RED LIST OF MAMMALS FOR PENINSULAR MALAYSIA

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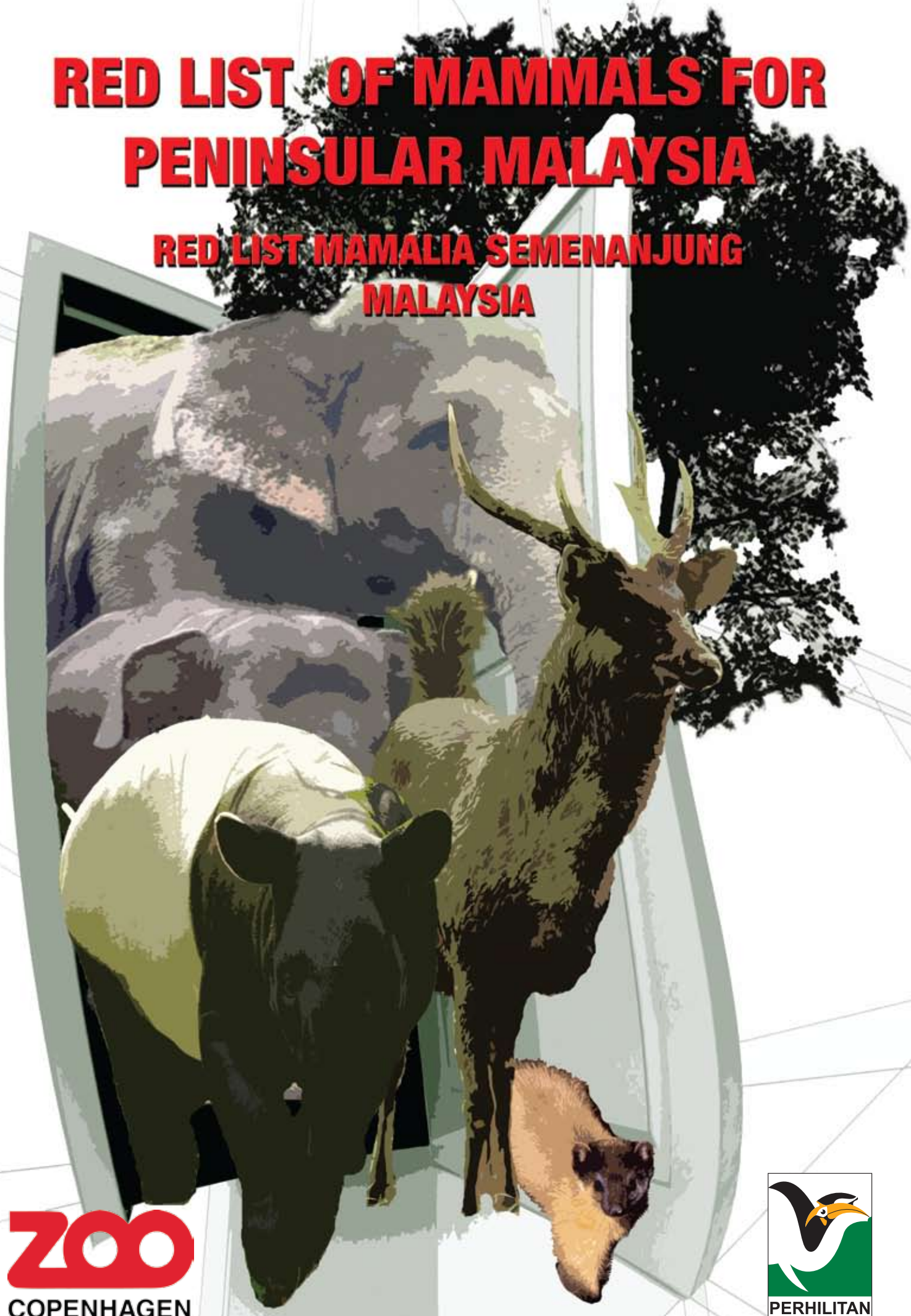

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RED LIST OF MAMMALS FOR PENINSULAR MALAYSIA

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Published by:
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS PENINSULAR MALAYSIA (DWNP),
2010

Published by:
Department of Wildlife and National Parks (DWNP), Peninsular Malaysia

Edition:
First edition December 2009

Available from:
Department of Wildlife and National Parks (DWNP), Peninsular Malaysia
KM. 10 Jalan Cheras
56100 Kuala Lumpur
Malaysia
Telephone : + 603-9086 6800
Fax : +603-9075 2873
Website : www.wildlife.gov.my

ISBN 978-967-5557-06-4

To quote:
DWNP, 2010, Red list Of Mammals For Peninsular Malaysia.
Department of Wildlife and National Parks Peninsular Malaysia

Foreword

Dato' Abd. Rasid bin Samsudin
Director General
Department of Wildlife and National Parks (DWNP), Peninsular Malaysia

Malaysia is one of the strongholds for biodiversity as it is blessed with huge number of flora and fauna species which is recognized by the world as one of the 12 mega-diversity countries. However, the status of knowledge regarding our biodiversity species ranges from some being well documented while many with sketchy information. To undertake the assessment, the government had decided to coordinate according to groups of species and on a regional basis. As an inaugural attempt, the DWNP decided to take the lead in coordinating the assessment for mammals of Peninsular Malaysia.

We are thankful that at global level, the World Conservation Union (IUCN) has undertaken the assessment on a regular basis and laid down some broad criteria to determine the status. Malaysia being a member of IUCN and a mega biodiversity country has also adopted the IUCN criteria in determining the status of our mammal species within the country.

Being an inaugural attempt, the assessment may not be perfect. The imperfection is not due to the lack of expertise in carrying out the assessment but rather due to the obvious gaps in information for various species. However, in the juncture I would like to place on record the invaluable contribution by our experts especially Dr. Lim Boo Liat, in providing the data, compiling and carrying out the analysis based on the standard criteria to determine the status of 222 species of mammals found in Peninsular Malaysia. It is the government's hope that following this assessment researcher will hence take proactive steps to minimize the information gap by increasing the efforts in the field while the relevant agencies strengthen their conservation efforts by reprioritizing the allocation of the limited resources to manage species that have been considered threatened within the Peninsular.

The Red List of Mammals in Peninsular Malaysia is a dynamic document as it will be reviewed periodically as more information is made available while human induced factors through conservation or exploitation efforts affect the population of the species. Through such periodic assessment, we too could evaluate ourselves in conserving our biodiversity resources. Once again my sincere thanks to all agencies, institutions and individuals who have contributed in producing this inaugural edition.

Thank you.

Dato' Abd. Rasid bin Samsudin
Director General
Department of Wildlife and National Parks
(DWNP), Peninsular Malaysia

Acknowledgements

This inaugural edition of the Red list of Mammals for Peninsular Malaysia was made possible due to the efforts of many experts within the country. The Mammal Working Group appreciates the support given by Dato' Abd. Rasid Samsudin, the Director General of DWNP in providing the needed leadership and resources to produce this edition. Special mention for DWNP officers, especially Hjh. Siti Hawa Yatim, Hj. Mohd. Nawayai Yasak, Dr. Sivananthan T. Elagupillay, Dennis Ten Choon Yung, Rahmah Ilias, Fauzul Azim Zainal Abidin, Khairul Nizam Kamaruddin and Nor Azinizi Azimat for the tireless effort in coordinating and compiling field data from DWNP and other sources which formed the basis of mammals redlist.

Greatest appreciation for the following experts who provided the analytical expertise and knowledge to draft this edition: Dr. Lim Boo Liat, Tunku Mohd Nazim Yaacob, Prof. Mohd Tajuddin Abdullah, Prof. Yong Hoi Sen, Prof. Rosli Hashim, Peter Malim, Oswald Braken Tisen and Ahmad Zafir Abdul Wahab.

Last but not least a special word of thanks to Universiti Malaya (UM), Universiti Malaysia Sarawak (UNIMAS) and World Wide Fund for Nature Malaysia (WWF-M) for their review of the drafts. Photos credit was also directed to Cosmas Ngau (DWNP), Zaharil Dzulkafly (DWNP), Ahmad Zafir Abdul Wahab [World Wide Fund for Nature (WWF-M)], Shariff Mohamed [World Wide Fund for Nature (WWF-M)], Johor National Park Corporation (JNPC), Wildlife Conservation Society (WCS-M), Forestry Department Peninsular Malaysia (JPSM) and Panthera Foudation.

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1.0 Introduction

This assessment has been undertaken to review and update of the conservation status of mammals in Peninsular Malaysia. The position taken has been that:

- The conservation status of all the mammal species in the Peninsular Malaysia need to be assessed according to a common set of criteria rather than to focus on those species selected by interests;
- Because of insufficient field data on populations, a standard method was needed to model the changes for species populations through changes in their available habitats and thus monitor population trends; and
- The assessment has to be made without consideration for the current capacity for a management response.

The need for a national red data list for fauna arose from the deliberations of the Biodiversity Fauna Technical Committee (BFTC) in 2006. This recommendation was accepted by the Biodiversity Committee, cleared by Secretary General, Ministry of Natural Resources and Environment (NRE) and since then an expert group from the Mammal Sub-Committee, under the Biodiversity Fauna Technical Committee has review a proposed list for mammal species and their habitat model for the Peninsular by deploying the categories and criteria from the *IUCN Red List of Threatened Species* to make an initial expert assessment of their status. The model was developed with thematic map information that allowed a more detailed habitat map to be made for each species and an estimate for the rate of habitat change over the last 30 years. Additionally, this also has allowed the assessment done for each species equally by proposing a list of species currently in most need of conservation management. The assessment categorizes the status of species ranging from extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated. We have used the global IUCN Red List Categories and Criteria version 3.1 to make an assessment for the 222 species on our current list for the Peninsular Malaysia.

The IUCN Red List of Threatened Species has assessed 68 species of the 222 we have listed for Peninsular Malaysia. Of these, seven (7) are considered to be endangered and 10 vulnerable. Of the 222 species assessed in the assessment, one (1) has been classed as *critically endangered*, 26 have been classed as *endangered* and 22 as *vulnerable*. And this is probably an underestimate since we have not used population data and estimates on all species facing selective conservation pressures such as poaching, habitat fragmentation and commercial exploitation.

The output of the assessment is the baseline information on species, a measure of their habitat and its rate of change over time, current population distribution maps and the findings from applying the red list criteria.

A key for protection status under the domestic law has been deliberately omitted since a new wildlife legislation is expected to be passed in the late part of 2010. The lists under the proposed new law, the wildlife conservation act have not been finalized.

