAFT IUCN RED LIST CATEGORIES - FEBRUARY 1994

ANY of the following criteria may be used to assign categories:	CRITICAL	ENDANGERED	VULNERABLE
Population reduction	$\geq$ 80% decline in last 10 yrs based on:	$\geq$ 50% decline in last 10 yrs or 2 generations based on:	$\geq$ 50% decline in last 20 yrs or 5 generations based on:
	a) direct observation OR b) decline in area of occupancy, occurrence and/or habitat quality OR c) actual or potential levels of exploitation OR d) introd. taxa, hybridization, pathogens, pollutants, competitors or parasites		
	OR	OR	OR
	$\geq$ 80% decline/10yrs predicted in near future	$\geq$ 50% decline/10 yrs or 2 generations predicted in near future	$\geq$ 50% decline/20 yrs or 5 generations predicted in near future
Extent of occurrence	Est. <100 km^2 or area of occupancy est. <10 km^2, AND TWO of the following:	Est. $<5{,}000$ km^2 or area of occupancy est. <500 km^2, AND TWO of the following:	Est. $<20{,}000$ km^2 or area of occupancy est. $<2{,}000$ km^2, AND TWO of the following:
	Severely fragmented OR single location.	Severely fragmented OR $\leq$ 5 locations	Severely fragmented OR $\leq$ 10 locations
	Decline in ANY of the following: a) extent of occurrence b) area of occupancy c) area, extent, and/or quality of habitat d) # of locations or subpopulations e) # of mature individuals		
	Extreme fluctuations in ANY of the following: a) extent of occurrence b) area of occupancy c) # of locations or subpopulations		
Population estimates	Est. <250 mature indivs. AND:	Est. $<2{,}500$ mature indivs. AND:	Est. $<10{,}000$ mature indivs. AND:
	Decline $\geq$25% within 3 yrs or one generation, whichever is longer	Decline $\geq$15% within 5 yrs or 2 generations, whichever is longer	Decline $\geq$20% within 10 yrs or 3 generations, whichever is longer
	OR	OR	OR
	Decline in mature individuals AND population structure EITHER a) no pop. w/$>$50 mature indivs. OR b) all indivs. in single subpop.	Decline in mature individuals AND population structure EITHER a) no pop. w/$>$250 mature indivs. OR b) all indivs. in single subpop.	Decline in mature individuals AND population structure EITHER a) no pop. w/$>$1,000 mature indivs. OR b) all indivs. in single subpop.
# of mature individuals	Est. $<$ 50 mature individuals	Est. $<$ 250 mature individuals	Est. $<$ 1,000 mature individuals
Probability of extinction	$\geq$ 50% within in 5 yrs or 2 generations, whichever is longer	$\geq$ 20% within 20 yrs or 5 generations, whichever is longer.	$\geq$ 10% within 100 yrs

Table 3. Number of Equid taxa in wild by range country or region and by Mace-Lande category of threat.

REGION/ COUNTRY	MACE/LANDE CATEGORY					TOTAL
	CRITICAL	ENDANG	VULNER	SECURE	UNKN	
S & C AMERICA	0	0	0	0	0	0
SE ASIA	1	0	1	0	0	2
N. AMERICA	0	0	0	0	0	0
EUROPE	1	0	0	0	0	1
INDIA	2	0	1	0	0	3
CHINA	2	0	1	1	0	4
JAPAN	0	0	0	0	0	0
AUSTRALASIA	0	0	0	0	0	0
AFRICA	2	2	3	3	0	10
MIDDLE EAST	1	0	0	0	0	1
TOTAL	9	2	6	4	0	21

** some taxa were assigned to more than one region

When *ex situ* management is recommended, the "level" of captive program was also determined, reflecting status, prospects in the wild, and taxonomic distinctiveness. The captive levels used during the CAMP workshop are defined below.

Level 1 (1) - A captive population is recommended as a component of a conservation program. This program has a tentative goal of developing and managing a population sufficient to preserve 90% of the genetic diversity of a population for 100 years (90%/100). The program should be further defined with a species management plan encompassing the wild and captive populations and implemented immediately with available stock in captivity. If the current stock is insufficient to meet program goals, a species management plan should be developed to specify the need for additional founder stock. If no stock is present in captivity then the program should be developed collaboratively with appropriate wildlife agencies, SSC Specialist Groups, and cooperating institutions.

Level 2 (2) - Similar to the above except a species/subspecies management plan would include periodic reinforcement of captive population with new genetic material from the wild. The levels and amount of genetic exchange needed should be defined in terms of the program goals, a population model, and species management plan. It is anticipated that periodic supplementation with new genetic material will allow management of a smaller captive population. The time period for implementation of a Level 2 program will depend on recommendations made at the CAMP workshop.

Level 3 (3) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies but is recommended for education, research, or husbandry.

Other captive recommendations include:

No (N) - A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies. Taxa already held in captivity may be included in this category. In this case species/subspecies should be evaluated either for management toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority as identified in the CAMP or in SSC Action Plans.

Pending (P) - A decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

Levels of Captive Programs Recommended for Equid Taxa

Twenty-six equid taxa were evaluated during the CAMP process and 18 of these were assigned a level of threat. These taxa were then considered for possible inclusion in captive propagation programs based on data generated from the CAMP tables. The number of equid taxa in the wild by range country or region and by level of captive program recommended is shown in Table 4. Five (28%) taxa were recommended for a Level 1 program because of their precarious status in the wild, both in terms of extremely low population numbers and the quality and/or availabilty of suitable habitat. Two taxa (11%) were identified as requiring less intensive, Level 2, captive management programs. The wild population of these taxa, while small, are increasing and there is no immediate threat to the environment. One taxon (5%) was recommended for a Level 3 captive program because, although not necessary for conservation, a captive population is needed for education and research purposes. Eight taxa (44%) were classified as 'Pending' because the genetic make-up of these populations has not yet been defined. The remaining two taxa (11%) were not recommended for captive breeding. Table 5 presents a summary of equid taxa recommended for captive population by Mace/Lande category of threat and type of captive program recommended. Table 6 presents the same information but only for taxa currently represented in captivity.

Table 4. Number of Equid taxa in wild by range country or region and by level of captive management recommended.

REGION/ COUNTRY	TYPE OF CAPTIVE PROGRAM					TOTAL
	LEVEL 1	LEVEL 2	LEVEL 3	PENDING	NO PROG	
S & C AMERICA	0	0	0	0	0	0
SE ASIA	1	1	0	1	0	3
N. AMERICA	0	0	0	0	0	0
EUROPE	1	0	0	0	0	1
INDIA	1	0	0	2	0	3
CHINA	1	0	1	2	0	4
JAPAN	0	0	0	0	0	0
AUSTRALASIA	0	0	0	0	0	0
AFRICA	2	1	0	5	2	10
MIDDLE EAST	1	0	0	0	0	1
TOTAL	7	2	1	10	2	22

** some taxa were assigned to more than one region

Table 5. Summary of equid taxa recommended for captive populations by M/L category of threat and type of captive population recommended.

MACE/LANDE	CAPTIVE POPULATION TYPES RECOMMENDED						TOTALS FOR LEVELS 1-3
	TAXA	LEVEL 1	LEVEL 2	LEVEL 3	PENDING	NO PROG	
CRITICAL	6	4	0	0	1	1	4
ENDANGERED	2	1	0	0	1	0	1
VULNERABLE	6	0	2	0	4	0	2
SECURE	4	0	0	1	2	1	1
UNKNOWN	0	0	0	0	0	0	0
TOTAL	18	5	3	0	8	2	8

Table 6. Summary of Equid taxa recommended for captive populations <u>and</u> <u>represented in captivity</u> by M/L category of threat and type of captive population recommended.

MACE/LANDE	CAPTIVE POPULATION TYPES RECOMMENDED						TOTALS FOR LEVELS 1-3
	TAXA	LEVEL 1	LEVEL 2	LEVEL 3	P	NO PROG	
CRITICAL	3	3	0	0	0	0	3
ENDANGERED	1	1	0	0	0	0	1
VULNERABLE	3	0	2	0	1	0	2
SECURE	2	0	0	1	0	1	1
UNKNOWN	0	0	0	0	0	0	0
TOTAL	9	4	2	1	1	1	7

The Equid GCAR process involved (and will further involve in the future) considering all these relevant data in intensive and interactive discussion involving experts representing various organized regions of the zoo world. The objectives are systematic decision-making (as a result of working through the GCAR process), captive program prioritization, initial selection of global species target population sizes and identification of regional distribution of each taxon. This is followed by determining which species/subspecies and the estimated number of individual animals that should be included in captivity globally (target population size).

Determining Global Target Populations Using the Capacity Program
The GCAR workshop process entails considering all relevant data in intensive and interactive discussion involving experts representing the various organized world regions of the zoo and aquarium world. The objectives are systematic decision-making, captive program prioritization, initial selection of global species target population sizes, and identification of regional distribution of each taxon. Second, a determination needs to be made about which species/subspecies and how many individual animals should be included in this global captive program. Target population sizes can be computed using the program CAPACITY 3 (Ballou, 1992).

Using the CAPACITY program, global target population sizes were determined to achieve the captive program goals recommended for a particular taxon. The CAMP and GCAR processes attempt to achieve a goal of maintenance 90% of the program's original founder's heterozygosity for 100 years. Other program parameters that are set and manipulated include:

1. generation length
2. annual growth rate of the population
3. size of the current captive population, and the effective population size
4. the estimated Ne/N ratio
5. % diversity retained to date
6. current year

Computation of Global Captive Population Targets for Equids
Steps used to calculate the global target population using Ballou's Capacity Program 3.0:
1. Calculate N, the total number in captivity, taken from international studbook where possible.
2. Use the generation time (T) for females from the mx/Qx report on the international data set from SPARKS where possible. If not available, a default value of 10 years was used.
3. Use the lambda value for females generated by the mx/Qx report on the international data set from SPARKS where possible or, if not available, a value of 1.05 was used.
4. The Ne value was calculated using the formula:

$$\frac{4 \times Nm \times Nf}{Nm + Nf}$$

where, Nm = number of males of breeding age (taken as animals in age classes 5 to 20)/2 (A division by 2 was made as a crude adjustment to account for the fact that not every male of breeding age is likely to breed) Nf = number of females of breeding age (taken as the number of females in age classes 3 to 20)
5. The Ne/N value is the ratio of the Ne value calculated above to the total global population size, N. Where it was not possible to calculate the number of individuals in each of the above age classes a default value of 0.4 was used, as this was indicated as biologically reasonable from calculations on captive populations with known age structures.

6. Different values for the gene diversity retained to date were used, as follows:
   i) 98% for species with a healthy founder population already in captivity
   ii) 99% where the genetic status of the captive population is unknown but where additional founders could be brought in should an analysis of the population show that more genetic diversity is required
   iii) A precise value different to those above may have been used when it is known precisely from a gene drop on the studbook, e.g. for Somali Wild Ass the starting value is 88.1%
7. The programme length considered is 100 years.
8. A target of 95% for retained diversity was considered justifiable for the taxa in captivity of conservation concern given the genetically healthy status of several of the equid taxa in captivity and the possibility to bring in additional founders for most taxa if necessary.

There is one exception to this, the Somali Wild Ass, which has already retained less than 90% of wild gene diversity in the captive population, for which a target of 85% was set (assuming no additional founders). To retain more of the wild gene diversity in captivity additional founders will have to be brought in.

For taxa in captivity which are not of current conservation concern but which are of educational value or would provide husbandry experience for related taxa of conservation concern, a target population may be recommended to meet a 90/100 level.

Using the methods described above, preliminary global target captive populations were set for 7 equid species/subspecies.

Taxon	Global Target Population
Equus zebra hartmanne	400
Equus grevyi	350
Equus africanus somalicus	600
Equus hemionus kulan	350
Equus hemionus onager	450
Equus kiang holdereri	175
Equus przewalskii	600

Equid GCAR Summary

Of the 20 subspecies of Equid recorded in the 20th century, 3 have become extinct in the wild, of which only one, Equus przewalskii, survives in captivity. Today there are 7 species in captivity: 3 zebras and a wild ass in Africa, 2 wild asses in Asia, and the Przewalski's horse (1992 SSC Equid Action Plan).

Fortunately, all equids breed well in captivity and are relatively easy to maintain. There are international studbooks for Grevy's zebra, Hartmann's Mountain Zebra, the African Wild Asses, Kulan, Onager and Przewalski's horse, and co-ordinated breeding programmes for these taxa are underway in several geographical zoo regions. In 1992, the IUCN/SSC Equid

Specialist Group published its Action Plan.