2.0 Objective

The objective of the assessment was to make a systematic assessment of the conservation status of mammals in Peninsular Malaysia based on a common and acceptable criterion.

3.0 Methodology

3.1 Data on species distribution.

The assessment was done based on IUCN Red List Categories and Criteria version 3.1. Among the criteria used were *extent of occurrence* (EOO), *area of occurrence* (AOO) and *population size*. Both qualitative and quantitative methods were used in this assessment. To provide the initial assessment, a qualitative approach was undertaken in 2007 with the formation of a *group* of mammal experts. This expert group assessed the level of threat and conservation status for the mammal species found in the Peninsular Malaysia.

Following this qualitative assessment, a quantitative assessment was undertaken to provide a more robust conservation status of the mammal species found in Peninsular. To undertake this quantitative measure, two criteria were used namely EOO and AOO. The EOO criterion the extent of the original habitat that was available for the concerned species. To get this measure, a model of the original ecology of the Peninsular Malaysia was developed (**Appendix I**). This original ecological habitat could then be compared with subsequent land use models of 1980, 1990 and 2000 to indicate the rate of change of the habitat for the concerned species.

As for the AOO measure, the thematic maps (land use including forest cover) and topology were provided by Department of Agricultural (DOA), Malaysian Geospatial Data Infrastructure (MacGDI), and Department of Survey and Mapping Malaysia (JUPEM). Using this methodology, AOOs were calculated for the years 1970, 1980, 1990 and 2000.

In addition to the EOO and AOO measures, there were population measure for selected species such as the Sumatran rhinoceros, elephant and tiger.

To map the present species range or AOO, field data was used that would indicate the presence of a species in a particular area. The main sources for data were from the Department of Wildlife and National Parks (DWNP), mainly large mammal records. As for small mammals, the main data source was from Dr. Lim Boo Liat, a prominent biologist with over 200 publications. Additional data were from Non Government Organizations and Universities.

Since this data came as point locations or named areas, it was normalized on the administrative district within the states. The data that contributed in determining the AOO included:

- data from general camera trapping exercises, biodiversity inventories and surveys undertaken by the DWNP and others over broad areas of the Peninsular;
- human-wildlife conflict reports made to state Department Wildlife and National Parks (DWNP) offices; and
- site specific studies by field workers interested in specific taxa groups such as bats and shrews.

The constraints of this assessment are:

- the limited and incomplete data on populations and distribution;
- the challenge in coordinating the diverse stakeholders involved in collecting data; and
- non-standard manner in data collection and storing.

3.2 Mapping the *extent of occurrence (EOO).*

Map was developed on the range of each species based on the administrative districts where they had been recorded. This map would be equivalent to the *extent of occurrence* (EOO) used by the IUCN Red List of Threatened Species (**Appendix II**). Under IUCN guidelines, EOO mapping is made by drawing the point location for each record of occurrence, and then joining up the outside points into a polygon. A species known from only three (3) points would have a triangular EOO, one (1) with four (4) points would have an EOO with four (4) sides, etc. and those known from two (2) locations or less would have no measurable EOO area. The assumption then is that each species would have an even chance of being found in suitable habitat throughout the EOO area.

However, the results from field investigations suggest that this assumption may not be true. Wildlife species can be distributed into three (3) classes: having a *broad* distribution where they are expected to be found throughout the EOO; having a *restricted* distribution where they may be restricted to 'clusters' within the EOO; and having a *spotted* distribution where they have very limited local distributions. Therefore, instead of using a nationwide or statewide distribution, we have opted to use the smallest unit (administrative districts) to demarcate the EOO.

3.3 A model for *area of occupancy* (AOO).

Land use changes in the past have altered the ecology of the Peninsular. To examine the trends for the habitats and AOO, the AOO model for each species was compared to forestry and land use maps of year 1980, 1990 and 2000. This allowed us to map and measure the extent of available habitat for each species at those dates and the rate of change in habitat availability between those dates. Since it was assumed that species densities have remained constant in

their habitats, it was argued that any decline in available habitat would have a proportional effect on species population.

Assessment was further refined for selected species for which population estimates were available for the whole Peninsular Malaysia. Only five (5) species have been assessed for the Peninsular using the population estimates: Sumatran rhinoceros, Elephant, Tapir, Malayan tiger and Gaur.

4.0 The results

4.1 The findings of the Assessment.

The assessment of the threat status for mammals in Peninsular Malaysia is made using data up to the year 2000 (**Appendix III**). The next review will make use of data from the period 2000 to 2010. The results give the assessments made for criteria 'A' to 'D' only, as criteria 'E' was not used and the current IUCN assessment category and the protection given in Peninsular Malaysia under the schedules of *Protection of Wildlife Act, 1972* (**Appendix IV and V**). The results summarized in **Appendix III** are given as: extinct (EX), under critical threat (CR), endangered (EN), vulnerable (VU) and under near threatened (NT).

4.2 Summary of the results.

The results are given below with notes on the information displayed in **Appendix III**. Of the 222 species listed for Peninsular Malaysia reviewed in this 2009 assessment:

- 3 were classes as *extinct* (EX),
- 1 as *critically endangered* (CR),
- 26 as *endangered* (EN),
- 22 as *vulnerable* (VU),
- 13 as *near threatened* (NT), and the remaining
- 156 as being of *least concern* (LC).

4.2.1 Extinct (EX).

For the three (3) species that are considered *extinct*, there have been no records of sightings in the Peninsular for more than 50 years. These were the Indian grey mongoose, Javan rhinoceros and Banteng. These species continue to be protected under the *Protection of Wildlife Act, 1972* (PWA) in Peninsular Malaysia.

Table 1: Summary of results for species classed as extinct.

Family	Genus	Species	Common name	Criteria A	Criteria B	Criteria C	Criteria D	IUCN 2009 Assessment	PWA schedule
Herpestidae	*Herpestes*	*edwardsi*	Indian grey mongoose	EX	EX	EX	EX		1.052
Rhinocerotidae	*Rhinoceros*	*sondaicus*	Javan rhinoceros	EX	EX	EX	EX	CR C2a(i)	1.001
Bovidae	*Bos*	*javanicus*	Banteng	EX	EX	EX	EX	EN A2cd+3cd+4cd	1.004

4.2.2 Critical (CR).

Only one (1) species, the Sumatran rhinoceros is currently considered to be under *critical* threat. It is experiencing continual decline, and since year 2000 after the period of this assessment, it is believed to have been exterminated by commercially driven hunting pressure from the area once occupied in the southern part of its range.

Table 2: Summary of results for species classed as critically endangered.

Family	Genus	Species	Common name	Criteria A	Criteria B	Criteria C	Criteria D	IUCN 2009 Assessment	PWA schedule
Rhinocerotidae	*Dicerorhinus*	*sumatrensis*	Sumatran Rhinoceros		LC	CR C2a(i)	CR	A2abd; C1+2a(i)	1.002

4.2.3 Endangered (EN).

When using information from map models on species distribution and change in available habitat space, only 26 species were found to meet the Red list criteria B for *endangered* because they were either limited by a current area of occupancy of less than 500 km² which was continuing to decline, or the area occupied by the species had declined by more than 50% over the previous 10 years with a corresponding decline assumed in the population that was supported. The Expert Group considered that the Otter civet, Leopard and Malayan tiger were also *endangered*. Though the area occupied by these three (3) species was greater than 500 km² and had not significantly declined, the data from recent field work suggested that populations were continuing to decline sufficiently to be considered to be *endangered*.

Of the 30 species considered to be *endangered*, only nine (9) are protected under the PWA. The unprotected species included: shrews, the smaller bats and the rat species.

Table 3: Summary of results for species classed as endangered.

Family	Genus	Species	Common name	Criteria A	Criteria B	Criteria C	Criteria D	IUCN 2009 Assessment	PWA schedule
Soricidae	*Crocidura*	*Negligens*	Grey shrew		EN B2ab(ii, iii)				
Pteropodidae	*Megaerops*	*wetmorei*	Wetmore's tailess fruit bat	EN A4c	EN B2ab(ii, iii)				
Pteropodidae	*Pteropus*	*hypomelanus*	Small flying fox		EN B2ab(ii, iii)				2.2.015
Pteropodidae	*Rousettus*	*leschenaulti*			EN B2ab(ii, iii)				
Rhinolophidae	*Rhinolophus*	*convexus*	Convex horseshoe bat		EN B2ab(ii, iii)			DD	
Rhinolophidae	*Rhinolophus*	*marshalli*	Marshall's horseshoe bat	EN A4c	EN B2ab(ii, iii)				
Rhinolophidae	*Rhinolophus*	*shameli*	Shamel's horseshoe bat	EN A4c	EN B2ab(ii, iii)				
Hipposideridae	*Aselliscus*	*stoliczkanus*	Trident horshoe bat		EN B2ab(ii, iii)				
Hipposideridae	*Coelops*	*frithii*	East asian tailess bat		EN B1ab(ii, iii);B2a b(ii,ii)				
Hipposideridae	*Hipposideros*	*dyacorum*	Dayak roundleaf horseshoe bat	EN A4c	EN B2ab(ii, iii)				
Hipposideridae	*Hipposideros*	*lekaguli*	Lekagul's roundleaf horshoe bat		EN B2ab(ii, iii)				
Hipposideridae	*Hipposideros*	*nequam*	Malayan roundleaf horshoe bat		EN B1ab(ii, iii); B2ab(ii, iii)				
Hipposideridae	*Hipposideros*	*orbiculus*	Roundleaf horseshoe bat		EN B2ab(ii, iii)				
Hipposideridae	*Hipposideros*	*pomona*	Roundleaf horseshoe bat		EN B2ab(ii, iii)				
Vespertilionidae	*Arielulus*	*circumdatus*	Black-gilded pipistrelle		EN B2ab(ii, iii)				
Vespertilionidae	*Hesperoptenus*	*doriae*	Doria's false serotine		EN B2ab(ii, iii)				
Cercopithecidae	*Macaca*	*arctoides*	Stump-tailed macaque	EN A4c	EN B2ab(ii, iii)				2.3.162
Mustelidae	*Lutra*	*lutra*	Common otter		EN B2ab(ii, iii)				1.038

Viverridae	*Cynogale*	*bennettii*	Otter civet	EN A4c	LC				1.017
Viverridae	*Viverra*	*megaspila*	Large spotted civet		EN B2ab(ii, iii)				1.046
Herpestidae	*Herpestes*	*urva*	Crab-eating mongoose	EN A4c	EN B2ab(ii, ii)				2.3.099
Felidae	*Panthera*	*pardus*	Leopard	EN A4d	LC				1.044
Felidae	*Panthera*	*tigris*	Malayan tiger	EN A2ad	LC			EN A2bcd_4bcd; C1+2a(i)	1.035
Pteromyidae	*Petinomys*	*genibarbis*	Whiskered flying squirrel		EN B2ab(ii, iii)			VU A2c+A3c+a4c	1.026
Muridae	*Berlymys*	*bowersii*	Bower's rat		EN B2ab(ii, iii)				
Muridae	*Leopoldamys*	*edwardsi*	Mountain giant rat		EN B2ab(ii, iii)				

4.2.4 Vulnerable (VU).

Using the information from the map models, 16 species were found to be *vulnerable* using the Red list criteria B. The *vulnerable* species list was expanded with a further seven (7) species to 23 by the Expert Group. The provisional 16 species were classed as *vulnerable* because either the area each species currently occupied was less than 2,000 km² and continued to be in decline, or had declined by more than 30% over the previous 10 years, with an assumed a proportional decline with the population that was supported. The additional seven (7) species identified by the Expert Group were found to have adequate area of occupation, but since they were targeted by hunting or collecting activities, they were considered to be vulnerable. These were Scaly anteater, Moonrat, Grey fruitbat, Malayan sun bear, Asian elephant, Sambar deer and Gaur.

Only seven (7) of the 30 *vulnerable* species currently have any protection under the PWA. Again this included the bats, as well as the species newly described for the Peninsular.

Table 4: Summary of results for species classed as vulnerable.

Family	Genus	Species	Common name	Criteria A	Criteria B	Criteria C	Criteria D	IUCN 2009 Assessment	PWA schedule
Manidae	*Manis*	*javanica*	Scaly anteater	VU A4cd	LC				1.008
Erinaceidae	*Echinosorex*	*gymnurus*	Moonrat, gymnure	VU A4e	LC				
Talpidae	*Euroscaptor*	*malayana*	Malayan mole		VU B2ab(ii,iii)				
Soricidiae	*Chimarrogale*	*hantu*	Malayan water shrew		VU B2ab(ii,iii)				
Tupaiidae	*Ptilocercus*	*lowii*	Pen-tailed treeshrew		VU B2ab(ii,iii)				2.3.237
Tupaiidae	*Tupaia*	*minor*	Lesser treeshrew	VU A4c	VU B2ab(iii)				2.3.241
Pteropodidae	*Aethalops*	*alecto*	Grey fruit bat	VU A2c	LC				
Rhinolophidae	*Rhinolophus*	*chiewkweeae*	Chiewkwee's horseshoe bat		VU B2ab(ii,iii)				
Hipposideridae	*Hipposideros*	*doriae*	Lawa'sroundleaf horseshoe bat		VU B2ab(ii,iii)				
Vespertilionidae	*Arielulus*	*societatis*	Benompipistrelle		VU B2ab(ii,iii)				
Vespertilionidae	*Hesperoptenus*	*blandfordi*	Lesser false serotine		VU B2ab(ii,iii)			LC	
Vespertilionidae	*Kerivoula*	*intermedia*	Small woolly bat		VU B2ab(ii,iii)				
Vespertilionidae	*Kerivoula*	*picta*	Painted bat		VU B2ab(ii,iii)				
Vespertilionidae	*Myotis*	*hermani*	Herman's bat		VU B2ab(ii,iii)				
Vespertilionidae	*Phoniscus*	*atrox*	Groove-toothed bat		VU B2ab(ii,iii)				
Vespertilionidae	*Phoniscus*	*jagorii*	Frosted groove-toothed bat		VU B2ab(ii,iii)				
Cercopithecidae	*Presbytis*	*siamensis*	Black-thighed leaf monkey		VU B2ab(ii,iii)				
Ursidae	*Helarctos*	*malayanus*	Malayan sun bear	VU A2d	LC				1.043
Felidae	*Prionailurus*	*viverrinus*	Fishing cat	VU A4c	VU B2ab(ii,iii)			EN A2cd+4cd	
Elephantidae	*Elephas*	*maximus*	Asian elephant	VU A4cd	LC			EN A2c	2.1.001
Cervidae	*Rusa*	*unicolor*	Sambar deer		LC	VU C1			2.2.001
Bovidae	*Bos*	*gaurus*	Gaur	VU A2ad	LC			VU A2cd+3cd+4cd	1.06

4.2.5 Near threatened (NT).

The provisional assessment made using only map models of habitat were not used to identify species experiencing *near threatened*. There were 14 species were considered by the Expert Group to be *near threatened*. All these species were understood to have an adequate area of occupation, but recent field data records suggest that they are becoming less frequently encountered.

All the species classed as *near threatened,* were protected under the PWA.

Table 5: Summary of results for species classed as near threatened.

Family	Genus	Species	Common name	Criteria A	Criteria B	Criteria C	Criteria D	IUCN 2009 Assessment	PWA schedule
Hylobatidae	*Symphalangus*	*syndactylus*	Siamang	NT	LC				1.005
Canidae	*Cuon*	*alpinus*	Red dog, Dhole	NT	LC				1.009
Mustelidae	*Martes*	*flavigula*	Yellow-throated marten		LC	NT		LC	1.019
Mustelidae	*Mustela*	*nudipes*	Malayan weasel		LC	NT		LC	1.02
Viverridae	*Prionodon*	*linsang*	Banded linsang		LC	NT		LC	1.014
Viverridae	*Viverra*	*zibetha*	Large indian civet		LC	NT			1.045
Viverridae	*Viverricula*	*malaccensis, indica*	Little civet		LC	NT			1.049
Felidae	*Neofelis*	*nebulosa*	Clouded leopard	NT	LC			VU C1+2a(i)	1.01
Felidae	*Prionailurus*	*planiceps*	Flat-headed cat	NT	LC			EN C1+2a(i)	1.012
Tapiridae	*Tapirus*	*indicus*	Malayan tapir	NT	LC				1.003
Suidae	*Sus*	*barbatus*	Bearded pig	NT	LC				2.2.006
Cervidae	*Muntiacus*	*muntjac*	Barking deer	NT	LC				2.2.002
Bovidae	*Capricornis*	*sumatraensis*	Serow	NT	LC				1.022

4.3 Comparison with to IUCN 2009 assessment and the Peninsular Malaysia Redlist 2009 assessment by the experts working group.

The IUCN redlist assessment for 2009 has reviewed 68 of the 222 mammal species listed for Peninsular Malaysia and found one (1) of the species to be *critically endangered* (CR), eight (8) *endangered* (EN) and eight (8) *vulnerable* (VU) with one (1) *near threatened* (NT), 25 of *least concern* (LC), and the remaining three (3) to be *data deficient* (DD). In comparison, when the same criteria for AOO were applied to the measured 2010 map model of the Peninsular, three (3) species were assessed as locally extinct, one (1) species as *critically endangered* (CR*)*, 26 as *endangered*, 22 as being *vulnerable* and 13 as *near threatened* (NT) with the remaining 156 as being of least concern. A summary of this comparison is given in Table 6.

Table 6: Comparison with IUCN red list 2009 Assessment with Peninsular Malaysia Red list 2009

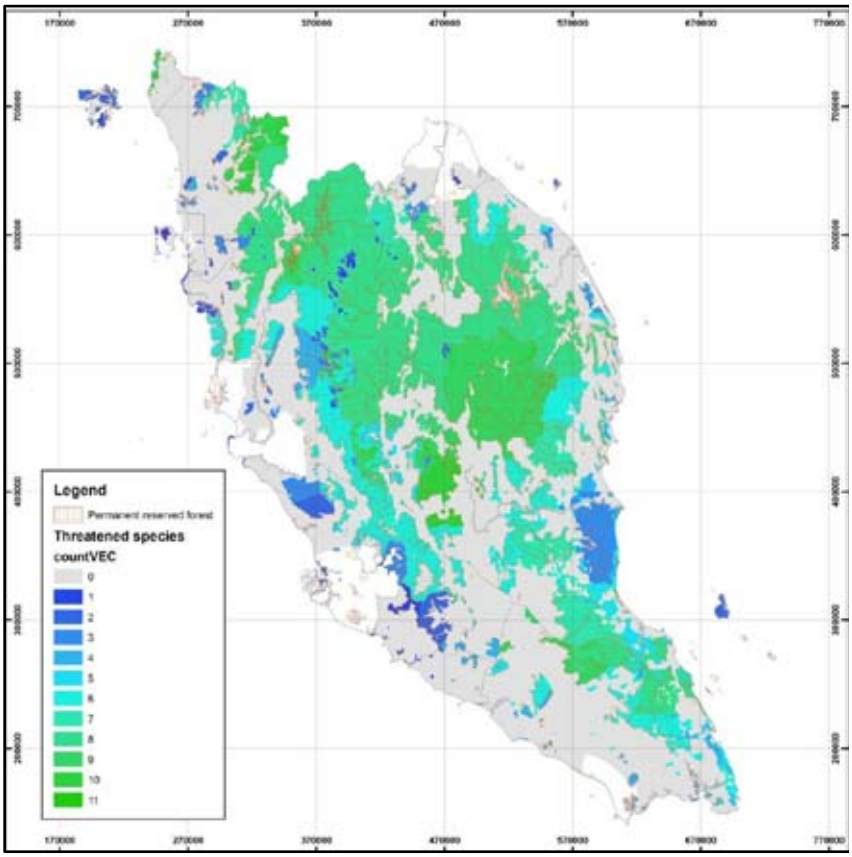
IUCN Red list 2009		Peninsular Malaysia Red list 2009					
		EX	CR	EN	VU	NT	LC
EX	-	3	-	-	-	-	-
CR	1	-	1	-	-	-	-
EN	8	-	-	26	-	-	-
VU	8	-	-	-	22	-	-
NT	1	-	-	-	-	14	-
LC	25	-	-	-	-	-	16
DD	3	-	-	-	-	-	-
Not assessed	-	-	-	-	-	-	-
Sub total	-	3	1	26	22	14	16
Total	68	222					

4.4 Other information derived from the results.

4.4.1 Distribution of threatened species.

One of the outcomes of mapping the model distribution of species was that it was possible to count the number of species that occupy any specific area and the map of mammal species richness. It is also possible to identify which areas contain the highest counts of threatened species. Map 1 shows the counts of the number of threatened species in Peninsular Malaysia whose distribution overlaps. The distribution is normalized by districts. The highest count for threatened species with overlapping distribution in any district is 11. The districts with the highest counts are in the lowland areas in Taman Negara and the forest areas of the northern states. Other lowland areas with a high count are at Krau area in Pahang and the Endau-Rompin forest areas. Highland and peat swamp areas are recorded as having the lowest numbers of threatened species.