The zebra's present a range of problems which illustrate the captive breeding decision-making process. The captive population of Grevy's zebra, *Equus grevyi*, has a large number of founders and the regional programmes are well enough advanced to consider moving towards a global management plan for this taxon (Level 1). Of the two subspecies of Mountain Zebra (the Cape Mountain Zebra, *E. z. zebra*, and Hartmann's Mountain Zebra, *E. z. Hartmannae*) only the latter has significant numbers in captivity and also has adequate founder base; a Level 2 programme is recommended. The Cape Mountain Zebra is increasing in protected areas and a decision is awaited from the South African government on the availability of animals for an *ex situ* captive breeding programme.

The taxonomy of the plains zebras, the *E. burchelli* group of subspecies, needs to be researched further. The only recommendation made for this group is that a captive programme is not necessary for Grant's zebra, *E. b. boehmi*, which is secure at this time.

There are two surviving African Wild Ass subspecies, the Nubian Wild Ass, *E. a. africanus* and the Somali Wild Ass, *E. a. somalicus*. The Nubian Wild Ass may be almost extinct and a survey is recommended to establish its status; it is at risk from hybridization with domestic donkeys and habitat loss. The Somali Wild Ass has a captive population of only 72 with a narrow founder base; the addition of new founders from the wild is needed.

Of the Asiatic Wild Asses, *E. h. hemionus* may already be extinct. It has never been clearly distinguished from *E. h. luteus* and the two were considered together pending further taxonomic clarification. Captive programmes exist already for both Kulan, *E. h. kulan* (recommended at Level 2) and Onager, *E. h. onager* (recommended at Level 1). Khur, *E. h. khur*, with a wild population of 1,000-2,000 and fewer than 20 in captivity at present, is recommended for a Level 1 programme.

Captive recommendations are Pending for both Western Kiang, *E. k. kiang*, and Southern Kiang, *E. k. polyodon*, both of which are not represented in captivity as yet. Eastern Kiang, *E. k. holdereri*, has a small captive population and is secure in the wild; it should be maintained at current levels to provide useful husbandry experience for the kiang group.

Finally, Przewalski's horse is already affectively managed at the global level and reintroduction plans continue to be pursued.

Regional Responsibilities

The last step of the GCAR is for individual regions to begin to define specific interest in each recommended species/subspecies, information that later will drive regional responsibilities (i.e., the development of Regional Collection Plans) to preserve an overall viable world population. GCAR spreadsheets are constructed with columns for identification of regions currently holding the taxon and the number of specimens in captivity within that region (Table 11). Tables 7-10 present regional captive population information for North America, Europe, Australasia and Africa. **These tables will be completed as each region reviews this GCAR document.**

Depending on the current captive population distribution and the global target recommendations for the taxon, regional population targets can be set, or current targets revised, by each organized region of the zoo and aquarium community on the basis of global conservation need.

Table 7. Current numbers of Equid taxa in regional captive populations by Mace-Lande category of threat.

REGION/ COUNTRY	MACE/LANDE CATEGORY					TOTAL
	CRITICAL	ENDANG	VULNER	SECURE	UNKN	
N. AMERICA	2	1	2	1	0	6
EUROPE	2	1	2	1	0	6
INDIA						
CHINA						
JAPAN						
AUSTRALASIA	1	1	1	1	0	4
AFRICA	1	1	1	0	0	3
OTHER						
TOTAL						

** some taxa were assigned to more than one region
This table will be completed as each region reviews this GCAR document.

Table 8. Current numbers of Equid specimens in regional captive populations by Mace-Lande category of threat.

REGION/ COUNTRY	MACE/LANDE CATEGORY					TOTAL
	CRITICAL	ENDANG	VULNER	SECURE	UNKN	
N. AMERICA	53	302	193	6	0	554
EUROPE	135	200	356	55	0	746
INDIA						
CHINA						
JAPAN						
AUSTRALASIA	9	6	58	16	0	89
AFRICA	5	2	3	0	0	10
OTHER						
TOTAL						

** some taxa were assigned to more than one region
This table will be completed as each region reviews this GCAR document.

Table 9. Number of Equid taxa in regional captive populations by level of captive management recommended.

REGION/ COUNTRY	TYPE OF CAPTIVE PROGRAM					TOTAL
	LEVEL 1	LEVEL 2	LEVEL 3	PENDING	NO PROG	
N. AMERICA	3	2	1	0	0	6
EUROPE	3	2	1	0	0	6
INDIA						
CHINA						
JAPAN						
AUSTRALASIA	2	0	0	1	1	4
AFRICA	2	1	0	0	0	3
OTHER						
TOTAL						

This table will be completed as each region reviews this GCAR document.

Table 10. Current numbers of Equid specimens in regional captive populations by level of captive management recommended.

REGION/ COUNTRY	TYPE OF CAPTIVE PROGRAM					TOTAL
	LEVEL 1	LEVEL 2	LEVEL 3	PENDING	NO PROG	
N. AMERICA	355	193	6	0	0	554
EUROPE	335	356	55	0	0	746
INDIA						
CHINA						
JAPAN						
AUSTRALASIA	15	0	0	58	16	89
AFRICA	7	3	0	0	0	10
OTHER						
TOTAL						

This table will be completed as each region reviews this GCAR document.

EQUID
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SECTION 2

SPREADSHEET CATEGORIES AND SPREADSHEET

GLOBAL CAPTIVE ACTION RECOMMENDATIONS (GCAR) SPREADSHEET CATEGORIES

The Global Captive Action Plan (GCAR) spreadsheet is a working document that provides information that can be used to assess the degree of threat and recommend conservation action.

The first part of the spreadsheet summarizes information, usually gathered during the Conservation Assessment and Management Plan (CAMP) Workshop process, on the status of the wild population and level of captive program recommended for each taxon. This information can be used to identify priorities for captive management action for taxa.

TAXON
SCIENTIFIC NAME: Scientific names of extant taxa: genus, species, subspecies.

WILD POPULATION
EST #: Estimated numbers of individuals in the wild. If specific numbers are unavailable, estimate the general range of the population size.

M/L STS: Status according to Mace/Lande criteria (Table 1, pg. 4).
- C = Critical
- E = Endangered
- V = Vulnerable
- S = Secure
- EXT = Extinct

IUCN: Status according to draft IUCN Red List criteria (Table 2, pg. 7).
- EX = Extinct
- EW = Extinct in the Wild
- CR = Critical
- EN = Endangered
- VU = Vulnerable
- CD = Conservation Dependent
- SU = Susceptible
- LR = Low Risk
- DD = Data Deficient
- NE = Not Evaluated

CAPTIVE PROGRAM RECOMMENDATIONS

Recommendation:	Level of Captive Program:
Level 1 (1)	A captive population is recommended as a component of a conservation program. This program has a tentative goal of developing and managing a population sufficient to preserve 90% of the genetic diversity of a population for 100 years (90%/100). The program should be further defined with a species management plan encompassing the wild and captive populations and implemented immediately with available stock in captivity. If the current stock is insufficient to meet program goals, a species management plan should be developed to specify the need for additional founder stock. If no stock is present in captivity then the program should be developed collaboratively with appropriate wildlife agencies, SSC Specialist Groups, and cooperating institutions.
Level 2 (2)	Similar to the above except a species/subspecies management plan would include periodic reinforcement of captive population with new genetic material from the wild. The levels and amount of genetic exchange needed should be defined in terms of the program goals, a population model, and species management plan. It is anticipated that periodic supplementation with new genetic material will allow management of a smaller captive population. The time period for implementation of a Level 2 program will depend on recommendations made at the CAMP workshop.
No (N)	A captive program is not currently recommended as a demographic or genetic contribution to the conservation of the species/subspecies. Taxa already held in captivity may be included in this category. In this case species/subspecies should be evaluated either for management toward a decrease in numbers or for complete elimination from captive programs as part of a strategy to accommodate as many species/subspecies as possible of higher conservation priority as identified in the CAMP or in SSC Action Plans.
Pending (P)	A decision on a captive program will depend upon further data either from a PHVA, a survey, or existing identified sources to be queried.

WORLD

The information entered into this section of the GCAR spreadsheet defines the current global captive population and will be used to calculate target populations for each taxon recommended for captive management.

N: Size of the current captive population
Gen Lgth: Generation length
Ne: Effective population size
Lambda: Annual growth rate of the population
Trg Pop: Target Population size computed using Ballou's CAPACITY program. This is the proposed number of individuals that must be maintained in captivity in order to carry out the level of captive program recommended for that taxon.

DISTRIBUTION OF CAPTIVE POPULATION

Loc: Location of a captive population of a particular taxon. This can be one of the organized regions of the zoo and aquarium world, a region not represented by a formal zoo association, or a specific country holding that taxon.

Pop: The number of individuals of a particular taxon currently maintained in the specified region.

Table 11. GLOBAL CAPTIVE ACTION RECOMMENDATIONS FOR EQUIDS

	TAXON		CAMP DATA				WORLD					DISTRIBUTION OF CAPTIVE POPULATIONS														
	SCIENTIFIC NAME		Wild Est#	M/L Sts	New IUCN Sts	Rec	N	Gen Lgth	Ne	Lambda	Trg Pop *	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg
	Equidae											N. Amer			Eur			Africa			ASMP**					
1	Equus	zebra										N. Amer			Eur			Africa			ASMP					
2	Equus	zebra zebra	680	E	VU	P						N. Amer			Eur			Africa			ASMP					
3	Equus	zebra hartmannae	8000	V	VU	2	278	10	109	1.03	400	N. Amer	138		Eur	98	+	Africa	3?		ASMP					
4	Equus	grevyi	4000 - 6000	E/V	EN	1	579	11	220	1.04	350	N. Amer	302		Eur	200	+	Africa	2?		ASMP	6	47			
5	Equus	burchelli										N. Amer	279 +		Eur	679 +		Africa	78		ASMP	?				
6	Equus	burchelli boehmi	500,000	S	LR	N						N. Amer			Eur		-	Africa			ASMP	16	10			
7	Equus	burchelli crawshayi	16,000	S/V	DD	P						N. Amer			Eur			Africa			ASMP					
8	Equus	burchelli zambeziensis	< 10,000	V	DD	P						N. Amer			Eur			Africa			ASMP					
9	Equus	burchelli chapmani	3000	V?	DD	P						N. Amer			Eur			Africa			ASMP	54	64			
10	Equus	burchelli antiquorum	51,000	S	LR	P						N. Amer			Eur			Africa			ASMP					
11	Equus	burchelli burchelli			EX							N. Amer			Eur			Africa			ASMP					
12	Equus	africanus										N. Amer			Eur			Africa			ASMP					
13	Equus	africanus africanus	0 - 100	C/E X?	CR/ Ex	No						N. Amer			Eur			Africa			ASMP					
14	Equus	africanus somalicus	100 - 1000	C	EN/ CR	1	70	10	35	1.08	600	N. Amer	10		Eur	48	+	Africa			ASMP					
15	Equus	hemionus										N. Amer			Eur			Africa			ASMP					

	TAXON		CAMP DATA				WORLD					DISTRIBUTION OF CAPTIVE POPULATIONS														
	SCIENTIFIC NAME		Wild Est#	M/L Sts	New IUCN Sts	Rec	N	Gen Lgth	Ne	Lambda	Trg Pop *	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg	Loc	Pop	Trg
16	Equus	hemionus hemionus (Incl. luteus)	5000 - 10,000	V	DD	P						N. Amer			Eur			Africa			ASMP					
17	Equus	hemionus kulan	>4,500	V/E	V	2	326	10	130	1.05	350	N. Amer	55		Eur	258	+	Africa			ASMP					
18	Equus	hemionus onager	<300	C/E	C	1	138	10	55	1.05	450	N. Amer	43		Eur	87	+	Africa			ASMP	9	12			
19	Equus	hemionus khur	1000 - 1,500	C/E	E	1						N. Amer			Eur			Africa			ASMP					
20	Equus	hemionus hemippus			EX							N. Amer			Eur			Africa			ASMP					
21	Equus	kiang										N. Amer			Eur			Africa			ASMP					
22	Equus	kiang kiang	>2000	V	DD	P						N. Amer			Eur			Africa			ASMP					
23	Equus	kiang holdereri	20,000 - 30,000	S	LR	3	61	10	25	1.05	175	N. Amer	6		Eur	55		Africa			ASMP					
24	Equus	kiang polyodon	<100	C	C	P						N. Amer			Eur			Africa			ASMP					
25	Equus	przewalskii	0	C	EW	1	1,1 00	10	?	1.09	600	N. Amer			Eur		+	Africa	5		ASMP	44	49			
26	Equus	ferus										N. Amer			Eur			Africa			ASMP					

*** Simon Wakefield will provide more accurate target data.**

**** ASMP: Australasian Species Management Program**

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SECTION 3

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SECTION 4

REFERENCE MATERIAL

Assessing Extinction Threats: Toward a Reevaluation of IUCN Threatened Species Categories