The results suggest that the least developed areas of the Peninsular contain the highest counts of threatened species. But they could also reflect the relative effort put into field investigation. The recently isolated Krau Wildlife Reserve and surrounding forest reserves, appears to have a higher count of threatened species than many of the surrounding areas connected to the central forest area probably because of the greater effort put into field work in the Krau area.



Map 1: Distribution of threatened species.

4.4.2 Administration of habitat of threatened species.

It was not intended to make management recommendations in this exercise, but discussion during the *Expert Meetings*, has invariably commented on conservation management issues. By overlying land use maps in maps of the areas occupied by threatened species, it is possible to see which agency has responsibility over the areas occupied by each species. Table 7 lists each threatened species and gives the extent of the habitat in three (3) classes of land management and administration. These are:

- Alienated land or state land where the managing entity is either an individual or commercial company and state land which is under the administration of the state.
- State forest land under the management control of the state forest departments.
- 'Protected Area' (PA) under the Department of Wildlife and National Parks (DWNP) or a state park authority.

Table 7: Current Area of occupation (AOO) for threatened species in size (hectares) by type of administrating agency.

Genus	Species	Alienated or state land	State forest under the SFD	PA under the DWNP or state parks	Alienated or state land	State forest under the SFD	PA under the DWNP or state parks
Critical							
Dicerorhinus	*sumatrensis*	599,701	2,563,955	773,553	*15.07%*	*65.48%*	*19.44%*
Endangered							
Crocidura	*negligens*	-	-	12,035	*0.00%*	*0.00%*	*100.00%*
Megaerops	*wetmorei*	1,479	7,212	-	*17.02%*	*82.98%*	*0.00%*
Pteropus	*hypomelanus*	-	-	11,774	*0.00%*	*0.00%*	*100.00%*
Rousettus	*leschenaulti*	4,529	11,441	198	*26.16%*	*72.69%*	*1.14%*
Rhinolophus	*convexus*	12,584	21,952	-	*35.11%*	*64.89%*	*0.00%*
Rhinolophus	*marshalli*	2,406	3,638	2,512	*27.66%*	*43.46%*	*28.87%*
Rhinolophus	*shameli*	2,431	4,158	4,286	*22.06%*	*39.04%*	*38.90%*
Aselliscus	*stoliczkanus*	1,070	363	1,139	*41.62%*	*14.10%*	*44.29%*
Coelops	*frithii*	4,861	23,197	198	*16.43%*	*82.90%*	*0.67%*
Hipposideros	*dyacorum*	2,406	3,638	2,512	*27.66%*	*43.46%*	*28.87%*
Hipposideros	*lekaguli*	2,431	4,158	4,286	*22.06%*	*39.04%*	*38.90%*
Hipposideros	*nequam*	1,172	3,529	-	*24.51%*	*75.49%*	*0.00%*
Hipposideros	*orbiculus*	339	13,709	-	*2.38%*	*97.62%*	*0.00%*
Hipposideros	*pomona*	2,431	4,158	4,286	*22.06%*	*39.04%*	*38.90%*
Arielulus	*circumdatus*	12,584	21,952	-	*35.11%*	*64.89%*	*0.00%*
Hesperoptenus	*doriae*	339	13,863	-	*2.35%*	*97.65%*	*0.00%*
Macaca	*arctoides*	2,406	3,638	2,512	*27.66%*	*43.46%*	*28.87%*
Lutra	*lutra*	1,370	17,885	38	*7.10%*	*92.70%*	*0.20%*
Cynogale	*bennettii*	70,298	476,558	181,187	*9.65%*	*65.46%*	*24.88%*
Viverra	*megaspila*	1,306	778	1,125	*40.69%*	*24.26%*	*35.05%*
Herpestes	*urva*	2,406	3,638	2,512	*27.66%*	*43.46%*	*28.87%*
Panthera	*pardus*	1,163,818	3,970,222	850,526	*19.22%*	*66.73%*	*14.05%*
Panthera	*tigris*	1,102,828	3,635,290	850,526	*19.49%*	*65.47%*	*15.03%*
Petinomys	*genibarbis*	5,599	11,804	1,337	*28.16%*	*65.11%*	*6.72%*
Berlymys	*bowersii*	4,489	31,962	87	*12.29%*	*87.48%*	*0.24%*
Leopoldamys	*edwardsi*	2,383	20,346	8,845	*7.53%*	*64.53%*	*27.94%*

Genus	Species	Alienated or state land	State forest under the SFD	PA under the DWNP or state parks	*Alienated or state land*	*State forest under the SFD*	*PA under the DWNP or state parks*
Manis	*javanica*	973,163	3,648,603	836,839	*17.61%*	*67.25%*	*15.14%*
Echinosorex	*gymnurus*	747,372	2,591,284	758,557	*18.11%*	*63.50%*	*18.39%*
Euroscaptor	*micrura*	24,439	31,077	-	*43.34%*	*56.66%*	*0.00%*
Chimarrogale	*hantu*	26,311	96,949	-	*21.16%*	*78.84%*	*0.00%*
Ptilocercus	*lowii*	9,427	120,664	-	*7.22%*	*92.78%*	*0.00%*
Tupaia	*minor*	23,306	154,229	-	*13.09%*	*86.91%*	*0.00%*
Aethalops	*alecto*	15,001	76,236	2,419	*15.78%*	*81.67%*	*2.55%*
Rhinolophus	*chiewkweeae*	18,856	70,637	12,498	*17.42%*	*71.04%*	*11.54%*
Hipposideros	*doriae*	6,227	98,020	-	*5.97%*	*94.03%*	*0.00%*
Arielulus	*societatis*	1,063	55,585	8,131	*1.63%*	*85.91%*	*12.46%*
Hesperoptenus	*blandfordi*	1,192	95,075	17,987	*1.03%*	*83.35%*	*15.61%*
Kerivoula	*intermedia*	8,897	44,535	53,754	*8.19%*	*42.34%*	*49.47%*
Kerivoula	*picta*	6,149	83,091	44	*6.85%*	*93.10%*	*0.05%*
Myotis	*hermani*	13,111	47,708	3,794	*20.14%*	*74.04%*	*5.83%*
Phoniscus	*atrox*	8,894	44,513	49,127	*8.55%*	*44.22%*	*47.23%*
Phoniscus	*jagorii*	8,897	44,535	53,754	*8.19%*	*42.34%*	*49.47%*
Presbytis	*siamensis*	21,821	78,199	-	*21.56%*	*78.44%*	*0.00%*
Helarctos	*malayanus*	1,017,819	3,440,916	836,989	*19.00%*	*65.38%*	*15.62%*
Prionailurus	*viverrinus*	13,549	33,227	17,493	*21.08%*	*51.70%*	*27.22%*
Elephas	*maximus*	816,551	3,197,576	846,935	*16.60%*	*66.18%*	*17.22%*
Cervus	*unicolor*	869,144	3,541,542	838,267	*16.38%*	*67.83%*	*15.79%*
Bos	*gaurus*	597,306	3,047,704	778,182	*13.36%*	*69.25%*	*17.40%*

From Table 7, it can be seen that the single species under critical threat, Sumatran Rhinoceros, has 19.44% of its area of occupation within a protected area and managed either by federal or state authorities for conservation.

Among the endangered species, though two (2) have all their area of occupation within PAs, 11 have less than 10% of their area of occupation in PAs, six (6) are only found outside PAs and 15 have more than 50% of their area of occupation in state forest reserves. *Endangered* species such as Wetmore's tailless fruit bat, the Convex horseshoe bat, Malayan roundleaf horseshoe bat, *Hipposideros orbiculus*, Black-gilded pipistrelle and Doria's false serotine appear to be both without any legal protection for their species and protection for their areas of occupation.

For the vulnerable species, there are also six (6) species found only outside PAs and 19 of the 23 have more than 50% if their area of occupation in state forest reserves. And at least four (4) species have neither protection under the PWA 1972 nor their habitat protected within a PA.

This underlines:

- the potential role of the state forest departments and other agencies that control land, to contribute to the conservation management of threatened species, especially those species of limited range, and the *high conservation value* (HCV) of the areas occupied by these species; and
- the consideration that land use planners could give to the habitats of threatened species, especially those areas where there is a high count of threatened species.

APPENDIX I

Building the model of ecological types

Appendix 1

Building the model of ecological types.

1. A series of models were built that have used thematic map data and expert to model the relative threat to species survival (Map 1). The first step was to build a model and map of the ecological types in the Peninsular and compare the state of those areas today with their optimum before human significant human disturbance. This was then generalized to fit with a model of species habitats and so create a map for original and remaining habitats. Our building a model for species populations according to their distribution and abundance in their habitats, the species population model was created that could compare populations today with that at their optimum.

2. Building the original ecology model.

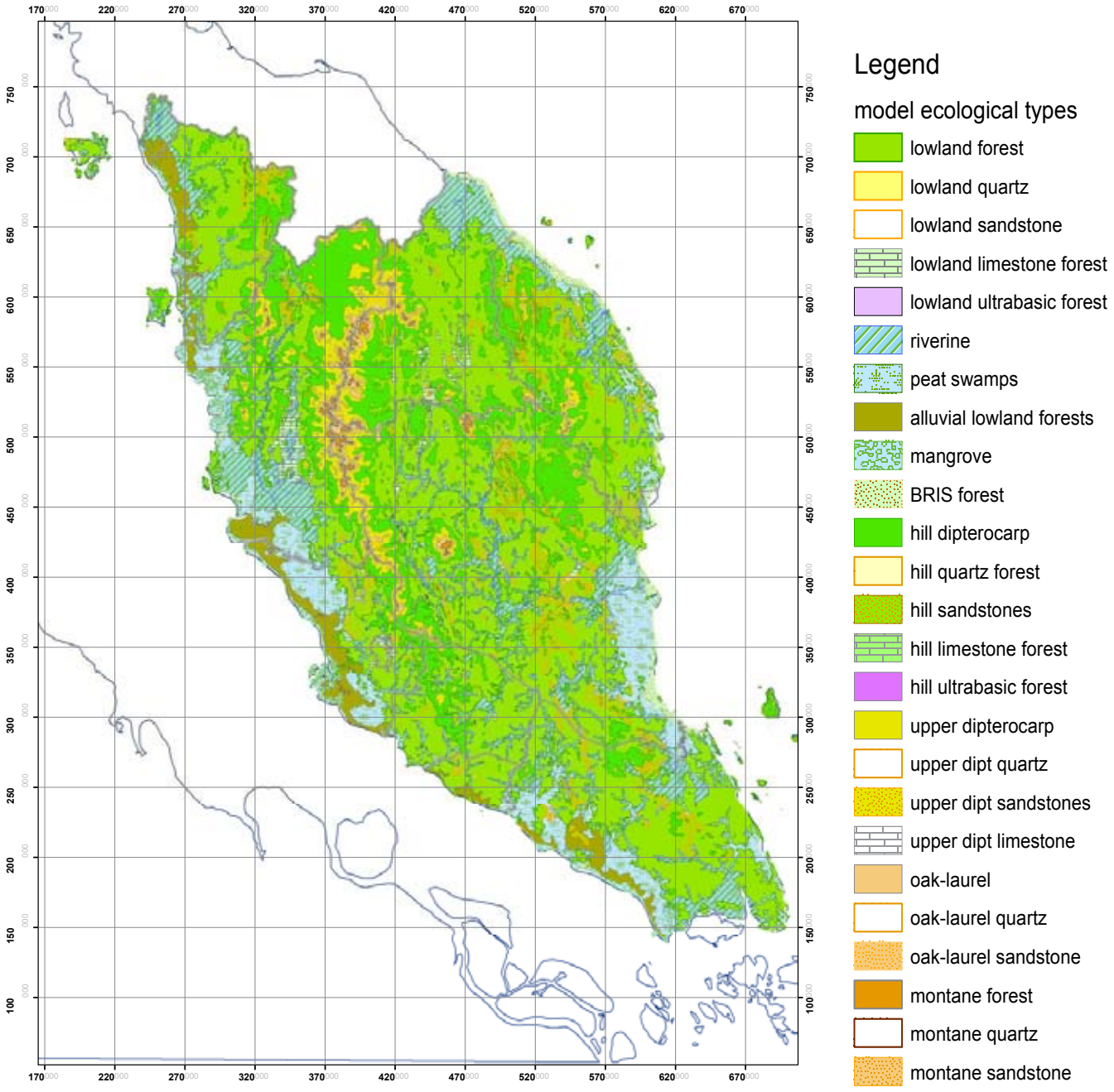
   Assumption:
   - Model ecological types can be created from geographical surrogates.

   In an earlier exercise, a model was created of the '*original ecology of the Peninsular'.* This was for a time before humans had made significant disturbance to structure of the ecosystem. The baseline for the original ecology model is set at about 5,000 years before present. After this date it is assumed human capacity to drain swamps or clear forest, etc. increased.

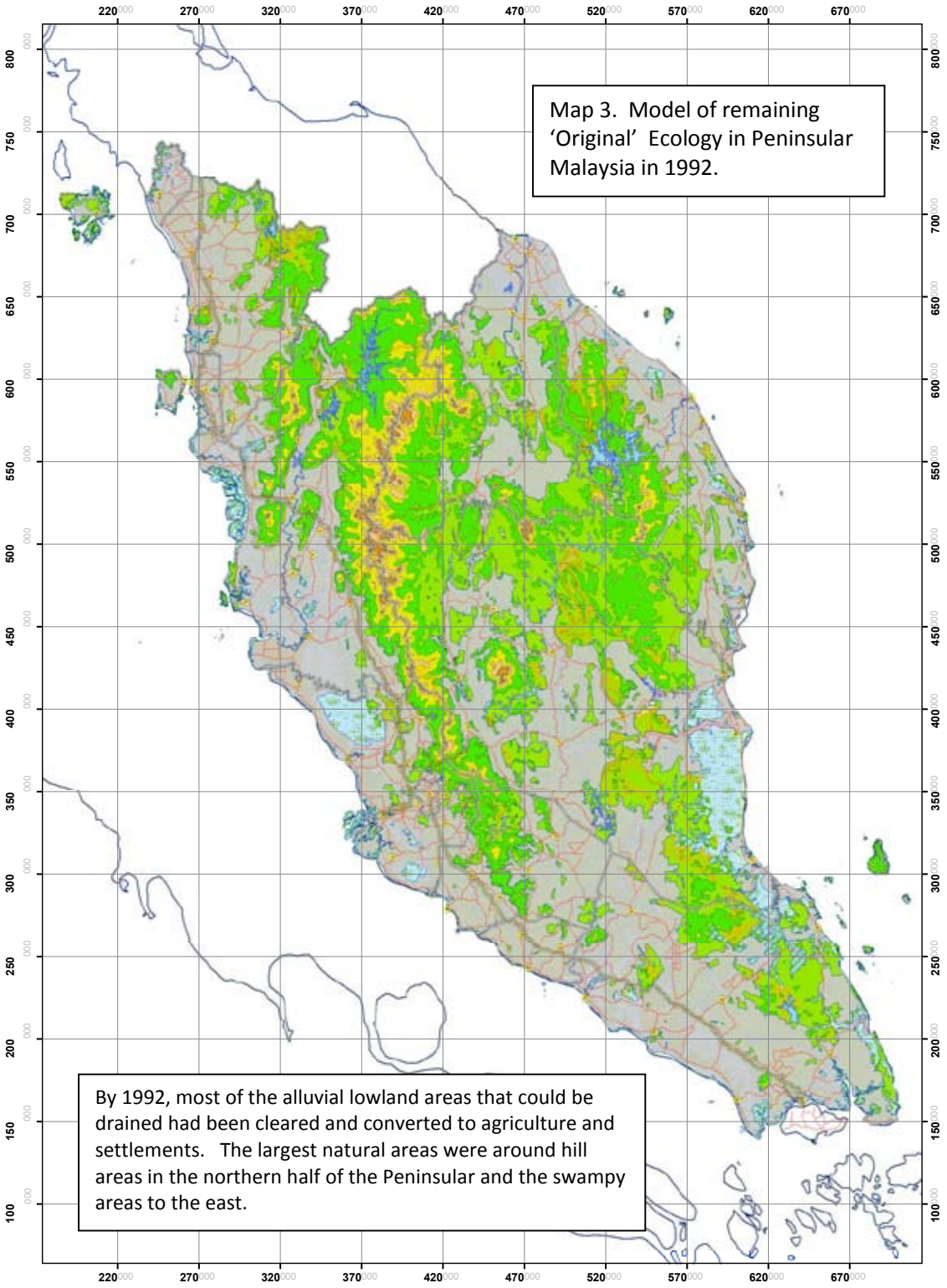
   The model created *ecological types* as surrogates for the range of qualitative descriptions used to describe species habitats and distribution. Geographical indicators were chosen for which map information was available in the public domain. These were digitized and a map built for the ecological model to identify the location and measure the area of different ecological types (Map 2). Depending on the area of interest field workers may feel some of the ecological types created may appear redundant – *ultrabasic hill forest?*, and some too crude – *lowland forest on neutral soils!* Alternative and more useful ecological models can be built later; the present exercise was limited by the map information available in the public domain that we could use as indicators for the whole of the Peninsular[1]. Where model ecotypes are redundant for species habitats and distribution use, they have been generalized. Too crude ecotypes will have to be refined later.

   We then compared this '*original ecological model*' (base) map with a map showing the extent of forest clearance and disturbance in 1992 then, and still the most up-to-date information available in the public domain (Map 3). The next question to ask was: *what lived in those ecological types and what effect has land development and forest disturbance had on the viability of their habitat and populations?*

[1] Better map data and up-to-date satellite data exists, but not in the public domain.



Map 2. A map of an 'Original Ecology Model' of Peninsular Malaysia before extensive human disturbance & clearance



Map 3. Model of remaining 'Original' Ecology in Peninsular Malaysia in 1992.

By 1992, most of the alluvial lowland areas that could be drained had been cleared and converted to agriculture and settlements. The largest natural areas were around hill areas in the northern half of the Peninsular and the swampy areas to the east.

The table below describes the standards used in the model and illustrates possible ecological types that could be identified by those standards.

Standard: Ecological types.

INDICATORS FROM THE MODEL ECOLOGICAL TYPES		'REAL WORLD AREAS' WHICH HAVE THE POTENTIAL TO CONTAIN THE HABITAT OF WILDLIFE SPECIES.
Lowland forest (on well drained, neutral mineral soils)		Any dry forest area below 300 m (<1000ft) with neutral soils unless otherwise qualified. Rolling country, well drained sedentary soils.
Other lowland areas qualified by soil types and hydrology	Riverine	Any area with river deposited soils over any parent rock material. These could be Holocene or from earlier periods. Some flooding. From *Gapis* belts to marine alluvium below.
	Marine alluvial soils	Holocene alluvium developed behind mangroves as Pleistocene rose. Generally nutrient-rich 'much' soils, some flooding. Also topogeneous swamp areas.
	BRIS	Sand ridges along beaches with intervening swamps, and strand forest.
	Peat	Any areas which had deep organic peat soils. These could overlay areas of marine sands or clay.
	Mangrove	Accreting shores and estuaries with self-regenerating mangrove forests.
Hill dipterocarp forest		Any dry forest from 300 to 740m (1000-2500ft) on any soil type. Ridges, slopes and valley bottoms.
Upper dipterocarp forest		Any forest from 740 to 1200m (2500-3500ft) on any soil. Ridges, slopes and valley bottoms.
Oak-laurel forest		Any forest from 1200 – 1500 (3500- 5000ft) on any soil. Ridges, slopes and valley bottoms.
Montane forest		Any forest area above 1500m (>5000ft). Ridges, slopes and valley bottoms with thin peat soils.

Standard: Geological qualifiers that could influence ecological community.

Geologic material	'Real world' ecological types which have the potential to contain the habitat of wildlife species.
Quartz	Areas over quartz – usually ridges such as at Klang Gates. Thin soils – fire risk, thin peat.
Sandstone	Any area over sandstone with sedentary soils. Generally acidic soils with pole forests.
Limestone	Any areas over limestone – karst and cave areas in with towers to eroded plains.
Ultrabasic	Any area over ultrabasic rocks.

Where these geologic qualifiers would have an influence on sedentary soils, they are used to qualify the model ecological type – *lowland quartz.* But where they have been covered by allochthonous soils – *marine alluvium, etc.,* they are ignored and only the soil considered as having a relevant effect on the model ecological type.

For most species, their notes on distribution place them into elevation bands or particular thematic areas – *caves, peat swamps, etc.,* thus cave dependent species are mapped as restricted to limestone areas and peat swamp species in peat swamps. Where species cover lowland areas in general, such soil and geological qualifiers are redundant.