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Abstract: *IUCN categories of threat (Endangered, Vulnerable, Rare, Indeterminate, and others) are widely used in 'Red lists' of endangered species and have become an important tool in conservation action at international, national, regional, and thematic levels. The existing definitions are largely subjective, and as a result, categorizations made by different authorities differ and may not accurately reflect actual extinction risks. We present proposals to redefine categories in terms of the probability of extinction within a specific time period, based on the theory of extinction times for single populations and on meaningful time scales for conservation action. Three categories are proposed (CRITICAL, ENDANGERED, VULNERABLE) with decreasing levels of threat over increasing time scales for species estimated to have at least a 10% probability of extinction within 100 years. The process of assigning species to categories may need to vary among different taxonomic groups, but we present some simple qualitative criteria based on population biology theory, which we suggest are appropriate at least for most large vertebrates. The process of assessing threat is clearly distinguished from that of setting priorities for conservation action, and only the former is discussed here.*

Resumen: *La categorización de la Unión Internacional para la Conservación de la Naturaleza (UICN) de las especies amenazadas (en peligro, vulnerables, raras, indeterminadas y otras) son ampliamente utilizadas en las Listas Rojas de especies en peligro y se han convertido en una herramienta importante para las acciones de conservación al nivel internacional, nacional, regional y temático. Las definiciones de las categorías existentes son muy subjetivas y, como resultado, las categorizaciones hechas por diferentes autores difieren y quizás no reflejen con certeza el riesgo real de extinción. Presentamos propuestas para re-definir las categorías en términos de la probabilidad de extinción dentro de un período de tiempo específico. Las propuestas están basadas en la teoría del tiempo de extinción para poblaciones individuales y en escalas de tiempo que tengan significado para las acciones de conservación. Se proponen tres categorías (CRITICA, EN PELIGRO, VULNERABLE) con niveles decrecientes de amenaza sobre escalas de tiempo en aumento para especies que se estima tengan cuando ménos un 10% de probabilidad de extinción en 100 años. El proceso de asignar especies a categorías puede que necesite variar dentro de los diferentes grupos taxonómicos pero nosotros presentamos algunos criterios cualitativos simples basados en la teoría de la biología de las poblaciones, las cuales sugerimos son apropiadas para cuando ménos la mayoría de los grandes vertebrados. El proceso de evaluar la amenaza se distingue claramente del de definir las prioridades para las acciones de conservación, sólamente el primero se discute aquí.*

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Introduction

Background

The Steering Committee of the Species Survival Commission (SSC) of the IUCN has initiated a review of the overall functioning of the Red Data Books. The review will cover three elements: (1) the form, format, content, and publication of Red Data Books; (2) the categories of threat used in Red Data Books and the IUCN Red List (Extinct, Endangered, Vulnerable, Rare, and Indeterminate); and (3) the system for assigning species to categories. This paper is concerned with the second element and includes proposals to improve the objectivity and scientific basis for the threatened species categories currently used in Red Data Books (see IUCN 1988 for current definitions).

There are at least three reasons why a review of the categorization system is now appropriate: (1) the existing system is somewhat circular in nature and excessively subjective. When practiced by a few people who are experienced with its use in a variety of contexts it can be a robust and workable system, but increasingly, different groups with particular regional or taxonomic interests are using the Red Data Book format to develop local or specific publications. Although this is generally of great benefit, the interpretation and use of the present threatened species categories are now diverging widely. This leads to disputes and uncertainties over particular species that are not easily resolved and that ultimately may negatively affect species conservation. (2) Increasingly, the categories of threat are being used in setting priorities for action, for example, through specialist group action plans (e.g., Oates 1986; Eudey 1988; East 1988, 1989; Schreiber et al. 1989). If the categories are to be used for planning then it is essential that the system used to establish the level of threat be consistent and clearly understood, which at present it does not seem to be. (3) A variety of recent developments in the study of population viability have resulted in techniques that can be helpful in assessing extinction risks.

Assessing Threats Versus Setting Priorities

In the first place it is important to distinguish systems for assessing threats of extinction from systems designed to help set priorities for action. The categories of threat should simply provide an assessment of the likelihood that if current circumstances prevail the species will go extinct within a given period of time. This should be a scientific assessment, which ideally should be completely objective. In contrast, a system for setting priorities for action will include the likelihood of extinction, but will also embrace numerous other factors, such as the likelihood that restorative action will be successful; economic, political, and logistical considerations; and perhaps the taxonomic distinctiveness of the species under review. Various categorization systems used in the past, and proposed more recently, have confounded these two processes (see Fitter & Fitter 1987; Munton 1987). To devise a general system for setting priorities is not useful because different concerns predominate within different taxonomic, ecological, geographical, and political units. The process of setting priorities is therefore best left to specific plans developed by specialist bodies such as the national and international agencies, the specialist groups, and other regional bodies that can devise priority assessments in the appropriate regional or taxonomic context. An objective assessment of extinction risk may also then contribute to the decisions taken by governments on which among a variety of recommendations to implement. The present paper is therefore confined to a discussion of assessing threats.

Aims of the System of Categorization

For Whom?

Holt (1987) identifies three different groups whose needs from Red Data Books (and therefore categories of threat) may not be mutually compatible: the lay public, national and international legislators, and conservation professionals. In each case the purpose is to highlight taxa with a high extinction risk, but there are differences in the quality and quantity of information needed to support the assessment. Scott et al. (1987) make the point that in many cases simple inclusion in a Red Data Book has had as much effect on raising awareness as any of the supporting data (see also Fitter 1974). Legislators need a simple, but objective and soundly based system because this is most easily incorporated into legislation (Bean 1987). Legislators frequently require some statement about status for every case they consider, however weak the available information might be. Inevitably, therefore, there is a conflict between expediency and the desire for scientific credibility and objectivity. Conservationists generally require more precision, particularly if they are involved in planning conservation programs that aim to make maximal use of limited resources.

Characteristics of an Ideal System

With this multiplicity of purposes in mind it is appropriate to consider various characteristics of an ideal system:

(1) The system should be essentially simple, providing easily assimilated data on the risk of extinction. In terms of assessing risk, there seems to be little virtue in developing numerous categories, or in categorizing risk on the basis of a range of different parameters (e.g., abundance, nature of threat, likelihood of persistence of threat, etc.). The categories should be few in number,

should have a clear relationship to one another (Holt 1987; Munton 1987), and should be based around a probabilistic assessment of extinction risk.

(2) The system for categorization has to be flexible in terms of data required. The nature and amount of data available to assess extinction risks varies widely from almost none (in the vast majority of species) to highly detailed population data (in a very few cases). The categorization system should make maximum use of whatever data are available. One beneficial consequence of this process would be to identify key population data for field workers to collect that would be useful in assessing extinction risk.

(3) The categorization system also needs to be flexible in terms of the population unit to which it applies. Throughout this discussion, it is assumed that the system being developed will apply to any species, subspecies, or geographically separate population. The categorization system therefore needs to be equally applicable to limited lower taxonomic levels and to more limited geographical scope. Action planning will need to be focused on particular taxonomic groups or geographical areas, and can then incorporate an additional system for setting priorities that reflect taxonomic distinctiveness and extinction risks outside the local area (e.g., see East 1988, 1989; Schreiber et al. 1989).

(4) The terminology used in categorization should be appropriate, and the various terms used should have a clear relationship to each other. For example, among the current terms both 'endangered' and 'vulnerable' are readily comprehended, but 'rare' is confusing. It can be interpreted as a statement about distribution status, level of threat, or local population size, and the relationships between these factors are complex (Rabinowitz et al. 1986). Rare (i.e., low-density) species are not always at risk and many species at risk are not numerically rare (King 1987; Munton 1987; Heywood 1988). The relationship of 'rare' to 'endangered' and 'vulnerable' is also unclear.

(5) If the system is to be objectively based upon sound scientific principles, it should include some assessment of uncertainty. This might be in terms of confidence levels, sensitivity analyses, or, most simply, on an ordinal scale reflecting the adequacy of the data and models in any particular case.

(6) The categories should incorporate a time scale. On a geological time scale all species are doomed to extinction, so terms such as "in danger of extinction" are rather meaningless. The concern we are addressing here is the high background level of the current rates of extinction, and one aim is therefore preservation over the upcoming centuries (Soulé & Simberloff 1986). Therefore, the probability of extinction should be expressed in terms of a finite time scale, for example, 100 years. Munton (1987) suggests using a measure of number of years until extinction. However, since most models of population extinction times result in approximately exponential distributions, as in Goodman's (1987) model of density-dependent population growth in a fluctuating environment, mean extinction time may not accurately reflect the high probability that the species will go extinct within a time period considerably shorter than the mean (see Fig. 1). More useful are measures such as "95% likelihood of persistence for 100 years."

Population Viability Analysis and Extinction Factors

Various approaches to defining viable populations have been taken recently (Shaffer 1981, 1990; Gilpin & Soulé, 1986; Soulé 1987). These have emphasized that there is no simple solution to the question of what constitutes a viable population. Rather, through an analysis of extinction factors and their interactions it is possible to assess probabilities and time scales for population persistence for a particular taxon at a particular time and place. The development of population viability analyses has led to the definition of intrinsic and extrinsic factors that determine extinction risks (see Soulé 1983; Soulé 1987; Gilpin & Soulé 1986; see also King 1987). Briefly these can be summarized as population dynamics (number of individuals, life history and age or stage distribution, geographic structure, growth rate, variation in demographic parameters), population characteristics (morphology, physiology, genetic variation, behavior and dispersal patterns), and environmental effects (habitat quality and quantity, patterns and rates of environmental disturbance and change, interactions with other species including man).

Preliminary models are available to assess a population's expected persistence under various extinction pressures, for example, demographic variation (Goodman 1987*a, b;* Belovsky 1987; CBSG 1989), catastrophes (Shaffer 1987), inbreeding and loss of genetic diversity (Lande & Barrowclough 1987; Lacy 1987), metapopulation structure (Gilpin 1987; Quinn & Hastings 1987; Murphy et al. 1990). In addition, various approaches have been made to modeling extinction in populations threatened by habitat loss (e.g., Gutiérrez & Carey 1985; Maguire et al. 1987; Lande 1988), disease (e.g., Anderson & May 1979; Dobson & May 1986; Seal et al. 1989), parasites (e.g., May & Anderson 1979; May & Robinson 1985; Dobson & May 1986), competitors, poaching (e.g., Caughley 1988), and harvesting or hunting (e.g., Holt 1987).

So far, the development of these models has been rather limited, and in particular they often fail to successfully incorporate several different extinction factors and their interactions (Lande 1988). Nevertheless the approach has been applied in particular cases even with existing models (e.g., grizzly bear: Shaffer 1983; spotted owl: Gutiérrez & Carey 1985; Florida panther: CBSG 1989), and there is much potential for further development.

Although different extinction factors may be critical for different species, other, noncritical factors cannot be ignored. For example, it seems likely that for many species, habitat loss constitutes the most immediate threat. However, simply preserving habitats may not be sufficient to permit long term persistence if surviving populations are small and subdivided and therefore have a high probability of extinction from demographic or genetic causes. Extinction factors may also have cumulative or synergistic effects; for example, the hunting of a species may not have been a problem before the population was fragmented by habitat loss. In every case, therefore, all the various extinction factors and their interactions need to be considered. To this end more attention needs to be directed toward development of models that reflect the random influences that are significant to most populations, that incorporate the effects of many different factors, and that relate to the many plant, invertebrate, and lower vertebrate species whose population biology has only rarely been considered so far by these methods.

Viability analysis should suggest the appropriate kind of data for assigning extinction risks to species, though much additional effort will be needed to develop appropriate models and collect appropriate field data.

Proposal

Three Categories and Their Justification

We propose the recognition of three categories of threat (plus EXTINCT), defined as follows:

CRITICAL:	50% probability of extinction within 5 years or 2 generations, whichever is longer.
ENDANGERED:	20% probability of extinction within 20 years or 10 generations, whichever is longer.
VULNERABLE:	10% probability of extinction within 100 years.

These definitions are based on a consideration of the theory of extinction times for single populations as well as on meaningful time scales for conservation action. If biological diversity is to be maintained for the foreseeable future at anywhere near recent levels occurring in natural ecosystems, fairly stringent criteria must be adopted for the lowest level of extinction risk, which we call VULNERABLE. A 10% probability of extinction within 100 years has been suggested as the highest level of risk that is biologically acceptable (Shaffer 1981) and seems appropriate for this category. Furthermore, events more than about 100 years in the future are hard to foresee, and this may be the longest duration that legislative systems are capable of dealing with effectively.

It seems desirable to establish a CRITICAL category to emphasize that some species or populations have a very high risk of extinction in the immediate future. We propose that this category include species or populations with a 50% chance of extinction within 5 years or two generations, and which are clearly at very high risk.

An intermediate category, ENDANGERED, seems desirable to focus attention on species or populations that are in substantial danger of extinction within our lifetimes. A 20% chance of extinction within 20 years or 10 generations seems to be appropriate in this context.