3.0 Fitting species habitats into the model ecology types.

Assumption:

- Species habitats could be fitted within the model ecological types and would change proportionately with changes in the model ecological type.

The ecological types above, are used as indicator to model what we understand to be species habitats. Rather than try to map the known distributions of the few species known, we chose to fit general habitat descriptions into our *ecological model*. This may not have been an entirely comfortable fit for all species but it treats all species equally. (The areas of discomfort can flagged and revisited later - aquatic and river dependent species especially).

Standard: Disturbance.
Using landuse and forest resource maps of the Peninsular from 1992, we could map which areas of original ecology that were: still in their original state or at least in a late succession state; logged or disturbed, but undergoing succession back to something structurally similar to their original; cleared and were no longer in their original state or maintained in a state of arrested or deflected succession. These are discussed in the box below.

Ecological model class	Tolerance and restrictions for species distribution
Original forest – mature forest	Primary: tall forest or other areas unaltered or disturbed by human activity. Original plant community structurally intact and original ecological assumed to be functioning. Now mostly in old Protected Areas.
Logged forest – undergoing successional change	Secondary: areas with historic disturbance, but local ecological structure mostly intact and considered able to self-regenerate characteristic plant community of the original forest. Production forest in State Forest Reserves and state forest land.
Altered – either deflected or arrested succession.	Areas that have been cleared of original vegetation, possibly drained and cut and maintained with an alternative plant cover. Plantations, orchards, urban areas, degraded mine tailings, *lalang, resam,* bamboo, etc.

a. Linking species populations to model habitats

3.1 Using ecological types and habitats to quantify relative population changes.

Assumption:

- species populations will change proportionately with changes in habitat; and
- relative species populations in the same habitats can be differentiated by models for distribution and abundance.

Each species was given a standard set of ecological notes that qualified distribution and abundance with parameters that could be matched to the ecological types of the map model shown in Map 2 and 3 above. It was recognised that the actual habitat of each species may not have perfectly matched the ecological types of the model, but the match was assumed to be adequate for assessment needs. It was assumed that the change in the extent of ecological types between the base map 5,000 years before present (YBP) and the current map dated 1992 would be proportionate with the change in species habitat. The model used the product of habitat-distribution-abundance-body mass as an indicator for a species population change standard.

3.2. Relative distribution.

From changes in the extent model ecological types, we can model the relative change in a species habitat and population. The actual area is not relevant, just the proportion of change. But where two or more species have the same relative model habitat and population change, we cannot see which species would have greater or lesser absolute numbers. It is not possible for use to model absolute numbers, but we can rank species into those which would be more or less numerous. With such information, we have an idea of which species has the lesser numbers and thus be closer to critical non-self sustaining population levels.

Distribution is seldom uniform. We know some animals are hard to find and some are very common. But there are also examples of animals being absent in some potential habitat areas, but locally common in others. The models have two (2) separate components to qualify population:

- Relative distribution – where species are found; and
- Abundance – how frequently we expect to meet them once we have found where they are.

The model allowed us to map and measure the potential extent of habitat of a species. But not all species occupy their full potential range. Even without stress imposed by human activities, species distribution is affected by competition for resources by other species –*camera trapping and systematic rentis surveys suggests leopards avoid areas occupied by tiger*, or other factors. For this exercise we have used expert opinion based on field experience to quantify wildlife species distribution[2].

[2] This task was undertaken as an 'expert opinion' exercise by Dr. Lim Boo Liat based on his extensive personal field experience. The exercise should be periodically updated, perhaps using a larger expert opinion group using alternative stakeholder derived systematic framework for evaluation.

Working with a scale of about 1:250,000 – *the peninsular would appear as a map about 2 m long*, the distribution of each species was described in one of the following distribution classes:

Distribution class	Benchmarks
Widely distributed (WD)	Expected to be found in 50% of its potential habitat range
Restricted distribution (R)	Expected to be found between 5 and 50% of its potential habitat range.
Spottedly distributed (SD)	Expected to be found in less than 5% of its habitat range.

In each case, the factors that control actual distribution within the model habitat are not considered.

3.3 Relative abundance.

Some species are seldom found, but when they are, they can be in large numbers –*examples include bat species* or some species in the northern region or some species on islands. Again we have used expert opinion to assign each species into one of three relative abundance classes. These are:

Abundance class	Benchmarks - guidelines
Very common (VC)	Expected to be recorded in > 10% of trap/survey effort unit (trap nights, rentis walks, etc.).
Common (C)	Expected to be recorded 1 to 10% of trap/survey effort units.
Rare (Ra)	Expected to be recorded in less than 1% of trap/survey effort units.

The measure is based on experience from small mammal trapping, but can be used as a guideline for field investigators working with other taxa surveyed with different techniques that record or capture specimens at different rates[3].

In the results that follow, we have combined distribution and abundance into a single score for each species. This allows the model to differentiate threat between species that have otherwise experienced the same population changes. This score has been multiplied with the percentage change for population to create a population-distribution-abundance score where the lowest values indicate the species that have experienced the most severe population declines.

3.4 Relative population densities.

Scale is important for animals, with larger species needing larger habitats areas than smaller species. The model assumes that each species has a similar biomass per unit area. This can be restated as for the same habitat area, there would be fewer large animals than small animals. In reality this may not necessarily be always true, even for closely related species or species that

[3] Ideally we would be able to normalize recording frequencies of different survey tools. At the present normalizing is based on expert opinion. Future discussion may result in a more objective process.

share similar positions in a trophic ecology model. We consider the factor useful, but recognise that it could be revisited and improved in a later model.

The model adjusts the population-distribution-abundance scores by multiplying with the factors below. These factors are assigned according to the band for the mass into which the adult of the species is assumed to fit. These are:

1) $>10^5$ gms, x 1
2) 10^4-10^5;gms, x 2
3) 10^3-10^4;gms, x 3
4) 10^2 - 10^3 gms, x 4 and
5) $<10^2$ gms. x 5.

The outcome can be called a (cumbersome) population-distribution-abundance-density value.

The significance is that species numbers do not decline to zero as habitat is reduced to zero, but will collapse when populations reach a critical size. Up to this point the model has only considered ranking score for population sizes. In the real world, when absolute population number get too small, stochastic or random events can have disastrous impacts on small populations but no significant effect on a larger one. We do not known that the critical population size would be for any species. All we can be certain about is that the larger species with their fewer numbers are expected to be more close to critical population size than smaller, but more numerous species.

3.5 Species richness and biodiversity.

Assumption:

- A single biodiversity dimension is sufficient to indicate effects from habitat and population changes.

Until now we have only considered species under threat of extinction. Each species has been assumed to have equal value, so our focus has been on loss of species richness. How would that affect biodiversity?.

In this part of the model we are concerned with amphibian, reptile and mammal species. Rather than to incorporate a factor for the functional roles each species plays in community ecology as a measure for biodiversity at the species level, the model uses a simpler surrogate at the genetic level. Instead of trying to create a factor for genotypes and alleles, the model has used the level of taxonomic representation as a simpler indicator to measure an indicator for genetic diversity. The model assumes that those taxa that are the sole representatives of their genus, have a greater genetic diversity value than those from genera with two or more species. And so on for family and orders.

4.0 Overview of methods and model output.

The methods chosen used basic ecological theories to build the ecology model GIS tools to build the maps and map information available in the public domain. Species information came from published sources, private communications and expert opinion.

What we have attempted can be seen as either a model based on habitats, ranks species according to their threat for extinction and then incorporates a factor for the severity of extinction or it builds a model that links habitats to species to biodiversity. Either way, it is just a model that applies the same standards to each species so that they can be evaluated according to a common basis for their conservation management needs.

The output can then be used to identify gaps in current conservation management effort and identify priority species on which management effort should be focused.

APPENDIX II

IUCN Red list of Threatened Species

I. INTRODUCTION

1. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk. However, while the Red List may focus attention on those taxa at the highest risk, it is not the sole means of setting priorities for conservation measures for their protection.

Extensive consultation and testing in the development of the system strongly suggest that it is robust across most organisms. However, it should be noted that although the system places species into the threatened categories with a high degree of consistency, the criteria do not take into account the life histories of every species. Hence, in certain individual cases, the risk of extinction may be under- or over-estimated.

2. Before 1994 the more subjective threatened species categories used in IUCN Red Data Books and Red Lists had been in place, with some modification, for almost 30 years. Although the need to revise the categories had long been recognized (Fitter and Fitter 1987), the current phase of development only began in 1989 following a request from the IUCN Species Survival Commission (SSC) Steering Committee to develop a more objective approach. The IUCN Council adopted the new Red List system in 1994.

The IUCN Red List Categories and Criteria have several specific aims:

- to provide a system that can be applied consistently by different people;
- to improve objectivity by providing users with clear guidance on how to evaluate different factors which affect the risk of extinction;
- to provide a system which will facilitate comparisons across widely different taxa;
- to give people using threatened species lists a better understanding of how individual species were classified.

3. Since their adoption by IUCN Council in 1994, the IUCN Red List Categories have become widely recognized internationally, and they are now used in a range of publications and listings produced by IUCN, as well as by numerous governmental and non-governmental organizations. Such broad and extensive use revealed the need for a number of improvements, and SSC was mandated by

the 1996 World Conservation Congress (WCC Res. 1.4) to conduct a review of the system (IUCN 1996). This document presents the revisions accepted by the IUCN Council.

The proposals presented in this document result from a continuing process of drafting, consultation and validation. 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 modifications as and when they become necessary, a system for version numbering has been adopted as follows:

Version 1.0: Mace and 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: Mace and Stuart (1994)
Following further comments received and additional validation exercises, some minor changes to the criteria were made. In addition, the Susceptible category present in Versions 2.0 and 2.1 was subsumed into the Vulnerable category. A precautionary application of the system was emphasised.

Version 2.3: IUCN (1994)
IUCN Council adopted this version, which incorporated changes as a result of comments from IUCN members, in December 1994. The initial version of this document was published without the necessary bibliographic details, such as date of publication and ISBN number, but these were included in the subsequent reprints in 1998 and 1999. This version was used for the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge 1996), *The World List of Threatened Trees* (Oldfield *et al.* 1998) and the *2000 IUCN Red List of Threatened Species* (Hilton-Taylor 2000).

Version 3.0: IUCN/SSC Criteria Review Working Group (1999)
Following comments received, a series of workshops were convened to look at the IUCN Red List Criteria following which, changes were proposed affecting the criteria, the definitions of some key terms and the handling of uncertainty.