For increasing levels of risk represented by the categories VULNERABLE, ENDANGERED, and CRITICAL, it is necessary to increase the probability of extinction or to decrease the time scale, or both. We have chosen to do both for the following reasons. First, as already mentioned, decreasing the time scale emphasizes the immediacy of the situation. Ideally, the time scale should be expressed in natural biological units of generation time of the species or population (Leslie 1966), but there is also a natural time scale for human activities such as conservation efforts, so we have given time scales in years and in generations for the CRITICAL and ENDANGERED categories.

Second, the uncertainty of estimates of extinction probabilities decreases with increasing risk levels. In population models incorporating fluctuating environments and catastrophes, the probability distribution of extinction times is approximately exponential (Nobile et al. 1985; Goodman 1987). In a fluctuating environment where a population can become extinct only through a series of unfavorable events, there is an initial, relatively brief period in which the chance of extinction is near zero, as in the inverse Gaussian distribution of extinction times for density-independent fluctuations (Ginzburg et al. 1982; Lande & Orzack 1988). If catastrophes that can extinguish the population occur with probability p per unit time, and are much more important than normal environmental fluctuations, the probability distribution of extinction times is approximately exponential, pe^{-pt}, and the cumulative probability of extinction up to time t is approximately $1 - e^{-pt}$. Thus, typical probability distributions of extinction times look like the curves in Figures 1A and 1B, and the cumulative probabilities of extinction up to any given time look like the curves in Figures 1C and 1D. Dashed curves represent different distributions of extinction times and cumulative extinction probabilities obtained by changing the model parameters in a formal population viability analysis (e.g., different amounts of environmental variation in demographic parameters). The uncertainty in an estimate of cumulative extinction probability up to a certain time can be measured by its coefficient of variation, that is, the standard deviation among different estimates of the cumulative extinction probability with respect to reasonable variation in model parameters, divided by the best estimate. It is apparent from Figures 1C and 1D that at least for small variations in the parameters (if the parameters are reasonably well known), the uncertainty of estimates of cumulative extinction probability at particular times decreases as the level of risk increases. Thus at times, t_1, t_2, and t_3 when the best estimates of the cumulative extinction probabilities are 10%, 20%, and 50% respectively, the corresponding ranges of extinction probabilities in Figure 1C are 6.5%–14.8%, 13.2%–28.6%, and 35.1%–65.0%, and in Figure 1D are 6.8%–13.1%, 13.9%–25.7%, and 37.2%–60.2%. Taking half the range as a rough approximation of the standard deviation in this simple illustration gives uncertainty measures of 0.41, 0.38, and 0.30 in Figure 1C, and 0.31, 0.29, and 0.23 in Figure 1D, corresponding to the three levels of risk. Given that for practical reasons we have chosen to shorten the time scales for the more threatened categories, these results suggest that to maintain low levels of uncertainty, we should also increase the probabilities of extinction in the definition of the ENDANGERED and CRITICAL categories.

These definitions are based on general principles of population biology with broad applicability, and we believe them to be appropriate across a wide range of life forms. Although we expect the process of assigning species to categories (see below) to be an evolving (though closely controlled and monitored) process, and one that might vary across broad taxonomic groups, we recommend that the definitions be constant both across taxonomic groups and over time.

Assigning Species or Populations to Categories

We recognize that in most cases, there are insufficient data and imperfect models on which to base a formal probabilistic analysis. Even when considerable information does exist there may be substantial uncertainties in the extinction risks obtained from population models containing many parameters that are difficult to estimate accurately. Parameters such as environmental stochasticity (temporal fluctuations in demographic parameters such as age- or developmental stage–specific mortality and fertility rates), rare catastrophic events, as well as inbreeding depression and genetic variability in particular characters required for adaptation are all difficult to estimate accurately. Therefore it may not be possible to do an accurate probabilistic viability analysis even for some very well studied species. We suggest that the categorization of many species should be based on more qualitative criteria derived from the same body of theory as the definitions above, which will broaden the scope and applicability of the categorization system. In these more qualitative criteria we use measures of effective population size (N_e) and give approximate equivalents in actual population size (N). It is important to recognize that the relationship between N_e and N depends upon a variety of interacting factors. Estimating N_e for a particular population will require quite extensive information on breeding structure and life history characteristics of the population and may then produce only an approximate figure (Lande & Barrowclough 1987). In addition, different methods of estimating N_e will give variable results (Harris & Allendorf 1989). N_e/N ratios vary widely across species, but are typically in the range 0.2 to 0.5. In the criteria below we give a value for N_e as well as an approximate value of N assuming that the N_e/N ratio is 0.2.

We suggest the following criteria for the three categories:

CRITICAL: 50% probability of extinction within 5 years or 2 generations, whichever is longer, or

(1) Any two of the following criteria:
  - (a) Total population $N_e < 50$ (corresponding to actual $N < 250$).
  - (b) Population fragmented: ≤ 2 subpopulations with $N_e > 25$ ($N > 125$) with immigration rates <1 per generation.
  - (c) Census data of >20% annual decline in numbers over the past 2 years, or >50% decline in the last generation, or equivalent projected declines based on demographic projections after allowing for known cycles.
  - (d) Population subject to catastrophic crashes (>50% reduction) per 5 to 10 years, or 2 to 4 generations, with subpopulations highly correlated in their fluctuations.

or (2) Observed, inferred, or projected habitat alteration (i.e., degradation, loss, or fragmentation) resulting in characteristics of (1).

or (3) Observed, inferred, or projected commercial exploitation or ecological interactions with introduced species (predators, competitors, pathogens, or parasites) resulting in characteristics of (1).

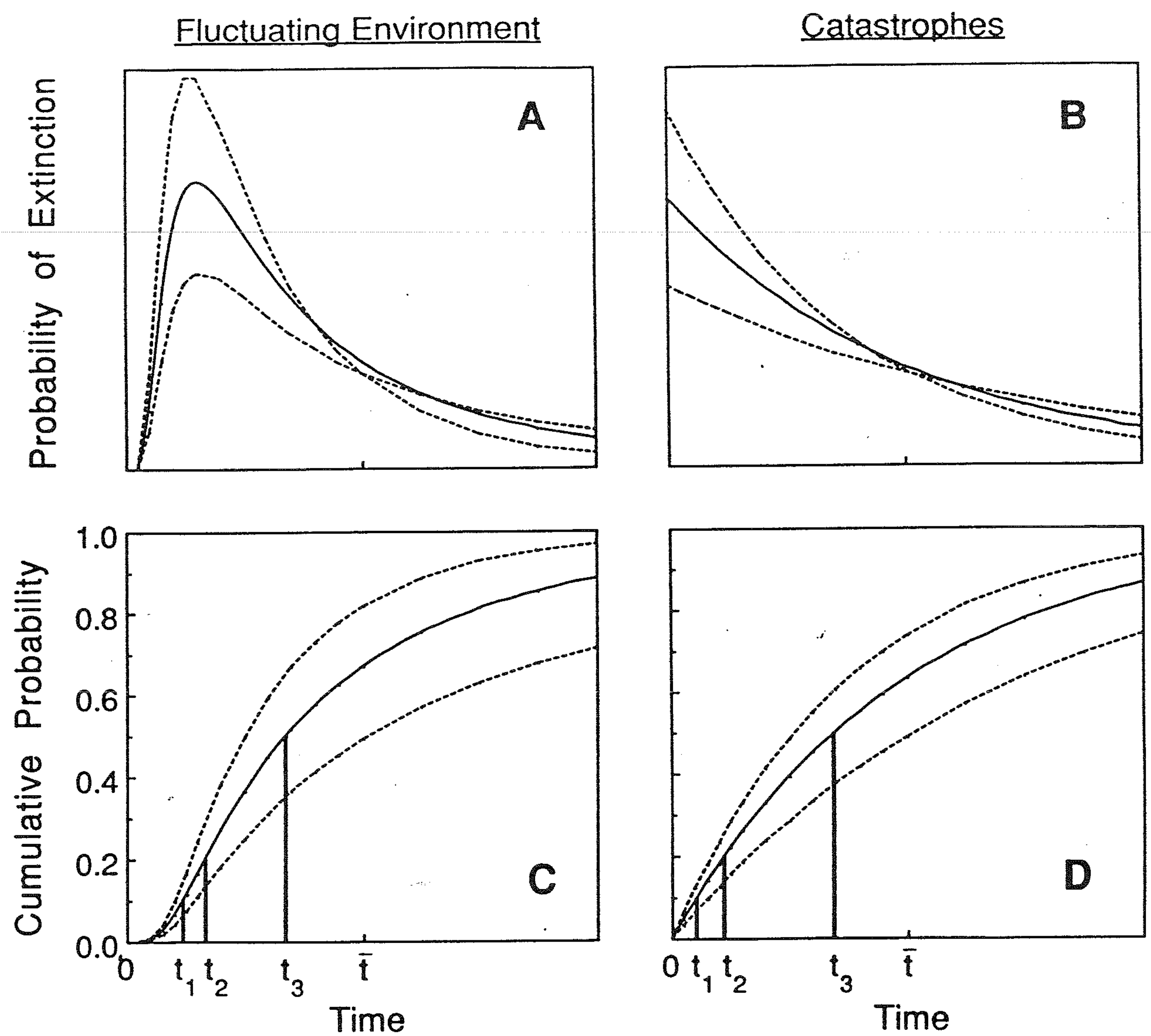

Figure 1. Probability distributions of time to extinction in a fluctuating environment, inverse Gaussian distributions (A), or with catastrophes, exponential distributions (B). Corresponding cumulative extinction probabilities of extinction up to any given time are shown below (C and D). Solid curves represent the best estimates from available data and dashed curves represent different estimates based upon the likely range of variation in the parameters. t_1, t_2, and t_3 are times at which the best estimates of cumulative extinction probabilities are 10%, 20%, and 50%. $\bar{t}$ is the expected time to extinction in the solid curves.

ENDANGERED:

20% probability of extinction within 20 years or 10 generations, whichever is longer, or

(1) Any **two** of the following or any **one** criterion under CRITICAL

(a) Total population $N_e < 500$ (corresponding to actual $N < 2{,}500$).

(b) Population fragmented:

(i) ≤ 5 subpopulations with $N_e > 100$ ($N > 500$) with immigration rates <1 per generation, or

(ii) ≤ 2 subpopulations with $N_e > 250$ ($N > 1{,}250$) with immigration rates <1 per generation.

(c) Census data of $>5\%$ annual decline in numbers over past 5 years, or $>10\%$ decline per generation over past 2 generations, or equivalent projected declines based on demographic data after allowing for known cycles.

(d) Population subject to catastrophic crashes: an average of >20% reduction per 5 to 10 years or 2 to 4 generations, or >50% reduction per 10 to 20 years or 5 to 10 generations, with subpopulations strongly correlated in their fluctuations.

or (2) Observed, inferred, or projected habitat alteration (i.e., degradation, loss, or fragmentation) resulting in characteristics of (1).

or (3) Observed, inferred, or projected commercial exploitation or ecological interactions with introduced species (predators, competitors, pathogens, or parasites) resulting in characteristics of (1).

VULNERABLE:

10% probability of extinction within 100 years, or

(1) Any **two** of the following criteria or any **one** criterion under ENDANGERED.

(a) Total population $N_e < 2{,}000$ (corresponding to actual $N <$ 10,000).

(b) Population fragmented:
(i) $\leq$5 subpopulations with $N_e >$ 500 ($N > 2{,}500$) with immigration rates <1 per generation, or
(ii) $\leq$2 subpopulations with N_e $> 1{,}000$ ($N > 5{,}000$) with immigration rates <1 per generation.

(c) Census data of >1% annual decline in numbers over past 10 years, or equivalent projected declines based on demographic data after allowing for known cycles.

(d) Population subject to catastrophic crashes: an average of >10% reduction per 5 to 10 years, >20% reduction per 10 to 20 years, or >50% reduction per 50 years, with subpopulations strongly correlated in their fluctuations.

or (2) Observed, inferred, or projected habitat alteration (i.e., degradation, loss, or fragmentation) resulting in characteristics of (1).

or (3) Observed, inferred, or projected commercial exploitation or ecological interactions with introduced species (predators, competitors, pathogens, or parasites) resulting in characteristics of (1).

Prior to any general acceptance, we recommend that these criteria be assessed by comparison of the categorizations they lead to in particular cases with the results of formal viability analyses, and categorizations based on existing methods. This process should help to resolve uncertainties about both the practice of, and results from, our proposals. We expect a system such as this to be relatively robust and of widespread applicability, at the very least for most higher vertebrates. For some invertebrate and plant taxa, different kinds of criteria will need to be developed within the framework of the definitions above. For example, many of these species have very high rates of population growth, short generation times, marked or episodic fluctuations in population size, and high habitat specificity. Under these circumstances, it will be more important to incorporate metapopulation characteristics such as subpopulation persistence times, colonization rates, and the distribution and persistence of suitable habitats into the analysis, which are less significant for most large vertebrate populations (Murphy et al. 1990; Menges 1990).