Version 3.1: IUCN (2001)
The IUCN Council adopted this latest version, which incorporated changes as a result of comments from the IUCN and SSC memberships and from a final meeting of the Criteria Review Working Group, in February 2000.

All new assessments from January 2001 should use the latest adopted version and cite the year of publication and version number.

4. In the rest of this document, the proposed system is outlined in several sections. Section II, the Preamble, presents basic information about the context and structure of the system, and the procedures that are to be followed in applying the criteria to species. Section III provides definitions of key terms used. Section IV presents the categories, while Section V details the quantitative criteria used for classification within the threatened categories. Annex I provides guidance on how to deal with uncertainty when applying the criteria; Annex II suggests a standard format for citing the Red List Categories and Criteria; and Annex III outlines the documentation requirements for taxa to be included on IUCN's global Red Lists. It is important for the effective functioning of the system that all sections are read and understood to ensure that the definitions and rules are followed. (**Note:** Annexes I, II and III will be updated on a regular basis.)

II. PREAMBLE

The information in this section is intended to direct and facilitate the use and interpretation of the categories (Critically Endangered, Endangered, etc.), criteria (A to E), and subcriteria (1, 2, etc.; 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. In the following information, definitions and criteria the term 'taxon' is used for convenience, and may represent species or lower taxonomic levels, including forms that are not yet formally described. There is 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, although in such cases special notice should be taken of point 14. In presenting the results of applying the criteria, the taxonomic unit and area under consideration should be specified in accordance with the documentation guidelines (see Annex 3). The categorization process should only be applied to wild populations inside their natural range, and to populations resulting from benign introductions. The latter are defined in the IUCN *Guidelines for Re-introductions* (IUCN 1998) 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. This is a feasible conservation tool only when there is no remaining area left within a species' historic range'.

2. Nature of the categories

Extinction is a chance process. Thus, a listing in a higher extinction risk category implies a higher expectation of extinction, and over the time-frames specified more taxa listed in a higher category are expected to go extinct than those in a lower one (without effective conservation action). However, the persistence of some taxa in high-risk categories does not necessarily mean their initial assessment was inaccurate.

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 categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories (see Figure 1).

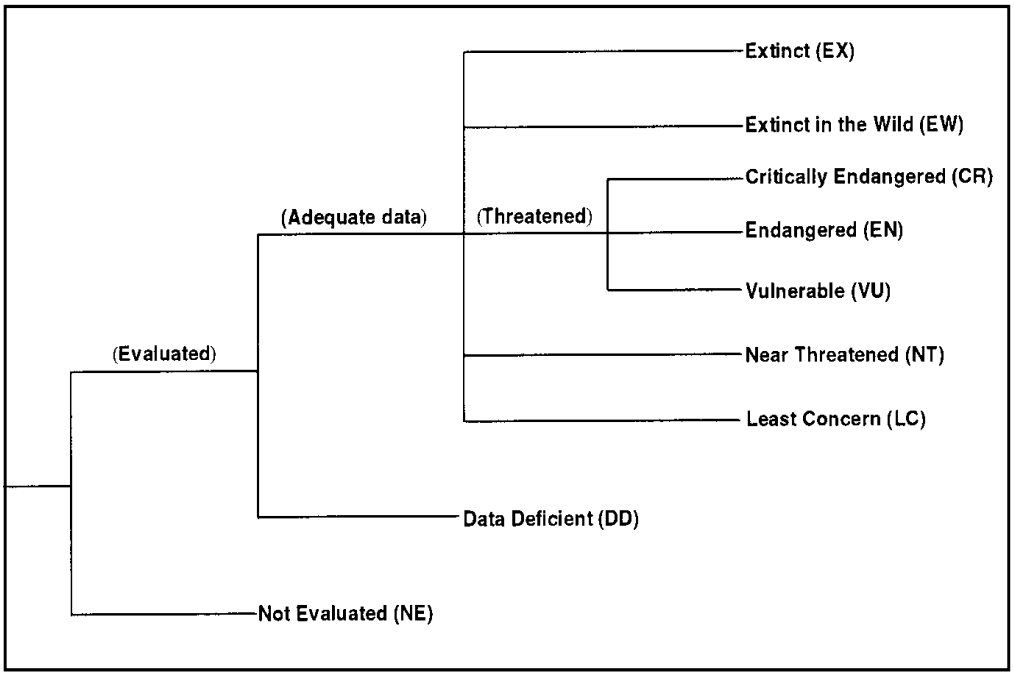


Figure 1. Structure of the categories.

3. Role of the different criteria

For listing as Critically Endangered, Endangered or Vulnerable there is a range of quantitative criteria; meeting any one of these criteria qualifies a taxon for listing at that level of threat. Each taxon should be evaluated against all the criteria. Even though some criteria will be inappropriate for certain taxa (some taxa will never qualify under these however close to extinction they come), there should be criteria appropriate for assessing threat levels for any taxon. The relevant factor is whether *any one* criterion is met, not whether all are appropriate or all are met. Because it will never be clear in advance which criteria are appropriate for a particular taxon, each taxon should be evaluated against all the criteria, and *all* criteria met at the highest threat category must be listed.

4. Derivation of quantitative criteria

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. 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. Broad consistency between them was sought.

5. Conservation actions in the listing process

The criteria for the threatened categories are to be applied to a taxon whatever the level of conservation action affecting it. It is important to emphasise here that a taxon may require conservation action even if it is not listed as threatened. Conservation actions which may benefit the taxon are included as part of the documentation requirements (see Annex 3).

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 as being acceptable throughout. Inference and projection may be based on extrapolation of current or potential threats into the future (including their rate of change), or 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 the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified as part of the documentation.

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 (e.g., pathogens, invasive organisms, hybridization).

7. 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 the area will be that they are found to occupy, and the less likely it will be that range estimates (at least for 'area of occupancy': see Definitions, point 10) exceed the thresholds specified in the criteria. Mapping at finer scales reveals more areas in which the taxon is unrecorded. Conversely, coarse-scale mapping reveals fewer unoccupied areas, resulting in range estimates that are more likely to exceed the thresholds for the threatened categories. The choice of scale at which range is estimated may thus, itself, influence the outcome of Red List assessments and could be a source of inconsistency and bias. It is impossible to provide any strict but general rules for mapping taxa or habitats; the most appropriate scale will depend on the taxon in question, and the origin and comprehensiveness of the distribution data.

8. Uncertainty

The data used to evaluate taxa against the criteria are often estimated with considerable uncertainty. Such uncertainty can arise from any one or all of the following three factors: natural variation, vagueness in the terms and definitions used, and measurement error. The way in which this uncertainty is handled can have a strong influence on the results of an evaluation. Details of methods recommended for handling uncertainty are included in Annex 1, and assessors are encouraged to read and follow these principles.

In general, when uncertainty leads to wide variation in the results of assessments, the range of possible outcomes should be specified. A single category must be chosen and the basis for the decision should be documented; it should be both precautionary and credible.

When data are very uncertain, the category of 'Data Deficient' may be assigned. However, in this case the assessor must provide documentation showing that this category has been assigned because data are inadequate to determine a threat category. It is important to recognize that taxa that are poorly known can often be assigned a threat category on the basis of background information concerning the deterioration of their habitat and/or other causal factors; therefore the liberal use of 'Data Deficient' is discouraged.

9. 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, taxa listed in these categories should not be treated as if they were non-threatened. It may be appropriate (especially for Data Deficient forms) to give them the same degree of attention as threatened taxa, at least until their status can be assessed.

10. Documentation

All assessments should be documented. Threatened classifications should state the criteria and subcriteria that were met. No assessment can be accepted for the IUCN Red List as valid unless at least one criterion is given. If more than one criterion or subcriterion is met, then each should be listed. If a re-evaluation indicates that the documented criterion is no longer met, this should not result in automatic reassignment to a lower category of threat (downlisting). Instead, the taxon should be re-evaluated against all the criteria to clarify its status. The factors responsible for qualifying the taxon against the criteria, especially where inference and projection are used, should be documented

(see Annexes 2 and 3). The documentation requirements for other categories are also specified in Annex 3.

11. 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 extinction risk 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 other biological characteristics of the subject.

12. Re-evaluation

Re-evaluation of taxa against the criteria should be carried out at appropriate intervals. This is especially important for taxa listed under Near Threatened, Data Deficient and for threatened taxa whose status is known or suspected to be deteriorating.

13. Transfer between categories

The following rules govern the movement of taxa between categories:

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 been met for five years or more.
B. If the original classification is found to have been erroneous, the taxon may be transferred to the appropriate category or removed from the threatened categories altogether, without delay (but see Point 10 above).
C. Transfer from categories of lower to higher risk should be made without delay.

14. Use at regional level

The IUCN Red List Categories and Criteria were designed for global taxon assessments. However, many people are interested in applying them to subsets of global data, especially at regional, national or local levels. To do this it is important to refer to guidelines prepared by the IUCN/SSC Regional Applications Working Group (e.g., Gärdenfors *et al*. 2001). When applied at national or regional levels it must be recognized that a global category may not be the same as a national or regional category for a particular taxon. For example, taxa classified as Least Concern globally might be Critically Endangered within a particular region where numbers are very small or declining, perhaps only because they are at the margins of their global range. Conversely, taxa classified as Vulnerable on the basis of their global declines in numbers or range might be

Least Concern within a particular region where their populations are stable. It is also important to note that taxa endemic to regions or nations will be assessed globally in any regional or national applications of the criteria, and in these cases great care must be taken to check that an assessment has not already been undertaken by a Red List Authority (RLA), and that the categorization is agreed with the relevant RLA (e.g., an SSC Specialist Group known to cover the taxon).

III. DEFINITIONS

1. Population and Population Size (Criteria A, C and D)

The term 'population' is used in a specific sense in the Red List Criteria that is different to its common biological usage. Population is here defined as the total number of individuals of the taxon. For functional reasons, primarily owing to differences between life forms, population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

2. Subpopulations (Criteria B and C)

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

3. Mature individuals (Criteria A, B, C and D)

The number of mature individuals is the number of individuals known, estimated or inferred to be capable of reproduction. When estimating this quantity, the following points should be borne in mind:

- Mature individuals that will never produce new recruits should not be counted (e.g. densities are too low for fertilization).
- 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.
- Where the population size fluctuates, use a lower estimate. In most cases this will be much less than the mean.
- 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.
- Re-introduced individuals must have produced viable offspring before they are counted as mature individuals.