Change of Status

The status of a population or species with respect to risk of extinction should be up-listed (from unlisted to VULNERABLE, from VULNERABLE to ENDANGERED, or from ENDANGERED to CRITICAL) as soon as current information suggests that the criteria are met. The status of a population or species with respect to risk of extinction should be down-listed (from CRITICAL to ENDANGERED, from ENDANGERED to VULNERABLE, or from VULNERABLE to unlisted) only when the criteria of the lower risk category have been satisfied for a time period equal to that spent in the original category, or if it is shown that past data were inaccurate.

For example, if an isolated population is discovered consisting of 500 individuals and no other information is available on its demography, ecology, or the history of the population or its habitat, this population would initially be classified as ENDANGERED. If management efforts, natural events, or both caused the population to increase so that 10 years later it satisfied the criteria of the VULNERABLE category, the population would not be removed from the ENDANGERED category for a further period of 10 years. This time lag in down-listing prevents frequent up-listing and down-listing of a population or species.

Uncertain or Conflicting Results

Because of uncertainties in parameter estimates, especially those dealing with genetics and environmental variability and catastrophes, substantial differences may arise in the results from analyses of equal validity performed by different parties. In such cases, we recommend that the criteria for categorizing a species or population should revert to the more qualitative ones outlined above.

Reporting Categories of Threat

To objectively compare categorizations made by different investigators and at different times, we recommend that any published categorization also cite the method used, the source of the data, a date when the data were accurate, and the name of the investigator who made the categorization. If the method was by a formal viability model, then the name and version of the model used should also be included.

Conclusion

Any system of categorizing degrees of threat of extinction inevitably contains arbitrary elements. No single system can adequately cover every possibility for all species. The system we describe here has the advantage of being based on general principles from population biology and can be used to categorize species for which either very little or a great deal of information is available. Although this system may be improved in the future, we feel that its use will help to promote a more uniform recognition of species and populations at risk of premature extinction, and should thereby aid in setting priorities for conservation efforts.

Summary

1. Threatened species categories should highlight species vulnerable to extinction and focus appropriate reaction. They should therefore aim to provide objective, scientifically based assessments of extinction risks.
2. The audience for Red Data Books is diverse. Positive steps to raise public awareness and implement national and international legislation benefit from simple but soundly based categorization systems. More precise information is needed for planning by conservation bodies.
3. An ideal system needs to be simple but flexible in terms of data required. The category definitions should be based on a probabilistic assessment of extinction risk over a specified time interval, including an estimate of error.
4. Definitions of categories are appropriately based on extinction probabilities such as those arising from population viability analysis methods.
5. We recommend three categories, CRITICAL, ENDANGERED, and VULNERABLE, with decreasing probabilities of extinction risk over increasing time periods.
6. For most cases, we recommend development of more qualitative criteria for allocation to categories based on basic principles of population biology. We present some criteria that we believe to be appropriate for many taxa, but are appropriate at least for higher vertebrates.

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Features

Draft IUCN Red List Categories, Version 2.2

Georgina Mace and Simon Stuart

I. Introduction

The threatened species categories now used in Red Data Books and Red Lists have been in place, with some modification, for almost 30 years. Since their inception they have become widely recognized internationally, and they are now used in a whole range of publications and listings produced by IUCN as well as by numerous governmental and non-governmental organizations. The Red Data Book categories provide an easily and widely understood method for highlighting those species under higher extinction risk, so as to focus attention on conservation measures designed to protect them. The system has worked well under the existing definitions, and underlies many valuable conservation assessments and management plans. However, with the increasing recognition that the resources available for conservation are very limited and need to be allocated rationally among many different demands, the categories have been used more frequently for setting priorities for conservation action. It is this change in emphasis that has provoked recent moves to revise the category definitions.

The need to revise the categories has been recognized for some time. In 1984, the SSC held a symposium, "The Road to Extinction" (Fitter & Fitter 1987) which examined the issues in some detail, and at which a number of options were considered for the revised system. However, no single proposal resulted. The current phase of development began in 1987 with a request from the SSC Steering Committee to develop a new approach that would provide the conservation community with useful information for action planning.

The revision has several aims: to provide an explicit system that can be applied consistently by different people; to improve the objectivity by providing those using the criteria with clear guidance on how to evaluate different factors that affect risk of extinction; to provide a system which will facilitate comparisons across widely different taxa; and to give people using threatened species lists a better understanding of how individual species were classified. In this document, proposals for new definitions for Red List categories are presented. The general aim of the new system is to provide an objective framework for the classification of species according to their extinction risk. This is intended to be equally applicable across taxa, and to be useful in the planning of conservation actions.

The proposals presented in this document result from a continuing process of drafting, consultation and validation exercises, and redrafting. It is clear that the production of a large number of draft proposals has led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for future modifications as and when they become necessary, a system for version numbering is now being introduced as follows:

Version 1.0: Mace & Lande (1991)
The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace et al. (1992)
A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing the non-threatened categories.

Version 2.1: IUCN (1993)
Following an extensive consultation process within SSC, a number of changes were made to the details of the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: 1994 (this paper)
Following further comments received and additional validation exercises, some minor changes to the criteria have been made. In addition, the Susceptible category present in Versions 2.0 and 2.1 has been subsumed into the Vulnerable category. A precautionary application of the system is emphasized.

In future, any application of the criteria should include the appropriate version number as given above.

In the rest of this document, the proposed system is outlined in several sections. The Preamble presents some basic information about the context and structure of the proposal, and the procedures that are to be followed in applying the definitions to species. This is followed by a section giving definitions for terms used in a specific fashion within the definitions. Finally the definitions are presented, followed by the quantitative criteria used for classification within the threatened categories. It is important for the effective functioning of the new system that all sections are read and understood, and the guidelines followed.

II. Preamble

The following points present important information on the use and interpretation of the categories (=Critically Endangered, Endangered, etc.), criteria (= A to E), and sub-criteria (=a, b, etc., i, ii, etc.):

1. Taxonomic Level and Scope of the Categorization Process

The criteria can be applied to any taxonomic unit at or below the species level. The term "taxon" in the following notes, definitions, and criteria is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is a sufficient range among the different criteria to enable the appropriate listing of taxa from the complete taxonomic spectrum, with the exception of microorganisms. The criteria may also be applied within any specified geographical or political area although special notice should be taken of poir 11 below. In presenting the results of applyin the criteria, the unit and area under conside ation should be made explicit. The categoriz tion process should only be applied to wil populations reproducing naturally inside thei natural range, and to populations resultin from benign introductions (defined in the dra IUCN Guidelines for Reintroductions as "...a attempt to establish a species, for the purpos of conservation, outside its recorded distribu tion, but within an appropriate habitat and eco geographical area") .

2. Nature of the Categories

All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all liste as Endangered qualify for Vulnerable. Together these categories are described as "threatened." The threatened species categories form a part of the overall scheme. It will be possible to place all taxa into at least one of the categories (see Fig. 1).

3. Role of the Different Criteria

For listing as Critically Endangered, Endangered, or Vulnerable, there are five quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. The different criteria (A-E) are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. Even though some criteria will be inappropriate for particular taxa and some taxa will never qualify under particular criteria however close to extinction they come, there should be criteria appropriate for assessing threat levels for any taxon (other than microorganisms). The relevant factor is whether any one criterion is met, not whether all are appropriate or all are met.

4. Derivation of Quantitative Criteria

The quantitative values in the criteria associated with threatened categories were developed through wide consultation, and are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but

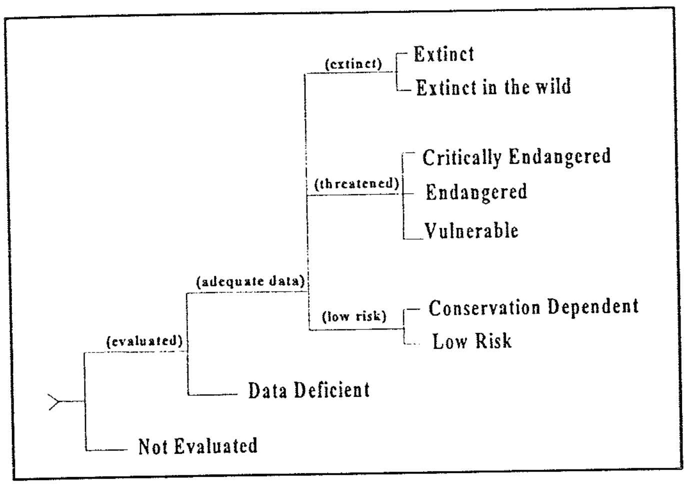

Figure 1. Structure of the Categories.

against a common standard. Some broad consistency between them was sought. However, a given taxon should not be expected to meet all (A-E) criteria in a category; meeting any one criterion is sufficient.

5. Implications of Listing

Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made, though for different reasons. Until such time as an assessment is made, species listed in these categories should not be treated as if they were non-threatened, and it will be appropriate (especially for Data Deficient forms) to give them the same degree of protection as threatened taxa, at least until their status can be evaluated.

Extinction is seen as a probabilistic or chance process. Thus, a listing in a higher extinction risk category implies a higher expectation of extinction, and over the time-frames under consideration more taxa listed here are expected to go extinct (without effective conservation action) than taxa listed in the lower risk categories. However, the fact that some taxa listed at high risk persist, does not necessarily mean their initial assessment was inaccurate.

6. Data Quality and the Importance of Inference and Projection

The criteria are clearly quantitative in nature. However, the absence of high-quality data should not deter attempts to apply the criteria, as methods involving estimation, inference, and projection are emphasized to be sufficient throughout. Inference and projection may be based on extrapolation of current or potential threats into the future and their rate of change, or on extrapolation of factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in either the recent past, present, or near future can be based on any of a series of related factors, and these factors should be specified.

Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by the criteria (e.g. small distributions, few locations). Some threats need to be identified particularly early, and appropriate actions taken, because their effects are irreversible, or nearly so (pathogens, invasive organisms, hybridization).

7. Uncertainty

The criteria should be applied on the basis of the available evidence on taxon numbers, trend and distribution, making due allowance for statistical and other uncertainties. In cases where a wide variation in estimates is found, it is legitimate to apply the precautionary principle and use the lowest *credible* estimate.

Where data are insufficient to assign a category (including Low Risk), the category of "Data Deficient" may be assigned. However, it is important to recognize that this category indicates that data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, it is important to attempt threatened listing, even though there may be little direct information on the biological status of the taxon itself. The category "Data Deficient" is not a threatened category, although it indicates a need to obtain more information on such species to determine their appropriate listing.

8. Conservation Actions in the Listing Process

The criteria for the threatened categories are to be applied to a taxon irrespective of whether conservation action is taking place. In cases where it is only conservation action that prevents the taxon from meeting the threatened criteria, the designation of "Conservation Dependent" is appropriate. It is important to emphasize here that a taxon requires conservation action even if it is not listed as threatened.

9. Documentation

All taxon lists including categorization resulting from these criteria should state the version number of the category definitions as well as the criteria and sub-criteria that were met. No listing can be accepted as valid unless at least one criterion is given. If more than one criterion or sub-criterion was met, then each should be listed. However, failure to mention a criterion should not necessarily imply that it was not met. Therefore, if a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic down-listing. Instead, the taxon should be re-evaluated with respect to all criteria to indicate its status. The factors responsible for triggering the criteria, especially where inference and projection are used, should at least be logged by the evaluator, even if they cannot be included in published lists.

10. Threats and Priorities

The category of threat is not necessarily sufficient to determine priorities for conservation action. The category of threat simply provides an assessment of the likelihood of extinction under current circumstances, whereas a system for assessing priorities for action will include numerous other factors concerning conservation action such as costs, logistics, chances of success, and even perhaps the taxonomic distinctiveness of the subject.

11. Use at Regional Level

The criteria are most appropriately applied to whole taxa at a global scale, rather than to those units defined by regional or national boundaries. Regionally or nationally based threat categories are best used with two key pieces of information: the global status category for the taxon, and the proportion of the global population or range that occurs within the region or nation. However, if applied at regional or national level it must be recognized that a global category of threat may not be the same as a regional or national category for a particular taxon. For example, taxa that were classified as Vulnerable on the basis of their global declines in numbers or range might be Low Risk within a particular region where the populations were stable. Conversely, taxa classified as Low Risk globally might be Critically Endangered within a particular region where numbers were very small or declining, perhaps only because they were at the margins of their global range.

12. Re-evaluation

As circumstances change, re-evaluation of taxa against the criteria will be necessary, and listings should indicate explicitly the taxa for which re-evaluation should occur within a short time-frame (typically within 5 years), or under some specified circumstance. This is especially important for taxa listed under Low Risk, but which are close to qualifying as Vulnerable or Conservation Dependent.

13. Transfer Between Categories

There are rules to govern the movement of taxa between categories. These are as follows: (A) A taxon may be moved from a category of higher threat to a category of lower threat if none of the criteria of the higher category has applied for 5 years or more. (B) If the original classification is found to have been erroneous (based on reanalysis of the data or new information), the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Section 9). (C) Transfer from lower risk to higher risk categories of threat should be made without delay.

14. Problems of Scale

Classification based on the sizes of geographic ranges or the patterns of habitat occupancy is complicated by problems of spatial scale. The finer the scale at which the distributions or habitats of taxa are mapped, the smaller will be the area that they are found to occupy. Mapping at finer scales reveals more areas in which the taxon is unrecorded. It is impossible to provide any strict rules for mapping taxa or habitats; the most appropriate scale will depend on the taxa in question, and the origin and comprehensiveness of the distributional data. However, the thresholds for some criteria (e.g. Critically Endangered) necessitate mapping at a fine scale (in units of one square kilometer or finer).

III. Definitions

Population

Population is defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life forms, population numbers are expressed as numbers of mature individuals only. In the case of taxa biologically dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

Subpopulations

Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little exchange (typically one successful migrant individual or gamete per year or less).

Mature Individuals

The number of mature individuals is defined as the number of individuals known, estimated, or inferred to be capable of reproduction. Where the population is characterized by normal or extreme fluctuations, the minimum number should be used. This measure is intended to count individuals capable of reproduction and should therefore exclude individuals that are environmentally, behaviorally, or otherwise reproductively suppressed in the wild. In the case of populations with biased adult or breeding sex ratios it is appropriate to use lower estimates for the number of mature individuals which take this into account. Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals). In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.

Generation

Generation may be measured as the average age of parents in the population.

Continuing Decline

A continuing decline is a recent, current, or projected future decline whose causes are not known or not adequately controlled and so is liable to continue unless remedial measures are taken. Natural fluctuations will not normally count as a continuing decline, but an observed decline should not be considered to be part of a natural fluctuation unless there is evidence for this.

Severe Decline

A severe decline (criterion A) is a reduction in the number of mature individuals of at least the amount (%) stated over the time period (years) specified, although the decline need not still be continuing. A severe decline should not be interpreted as part of a natural fluctuation unless there is good evidence for this. Downward trends that are part of natural fluctuations will not normally count as a severe decline.

Extreme Fluctuations

Extreme fluctuations occur in a number of taxa where population size or distribution area varies widely, rapidly, and frequently, with a variation greater than one order of magnitude.

Severely Fragmented
Severely fragmented is defined as the case where increased extinction risks result from the fact that most individuals within a taxon are found in small and relatively isolated subpopulations. These small subpopulations may go extinct, with a reduced probability of recolonization.

Extent of Occurrence
Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure does not take account of discontinuities or disjunctions in the spatial distributions of taxa (but see "Area of Occupancy"). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

Area of Occupancy
Area of occupancy is defined as the area within the "extent of occurrence" (see definition) which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may, for example, contain unsuitable habitats. The area of occupancy is the smallest area essential at any stage to the survival of a taxon (e.g. colonial nesting sites, feeding sites for migratory taxa). The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon. The criteria include values in km^2, and thus to avoid errors in classification, the area of occupancy should be measured on grid squares (or equivalents) which are sufficiently small (see Figure 2).

Quantitative Analysis
A quantitative analysis is defined here as the technique of population viability analysis (PVA), or any other quantitative form of analysis, which estimates the extinction probability of a taxon or population based on the known life history and specified management or non-management options. In presenting the results of quantitative analyses, the structural equations and the data should be explicit.

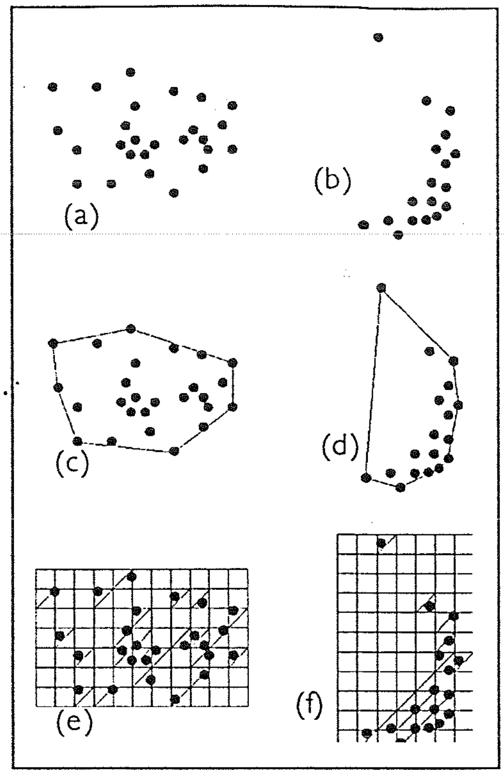

Figure 2. Two examples of the distinction between extent of occurrence and area of occupancy. (a) and (b) are the spatial distribution of known, inferred, or projected sites of occurrence. (c) and (d) show one possible boundary to the extent of occurrence, which is the measured area within this boundary. (e) and (f) show one measure of area of occupancy which can be measured by the sum of the occupied grid squares.

IV. The Categories

Extinct (EX)
A taxon is **Extinct** when there is no reasonable doubt that its last individual has died.

Extinct in the Wild (EW)

A taxon is **Extinct in the Wild** when it is known only to survive in cultivation, in captivity, or as a naturalized population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR)

A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by *any of* the criteria (A to E) on page 20.

Endangered (EN)

A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by *any of* the criteria (A to E) on pages 20-21.

Vulnerable (VU)

A taxon is **Vulnerable** when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by *any of* the criteria (A to E) on pages 21-22.

Conservation Dependent (CD)

Taxa that do not currently qualify as Critically Endangered, Endangered, or Vulnerable, may be classified as Conservation Dependent. To be considered **Conservation Dependent,** a taxon must be the focus of a continuing taxon-specific or habitat-specific conservation program which directly affects the taxon in question. The cessation of this conservation program would result in the taxon qualifying for one of the threatened categories above.

Low Risk (LR)

A taxon is **Low Risk** when it has been evaluated and does not qualify for any of the categories Critically Endangered, Endangered, Vulnerable, Conservation Dependent, or Data Deficient. It is clear that a range of forms will be included in this category including: (i) those that are close to qualifying for the threatened categories (ii) those that are of less concern and (iii) those that are presently abundant and unlikely to face extinction in the foreseeable future. It may be appropriate to indicate into which of these three classes taxa in Low Risk seem to fall. It is especially recommended to indicate an appropriate interval, or circumstance, before re-evaluation is necessary for taxa in the Low Risk class, especially for those indicated in (i) above.

Data Deficient (DD)

A taxon is **Data Deficient** when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. DD is therefore not a category of threat or Low Risk. Listing of taxa in this category indicates that more information is required. Listing a taxon as DD acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, or if there are reasonable chances of unreported surveys in which the taxon has not been found, or that habitat loss has had an unfavorable impact, threatened status may well be justified.

Not Evaluated (NE)

A taxon is **Not Evaluated** when it is has not yet assessed against the criteria.

V. The Criteria for Critically Endangered, Endangered, and Vulnerable

Critically Endangered (CR)

A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by *any of* the following criteria (A to E):

A. Population reduction in the form of *either of* the following:

1. An observed, estimated, inferred, or suspected severe decline of at least 80% during the last 10 years or 3 generations for which data are available, based on (and specifying) any of the following: (a) direct observation; (b) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (c) actual or potential levels of exploitation; (d) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites.

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

B. Extent of occurrence estimated to be less than 100 km^2 or area of occupancy estimated to be less than 10 km^2, *and* estimates indicating *any two of* the following:

1. Severely fragmented *or* found only at a single location.

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

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

C. Population estimated to number less than 250 mature individuals *and either:*

1. An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer *or*

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals *and* population structure in the form of *either* (a) severely fragmented (i.e. no population estimated to contain more than 50 mature individuals); (b) all individuals are in a single subpopulation.

D. Population estimated to number less than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 5 years or 2 generations, whichever is the longer.

Endangered (EN)

A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by *any of* the following criteria (A to E):

A. Population reduction in the form of *either of* the following:

1. An observed, estimated, inferred, or suspected severe decline of at least 50% during the last 10 years or three generations for which data are available, based on (and specifying) *any of* the following: (a) direct observation; (b) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (c) actual or potential levels of exploitation; (d) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

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

B. Extent of occurrence estimated to be less than 5,000 km^2 *or* area of occupancy estimated to be less than 500 km^2, *and* estimates indicating *any two of* the following:

1. Severely fragmented *or* found only at no more than five locations.

2. Continuing decline, inferred, observed or projected, in *any of* the following: (a) extent of occurrence; (b) area of occu-

pancy; (c) area, extent and/or quality of habitat; (d) number of locations or subpopulations; (e) number of mature individuals .

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

C. Population estimated to number less than 2,500 mature individuals and *either:*

1. An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, *or*

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals *and* population structure in the form of *either* (a) severely fragmented (i.e. no population estimated to contain more than 250 mature individuals); (b) all individuals are in a single subpopulation.

D. Population estimated to number less than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or 5 generations, whichever is the longer.

Vulnerable (VU)

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

A. Population reduction in the form of *either of* the following:

1. An observed, estimated, inferred, or suspected severe decline of at least 50% during the last 20 years or 5 generations for which data are available, based on (and specifying) *any of* the following: (a) direct observation; (b) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (c) actual or potential levels of exploitation; (d) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites.

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

B. Extent of occurrence estimated to be less than 20,000 km^2 or area of occupancy estimated to be less than 2,000 km^2, and estimates indicating *any two of* the following:

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

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

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

C. Population estimated to number less than 10,000 mature individuals and *either:*

1. An estimated continuing decline of at least 20% within 10 years or 3 generations, whichever is longer, *or*

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals *and* population structure in the form of *either* (a) severely fragmented (i.e. no population estimated to contain more than 1,000 mature individuals); (b) all individuals are in a single subpopulation.

D. Population very small or restricted in the form of *either of* the following:

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

2. Population is characterized by an acute restriction in its area of occupancy (typically less than 100 km^2) or in the number of locations (typically less than 5). Such a taxon would thus be prone to the ef-

fects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

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

VI. Some Examples of the Application of the Criteria

During the process of developing the new draft Red List categories and criteria, it has become clear that it is very hard to understand how the proposed new system actually works without seeing some worked examples of particular species. To assist in understanding the process, eight species have been chosen as examples. Most of these species are not particularly well-known, thus demonstrating that the criteria do not require large amounts of quantitative data to be available before they can be applied.

Ceratotherium simum

The white rhinoceros *Ceratotherium simum* is the least threatened of the world's five species of rhinoceros. The northern subspecies is Critically Endangered and is restricted to Garamba National Park in Zaire, where only 33 animals survive. The southern subspecies is largely confined to South Africa, where it has been increasing for many years under strict protection, and now numbers more than 6,000 individuals.

Criterion A. The species does not qualify as Threatened, since it is not in decline, nor is there any sign of breakdown in the protection system in South Africa that would result in a high level of poaching.

Criterion B. The species does not qualify as Threatened, since its area of occupancy is greater than 2,000 km^2.

Criterion C. The species does not qualify as Threatened, since although it has a population of less than 10,000 mature individuals, it is not in decline.

Criterion D. The species does not qualify as Threatened, since its population is greater than 1,000 mature individuals.

Conservation Dependent. The species certainly qualifies, since the cessation of the conservation programme in South Africa would result in the species qualifying as Threatened very rapidly.

Conclusion. List as Conservation Dependent.

Columba mayeri

The pink pigeon *Columba mayeri* is endemic to Mauritius, where it has declined to a tiny population of around 20 birds. A newly reintroduced popuation at a different site might offer the only hope for the species in the wild. Since the species obviously satisfies criterion D for Critically Endangered, it is not essential to test it against the other criteria. However, a Population Viability Analysis has been carried out on this species, which indicates a probability of extinction in the wild of 50% in two generations, hence qualifying as Critically Endangered.

Conclusion. List as Critically Endangered under Criteria D and E.

Eos cyanogenia

The black-winged lory *Eos cyanogenia* is a parrot that is restricted to the small Indonesian islands of Biak, Manim, Meos Num, Numfor, and Supiori. The species has almost certainly declined as a result of loss of forest habitat, though it is still reported to be relatively common on forested areas of Biak. International trade has accelerated since 1987, giving cause for concern for this species, especially in view of its very restricted distribution.

Criterion A. Given the number of birds reported in international trade, and the small wild population, a postulated decline of 50% in the last ten years, or a projected decline of 50% in the next ten years, is supportable. The species can therefore be listed as Endangered under criterion A.

Criterion B. The species is likely to have a distribution of less than 20,000 km^2, and is in decline, and since its distribution is severely fragmented, it satisfies this criterion at the Vulnerable level.

Criterion C. The species almost certainly satisfies this criterion at the Vulnerable level, since its population is believed to be less than 10,000 mature individuals, and its rate of decline is probably at least 20% during the last 10 years.

Conclusion. Since the species qualifies as Endangered under criterion A1c and Vulnerable under criteria B1 & B2e and C1, the former takes precedence, and it is listed as Endangered.

Eretmochelys imbricata

The hawksbill turtle *Eretmochelys imbricata* is a very widespread species, known to nest in at least 60 countries in the tropics and subtropics, but suspected to nest in more. Compared with some other marine turtle species, the total numbers appear to be quite small (a minimum of 15,000 - 25,000 females nest annually). It can be inferred that the relative rarity of the hawksbill is largely the result of prolonged over-exploitation for eggs and the international tortoiseshell trade.

Criterion A. Assuming the generation length to be 40 years, it is a supportable hypothesis that the species has declined by 50% over the last three generations (120 years), thus qualifying as Endangered.

Criterion B. The species does not qualify in view of its very wide distribution.

Criteria C and D. The species does not qualify, since more than 10,000 mature individuals survive.

Conclusion. List as Endangered under criterion A2c.

Dyscophus antongilii

This large frog is endemic to Madagascar, where it has a very small distribution in the east of the country, mainly between Maroantsetra and Andevoranto, and further south around Ambatovaky. The species favours swamps, shallow pools and water ditches, and although the status of the species is poorly known, it can be found in large concentrations. It is probably suffering from loss of habitat. The species appeared in the international pet trade prior to its listing on Appendix I in 1987.

Criteria A. It is unlikely that the decline in this species has amounted to, or will amount to, 50% in 20 years or five generations, and so does not qualify as Threatened under this criterion.

Criterion B. The area of distribution of this species is almost certainly less than 10,000 km^2. If it is assumed, probably correctly, that the species is in decline, and that its population is severely fragmented, then it would qualify as Vulnerable under criterion B.

Criteria C and D. Given that it can occur in large concentrations, the population of this species is probably greater than 10,000 mature individuals, and so the species does not qualify as Threatened under these criteria.

Conclusion. List as Vulnerable under criterion B1 & B2c.

Partula rosea

Partula rosea is a land snail that is endemic to the island of Huahine in French Polynesia. Its approximate range has been assessed by field biologists. Partulid snails have become extinct in recent years on all the surrounding islands following the introduction (either accidental or intentional) of the predatory snail *Euglandina rosea*. The last visit to the island by experts on *Partula* was in 1991, and no *Euglandina* were seen at that time. However, based on the colonisation of other islands in French

Polynesia, *Euglandina* is expected to invade during the next ten years.

Criterion A. Although currently stable, a decline of 50% over the next ten years is projected on the basis of the likely introduction of a predatory species, and the species thus qualifies as Endangered.

Criterion B. The species probably has an area of occupancy of less than 500 km^2, occurs at no more than five locations, and is facing a projected decline following the introduction of a predator, and thus qualifies as Endangered.

Criteria C and D. The species probably still has a large population, and so does not qualify under these criteria.

Conclusion. List as Endangered under criteria A2d and B1 & B2e.

Aztekium ritteri

Aztekium ritteri is one of the most unusual Mexican cacti, and is prized by cacti collectors. The population is estimated to number in the millions, but it is restricted to a single valley covering only 50 km^2. The species has probably declined somewhat, since it has been subject to heavy collecting for many years.

Criterion A. Although the species has probably declined, in view of its large population size, it seems unlikely that the collecting pressure has been sufficient to cause a decline of 50% over the last 20 years or five generations.

Criterion B. The species qualifies as Endangered under this criterion, in view of its area of occupancy of only 50 km^2, and the fact that it probably occurs in only one location, and is in decline.

Criteria C and D. The species does not qualify in view of its large population size.

Conclusion. List as Endangered under criterion B1 & B2e.

Paphiopedalum stonei

The species of slipper orchid is found in the limestone cliffs and hills of western Sarawak, Malaysia. It is in decline as a result of limestone quarrying and mining. It is also potentially at risk from international trade.

Criterion A. The species is believed to have declined in the past, or be likely to decline in the future, by at least 50% during 10 years or three generations, and as such qualifies as Endangered.

Criterion B. The species has an area of occupancy of less than 500 km^2, has a fragmented distribution, and is in decline, and so qualifies as Endangered.

Criteria C and D. The species probably has a population of more than 2,500 mature individuals, and so could not qualify as Endangered under these criteria. If its population is less than 10,000 mature individual, it would qualify and Vulnerable under criterion C.

Conclusion. List as Endangered under criteria A2b and B1 & B2c.

Georgina Mace
Simon Stuart

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DRAFT IUCN RED LIST CATEGORIES

Version 2.2

I) Introduction

1. The threatened species categories now used in Red Data Books and Red Lists have been in place, with some modification, for almost 30 years. Since their inception they have become widely recognised internationally, and they are now used in a whole range of publications and listings, produced by IUCN as well as by numerous governmental and non-governmental organisations. The Red Data Book categories provide an easily and widely understood method for highlighting those species under higher extinction risk, so as to focus attention on conservation measures designed to protect them. The system has worked well under the existing definitions, and underlies many valuable conservation assessments and management plans. However, with the increasing recognition that the resources available for conservation are very limited and need to be allocated rationally among many different demands, the categories have been used more frequently for setting priorities for conservation action. It is this change in emphasis that has provoked recent moves to revise the category definitions.

2. The need to revise the categories has been recognised for some time. In 1984, the SSC held a symposium, 'The Road to Extinction' (Fitter & Fitter 1987) which examined the issues in some detail, and at which a number of options were considered for the revised system. However, no single proposal resulted. The current phase of development began in 1987 with a request from the SSC Steering Committee develop a new approach that would provide the conservation community with useful information for action planning.

The revision has several aims: to provide an explicit system that can be applied consistently by different people; to improve the objectivity by providing those using the criteria clear guidance on how to evaluate different factors which affect risk of extinction; to provide a system which will facilitate comparisons across widely different taxa; and to give people using threatened species lists a better understanding of how individual species were classified. In this document, proposals for new definitions for Red List categories are presented. The general aim of the new system is to provide an objective framework for the classification of species according to their extinction risk. This is intended to be equally applicable across taxa, and to be useful in the planning of conservation actions.

3. The proposals presented in this document result from a continuing process of drafting, consultation and validation exercises, and re-drafting. It is clear that the production of a large number of draft proposals has led to some confusion, especially as each draft has been used for classifying some set of species for conservation purposes. To clarify matters, and to open the way for future modifications as and when they become necessary, a system for version numbering is now being introduced as follows:

Version 1.0: Mace & Lande (1991)
The first paper discussing a new basis for the categories, and presenting numerical criteria especially relevant for large vertebrates.

Version 2.0: Mace et al (1992)
A major revision of Version 1.0, including numerical criteria appropriate to all organisms and introducing the non-threatened categories.

Version 2.1: IUCN (1993)
Following an extensive consultation process within SSC, a number of changes were made to the details of the criteria, and fuller explanation of basic principles was included. A more explicit structure clarified the significance of the non-threatened categories.

Version 2.2: this paper
Following further comments received and additional validation exercises, some minor

changes to the criteria have been made. In addition, the Susceptible category present in Versions 2.0 and 2.1 has been subsumed into the Vulnerable category. A precautionary application of the system is emphasised.

In future any application of the criteria should include the appropriate version number as given above.

4. In the rest of this document the proposed system is outlined in several sections. The Preamble presents some basic information about the context and structure of the proposal, and the procedures that are to be followed in applying the definitions to species. This is followed by a section giving definitions for terms used in a specific fashion within the definitions. Finally the definitions are presented, followed by the quantitative criteria used for classification within the threatened categories. It is important for the effective functioning of the new system that all sections are read and understood, and the recommendations followed by people applying the system.

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II) Preamble

The following points present important information on the use and interpretation of the categories (= Critically Endangered, Endangered, etc.), criteria (= A to E), and sub-criteria (= a,b etc., i,ii etc.):

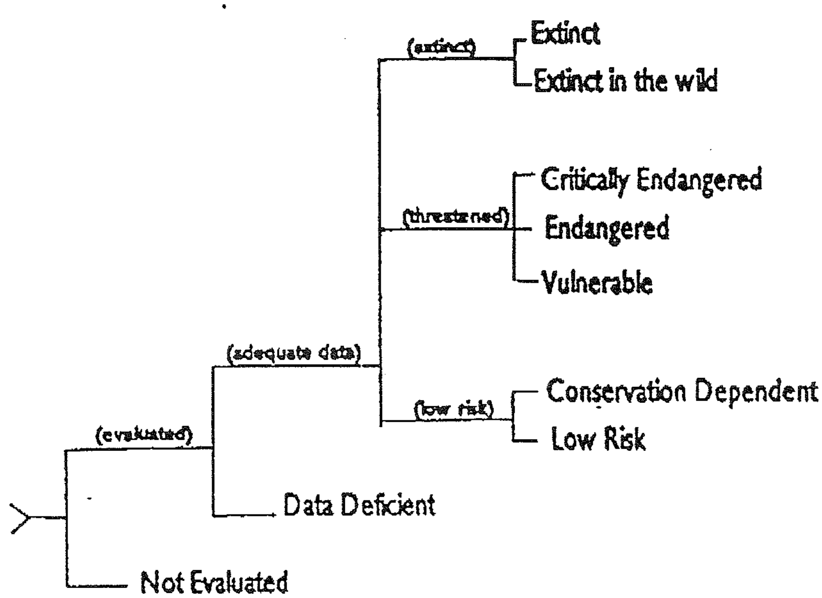
1. **Taxonomic level and scope of the categorisation process**

The criteria can be applied to any taxonomic unit at or below the species level. The term 'taxon' in the following notes, definitions and criteria is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is a sufficient range among the different criteria to enable the appropriate listing of taxa from the complete taxonomic spectrum, with the exception of micro-organisms. The criteria may also be applied within any specified geographical or political area althoughspecial notice should be taken of point 11 below. In presenting the results of applying the criteria, the unit and area under consideration should be made explicit. The categorisation process should only be applied to wild populations reproducing naturally inside their natural range, and to populations resulting from benign introductions (defined in the draft IUCN Guidelines for Reintroductions as "..an attempt to establish a species, for the purpose of conservation, outside its recorded distribution, but within an appropriate habitat and eco-geographical area") .

2. **Nature of the categories**

The categories of Critically Endangered, Endangered and Vulnerable are nested. Thus all taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened' .The threatened species categories form a part of the overall scheme. It will be possible to place all taxa into at least one of the categories (see Figure 1).

Figure 1: Structure of the Categories



3. **Role of the different criteria**

For listing as Critically Endangered, Endangered or Vulnerable there are five quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. The different criteria (A-E) are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. Even though some criteria will be inappropriate for particular taxa and some taxa will never qualify under particular criteria however close to extinction they come, there should be criteria appropriate for assessing threat levels for any taxon (other than micro-organisms). The relevant factor is whether any one criterion is met, not whether all are appropriate or all are met.

4. **Derivation of quantitative criteria**
The quantitative values presented in the various criteria associated with threatened categories were developed through wide consultation and they are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but against a common standard. Some broad consistency between them was sought. However, a given taxon should not be expected to meet all (A-E) criteria in a category; meeting any one criterion is sufficient.

5. **Implications of listing**
Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made, though for different reasons. Until such time as an assessment is made, species listed in these categories should not be treated as if they were non-threatened, and it will be appropriate (especially for Data Deficient forms) to give them the same degree of protection as threatened forms, at least until their status can be evaluated.

Extinction is seen as a probabilistic or chance process. Thus, a listing in a higher extinction risk category implies a higher expectation of extinction, and over the time-frames under consideration more taxa listed here are expected to go extinct (without effective conservation action) than taxa listed in the lower risk categories. However, the fact that some taxa listed at high risk persist, does not necessarily mean their initial assessment was inaccurate.

6. **Data quality and the importance of inference and projection**
The criteria are clearly quantitative in nature. However, the absence of high quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasised to be sufficient throughout. Inference and projection may be based on extrapolation of current or potential threats into the future and their rate of change, or on extrapolation of factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in either the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified.

Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by other criteria (e.g. small distributions, few locations). Many threats are most easily dealt with as soon as they are identified (pathogens, invasive organisms, hybridization) rather than waiting until they have caused damage which is irreversible, or nearly so.

7. **Uncertainty**
The criteria should be applied on the basis of the available evidence on taxon numbers, trend and distribution, making due allowance for statistical and other uncertainties. In cases where a wide variation in estimates is found, it is legitimate to apply the precautionary principle and use the lowest credible estimate.

Where data are insufficient to assign a category (including Low Risk), the category of 'Data Deficient' may be assigned. However, it is important to recognise that this category indicates that data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, it is important to attempt threatened listing, even though there may be little direct information on the biological status of the taxon itself. The category 'Data Deficient' is not a threatened category, although it indicates a need to obtain more information on such species to determine their appropriate listing.

8. **Conservation actions in the listing process**
The criteria for the threatened categories are to be applied to a taxon irrespective of whether conservation action is taking place. In cases where it is only conservation action that prevents the

taxon from meeting the threatened criteria, the designation of 'Conservation Dependent' is appropriate. It is important to emphasise here that a taxon may be deserving of conservation action even if it is not listed as threatened.

9. Documentation

All taxon lists including categorisation resulting from these criteria should state the version number of the category definitions as well as the criteria and sub-criteria that were met. No listing can be accepted as valid unless at least one criterion is given. If more than one criterion or sub-criterion was met, then each should be listed. However, failure to mention a criterion should not necessarily imply that it was not met. Therefore, if a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic down-listing. Instead, the taxon should be re-evaluated with respect to all criteria to indicate its status. The factors responsible for triggering the criteria, especially where inference and projection are used, should at least be logged by the evaluator, even if they cannot be included in published lists.

10. Threats and priorities

The category of threat is not necessarily sufficient to determine priorities for conservation action. The category of threat simply provides an assessment of the likelihood of extinction under current circumstances, whereas a system for assessing priorities for action will include numerous other factors concerning conservation action such as costs, logistics, chances of success, and even perhaps the taxonomic distinctiveness of the subject.

11. Use at regional level

The criteria are most appropriately applied to whole taxa at a global scale, rather than to those units defined by regional or national boundaries. Regionally or nationally based threat categories are best used with two key pieces of information: the global status category for the taxon, and the proportion of the global population or range that occurs within the region or nation. However, if applied at regional or national level it must be recognised that a global category of threat may not be the same as a regional or national category for a particular taxon. For example, taxa that were classified as Vulnerable on the basis of their global declines in numbers or range might be Low Risk within a particular region where the population was stable. Conversely, taxa classified as Low Risk globally might be Critically Endangered within a particular region where numbers were very small or declining, perhaps only because they were at the margins of their global range.

12. Re-evaluation

Evaluation of taxa against the criteria should not be seen as a single event. As circumstances change, re-evaluation will be necessary, and listings should indicate explicitly the taxa for which re-evaluation should occur within a short time-frame (typically within 5 years), or under some specified circumstance. This is especially important for taxa listed under Low Risk, but which are close to qualifying as Vulnerable or Conservation Dependent.

13. Transfer between categories

There are some rules to govern the movement of taxa between categories. These are as follows: (A) A taxon may be moved from a category of higher threat to a category of lower threat if none of the criteria of the higher category has applied for 5 years or more. (B) If the original classification is found to have been erroneous (based on reanalysis of the data or new information), the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Section 9). (C) Transfer from lower risk to higher risk categories of threat is immediate.

14. Problems of scale

Classification based on the sizes of geographic ranges or the patterns of habitat occupancy is complicated by problems of spatial scale. The finer the scale at which the distributions or habitats of taxa are mapped, the smaller will be the area that they are found to occupy. Mapping at finer scales reveals more areas in which the taxon is unrecorded. It is impossible to provide any strict rules for mapping taxa or habitats; the most appropriate scale will depend on the taxa in question, and the origin and comprehensiveness of the distributional data. However, the thresholds for some criteria (e.g. Critically Endangered) necessitate mapping at a fine scale (in units of one square kilometre).

III) Definitions

1. **Population**
Population is defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life-forms, population numbers are expressed as numbers of mature individuals only. In the case of taxa biologically dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

2. **Subpopulations**
Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little exchange (typically one successful migrant individual or gamete per year or less).

3. **Mature individuals**
The number of mature individuals is defined as the number of individuals known, estimated or inferred to be capable of reproduction. Where the population is characterised by normal or extreme fluctuations the minimum number should be used. This measure is intended to count individuals capable of reproduction and should therefore exclude individuals that are environmentally, behaviourally or otherwise reproductively suppressed in the wild. In the case of populations with biased adult or breeding sex ratios it is appropriate to use lower estimates for the number of mature individuals which take this into account. Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g. corals). In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.

4. **Generation**
Generation may be measured as the average age of parents in the population.

5. **Continuing decline**
A continuing decline is a recent, current or projected future decline whose causes are not known or not adequately controlled and so is liable to continue unless remedial measures are taken. Natural fluctuations will not normally count as a continuing decline, but an observed decline should not be considered to be part of a natural fluctuation unless there is evidence for this.

6. **Severe decline**
A severe decline (criterion A) is a reduction in the number of mature individuals of at least the amount (%) stated over the time period (years) specified, although the decline need not still be continuing. A severe decline should not be interpreted as part of a natural fluctuation unless there is good evidence for this. Downward trends that are part of natural fluctuations will not normally count as a severe decline.

7. **Extreme fluctuations**
Extreme fluctuations occur in a number of taxa where population size or distribution area varies widely, rapidly and frequently, with a variation greater than one order of magnitude.

8. **Severely fragmented**
Severely fragmented is defined as the case where increased extinction risks result from the fact that most individuals within a taxon are found in small and relatively isolated subpopulations. These small subpopulations may go extinct, with a reduced probability of recolonisation.

9. **Extent of occurrence**
Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure does not take account of discontinuities or disjunctions in the spatial distributions of taxa (but see 'Area of occupancy'). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

10. **Area of occupancy**
Area of occupancy is defined as the area within its 'extent of occurrence' (see definition) which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may, for example, contain unsuitable habitats. The area of occupancy is the smallest area essential at any stage to the survival of a taxon (e.g. colonial nesting sites, feeding sites for migratory taxa). The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon. The criteria include values in km², and thus to avoid errors in classification, the area of occupancy should be measured on grid squares (or equivalents) which are sufficiently small (see Figure 2).

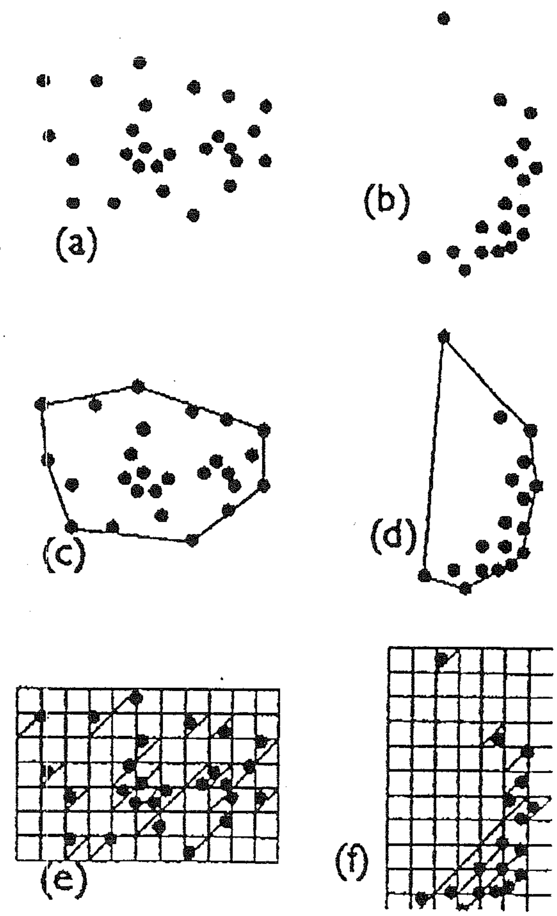


Figure 2:

Two examples of the distinction between extent of occurrence and area of occupancy. (a) and (b) are the spatial distribution of known, inferred or projected sites of occurrence. (c) and (d) show one possible boundary to the extent of occurrence, which is the measured area within this boundary. (e) and (f) show one measure of area of occupancy which can be measured by the sum of the occupie grid squares.

11. **Quantitative analysis**
A quantitative analysis is defined here as the technique of population viability analysis (PVA), or any other quantitative form of analysis, which estimates the extinction probability of a taxon or population based on the known life history and specified management or non-management options. In presenting the results of quantitative analyses the structural equations and the data should be explicit.

IV) The categories

EXTINCT (EX)
A taxon is **Extinct** when there is no reasonable doubt that its last individual has died.

EXTINCT IN THE WILD (EW)
A taxon is **Extinct in the wild** when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)
A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E) on page 10.

ENDANGERED (EN)
A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E) on page 11.

VULNERABLE (VU)
A taxon is **Vulnerable** when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to E) on page 12.

CONSERVATION DEPENDENT (CD)
Taxa which do not currently qualify as Critically Endangered, Endangered or Vulnerable, may be classified as **Conservation Dependent**. To be considered **Conservation Dependent**, a taxon must be the focus of a continuing taxon-specific or habitat-specific conservation programme which directly affects the taxon in question. The cessation of this conservation programme would result in the taxon qualifying for one of the threatened categories above.

LOW RISK (LR)
A taxon is **Low Risk** when it has been evaluated and does not qualify for any of the categories Critically Endangered, Endangered, Vulnerable, Conservation Dependent or Data Deficient. It is clear that a range of forms will be included in this category including: (i) those that are close to qualifying for the threatened categories (ii) those that are of less concern and (a) those that are presently abundant and unlikely to face extinction in the foreseeable future. It may be appropriate to indicate into which of these three classes taxa in Low Risk seem to fall. It is especially recommended to indicate an appropriate interval, or circumstance, before re-evaluation is necessary for taxa in the Low Risk class, especially for those indicated in (i) above.

DATA DEFICIENT (DD)
A taxon is **Data Deficient** when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. DD is therefore not a category of threat or Low Risk. Listing of taxa in this category indicates that more information is required. Listing a taxon as DD acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, or if there are reasonable chances of unreported surveys in which the taxon has not been found, or that habitat loss has had an unfavourable impact, threatened status may well be justified.

NOT EVALUATED (NE)
A taxon is **Not Evaluated** when it is has not yet assessed against the criteria.

V) The Criteria for Critically Endangered, Endangered and Vulnerable

CRITICALLY ENDANGERED (CR)

A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by **any** of the following criteria (A to E):

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

1) An observed, estimated, inferred or suspected severe decline of at least 80% during the last 10 years or 3 generations for which data are available, based on (and specifying) **any** of the following:

a) direct observation
b) a decline in area of occupancy, extent of occurrence and/or quality of habitat
c) actual or potential levels of exploitation
d) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

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

B) Extent of occurrence estimated to be less than 100 km^2 or area of occupancy estimated to be less than 10 km^2, **and** estimates indicating **any two** of the following:

1) Severely fragmented or found only at a single location.

2) Continuing decline, observed, inferred or projected, in **any** of the following:

a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in **any** of the following:

a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations

C) Population estimated to number less than 250 mature individuals and **either**:

1) An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer **or**

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals **and** population structure in the form of **either**

a) severely fragmented (i.e. no population estimated to contain more than 50 mature individuals)
b) all individuals are in a single sub-population.

D) Population estimated to number less than 50 mature individuals.

E) Quantitative analysis showing the probability of extinction in the wild is at least 50% within 5 years or 2 generations, whichever is the longer.

ENDANGERED (EN)

A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the following criteria (A to E):

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

1) An observed , estimated, inferred or suspected severe decline of at least 50% during the last 10 years or three generations for which data are available, based on (and specifying) **any of** the following:

a) direct observation
b) a decline in area of occupancy, extent of occurrence and/or quality of habitat
c) actual or potential levels of exploitation
d) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

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

B) Extent of occurrence estimated to be less than 5000 km^2 or area of occupancy estimated to be less than 500 km^2, and estimates indicating **any two of** the following:

1) Severely fragmented or found only at no more than five locations.

2) Continuing decline, inferred, observed or projected, in **any of** the following:

a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals .

3) Extreme fluctuations in **any of** the following:

a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations

C) Population estimated to number less than 2500 mature individuals and **either**:

1) An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of **either**

a) severely fragmented (i.e. no population estimated to contain more than 250 mature individuals)
b) all individuals are in a single sub-population.

D) Population estimated to number less than 250 mature individuals .

E) Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or 5 generations, whichever is the longer.

VULNERABLE (VU)

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

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

1) An observed , estimated, inferred or suspected severe decline of at least 50% during the last 20 years or 5 generations for which data are available, based on (and specifying) **any of** the following:

a) direct observation
b) a decline in area of occupancy, extent of occurrence and/or quality of habitat
c) actual or potential levels of exploitation
d) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

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

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

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

2) Continuing decline, inferred, observed or projected, in **any of** the following:

a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals .

3) Extreme fluctuations in **any of** the following:

a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations

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

1) An estimated continuing decline of at least 20% within 10 years or 3 generations, whichever is longer, **or**

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of **either**

a) severely fragmented (i.e. no population estimated to contain more than 1000 mature individuals)
b) all individuals are in a single sub-population.

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

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

2) Population is characterised by an acute restriction in its area of occupancy (typically

less than 100 km²) or in the number of locations (typically less than 5). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

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