4. Generation (Criteria A, C and E)

Generation length is the average age of parents of the current cohort (i.e. newborn individuals in the population). Generation length therefore reflects the turnover rate of breeding individuals in a population. Generation length is greater than the

age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once. Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.

5. Reduction (Criterion A)

A reduction is a decline in the number of mature individuals of at least the amount (%) stated under the criterion over the time period (years) specified, although the decline need not be continuing. A reduction should not be interpreted as part of a fluctuation unless there is good evidence for this. The downward phase of a fluctuation will not normally count as a reduction.

6. Continuing decline (Criteria B and C)

A continuing decline is a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken. Fluctuations will not normally count as continuing declines, but an observed decline should not be considered as a fluctuation unless there is evidence for this.

7. Extreme fluctuations (Criteria B and C)

Extreme fluctuations can be said to occur in a number of taxa when population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e. a tenfold increase or decrease).

8. Severely fragmented (Criterion B)

The phrase 'severely fragmented' refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonization.

9. Extent of occurrence (Criteria A and B)

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 (see Figure 2). This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat) (but see 'area of occupancy', point 10 below). 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).

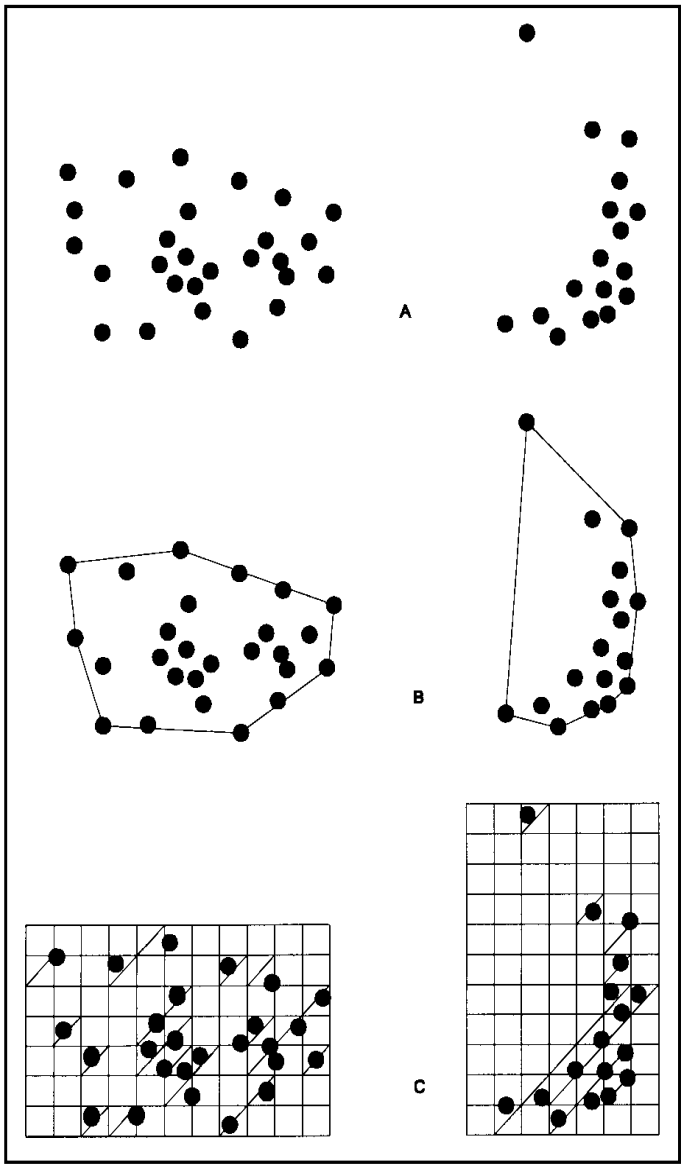


Figure 2. Two examples of the distinction between extent of occurrence and area of occupancy.
(A) is the spatial distribution of known, inferred or projected sites of present occurrence.
(B) shows one possible boundary to the extent of occurrence, which is the measured area within this boundary.
(C) shows one measure of area of occupancy which can be achieved by the sum of the occupied grid squares.

10. Area of occupancy (Criteria A, B and D)

Area of occupancy is defined as the area within its 'extent of occurrence' (see point 9 above) 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 contain unsuitable or unoccupied habitats. In some cases (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. 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 nature of

threats and the available data (see point 7 in the Preamble). To avoid inconsistencies and bias in assessments caused by estimating area of occupancy at different scales, it may be necessary to standardize estimates by applying a scale-correction factor. It is difficult to give strict guidance on how standardization should be done because different types of taxa have different scale-area relationships.

11. Location (Criteria B and D)

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

12. Quantitative analysis (Criterion E)

A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. Population viability analysis (PVA) is one such technique. Quantitative analyses should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate of extinction risk (for instance, estimating the impact of stochastic events on habitat). In presenting the results of quantitative analyses, the assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must be documented.

IV. THE CATEGORIES [1]

A representation of the relationships between the categories is shown in Figure 1.

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct 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.

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 the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

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[1] *Note: As in previous IUCN categories, the abbreviation of each category (in parenthesis) follows the English denominations when translated into other languages (see Annex 2).*

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

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 are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and 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 a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

V. THE CRITERIA FOR CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible**,** based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at only a single location.

   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at only a single location.

   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

   a. Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 50 mature individuals, OR
      (ii) at least 90% of mature individuals in one subpopulation.

   b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a–c:

    a. Severely fragmented or known to exist at no more than five locations.

    b. Continuing decline, observed, inferred or projected, in any of the following:
        (i) extent of occurrence
        (ii) area of occupancy
        (iii) area, extent and/or quality of habitat
        (iv) number of locations or subpopulations
        (v) number of mature individuals.

    c. Extreme fluctuations in any of the following:
        (i) extent of occurrence
        (ii) area of occupancy
        (iii) number of locations or subpopulations
        (iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:

    1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

    2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

        a. Population structure in the form of one of the following:
            (i) no subpopulation estimated to contain more than 250 mature individuals, OR
            (ii) at least 95% of mature individuals in one subpopulation.

        b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at no more than 10 locations.

b. Continuing decline, observed, inferred or projected, in any of the following:
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) area, extent and/or quality of habitat
   (iv) number of locations or subpopulations
   (v) number of mature individuals.

c. Extreme fluctuations in any of the following:
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) number of locations or subpopulations
   (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at no more than 10 locations.

   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

   1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

    a. Population structure in the form of one of the following:
        (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
        (ii) all mature individuals are in one subpopulation.

    b. Extreme fluctuations in number of mature individuals.

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

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

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

Annex 1: Uncertainty

The Red List Criteria should be applied to a taxon based on the available evidence concerning its numbers, trend and distribution. In cases where there are evident threats to a taxon through, for example, deterioration of its only known habitat, a threatened listing may be justified, even though there may be little direct information on the biological status of the taxon itself. In all these instances there are uncertainties associated with the available information and how it was obtained. These uncertainties may be categorized as natural variability, semantic uncertainty and measurement error (Akçakaya *et al.* 2000). This section provides guidance on how to recognize and deal with these uncertainties when using the criteria.

Natural variability results from the fact that species' life histories and the environments in which they live change over time and space. The effect of this variation on the criteria is limited, because each parameter refers to a specific time or spatial scale. Semantic uncertainty arises from vagueness in the definition of terms or lack of consistency in different assessors' usage of them. Despite attempts to make the definitions of the terms used in the criteria exact, in some cases this is not possible without the loss of generality. Measurement error is often the largest source of uncertainty; it arises from the lack of precise information about the parameters used in the criteria. This may be due to inaccuracies in estimating the values or a lack of knowledge. Measurement error may be reduced or eliminated by acquiring additional data. For further details, see Akçakaya *et al.* (2000) and Burgman *et al.* (1999).

One of the simplest ways to represent uncertainty is to specify a best estimate and a range of plausible values. The best estimate itself might be a range, but in any case the best estimate should always be included in the range of plausible values. When data are very uncertain, the range for the best estimate might be the range of plausible values. There are various methods that can be used to establish the plausible range. It may be based on confidence intervals, the opinion of a single expert, or the consensus opinion of a group of experts. Whichever method is used should be stated and justified in the documentation.

When interpreting and using uncertain data, attitudes toward risk and uncertainty may play an important role. Attitudes have two components. First, assessors need to consider whether they will include the full range of plausible values in assessments, or whether they will exclude extreme values from consideration

(known as dispute tolerance). An assessor with a low dispute tolerance would include all values, thereby increasing the uncertainty, whereas an assessor with a high dispute tolerance would exclude extremes, reducing the uncertainty. Second, assessors need to consider whether they have a precautionary or evidentiary attitude to risk (known as risk tolerance). A precautionary attitude will classify a taxon as threatened unless it is certain that it is not threatened, whereas an evidentiary attitude will classify a taxon as threatened only when there is strong evidence to support a threatened classification. Assessors should resist an evidentiary attitude and adopt a precautionary but realistic attitude to uncertainty when applying the criteria, for example, by using plausible lower bounds, rather than best estimates, in determining population size, especially if it is fluctuating. All attitudes should be explicitly documented.

An assessment using a point estimate (i.e. single numerical value) will lead to a single Red List Category. However, when a plausible range for each parameter is used to evaluate the criteria, a range of categories may be obtained, reflecting the uncertainties in the data. A single category, based on a specific attitude to uncertainty, should always be listed along with the criteria met, while the range of plausible categories should be indicated in the documentation (see Annex 3).

Where data are so uncertain that any category is plausible, the category of 'Data Deficient' should be assigned. However, it is important to recognize that this category indicates that the data are inadequate to determine the degree of threat faced by a taxon, not necessarily that the taxon is poorly known or indeed not threatened. Although Data Deficient is not a threatened category, it indicates a need to obtain more information on a taxon to determine the appropriate listing; moreover, it requires documentation with whatever available information there is.

Annex 2: Citation of the IUCN Red List Categories and Criteria

In order to promote the use of a standard format for citing the Red List Categories and Criteria the following forms of citation are recommended:

1. The Red List Category may be written out in full or abbreviated as follows (when translated into other languages, the abbreviations should follow the English denominations):

Extinct, EX	Near Threatened, NT
Extinct in the Wild, EW	Least Concern, LC
Critically Endangered, CR	Data Deficient, DD
Endangered, EN	Not Evaluated, NE
Vulnerable, VU	

2. Under Section V (the criteria for Critically Endangered, Endangered and Vulnerable) there is a hierarchical alphanumeric numbering system of criteria and subcriteria. These criteria and subcriteria (all three levels) form an integral part of the Red List assessment and all those that result in the assignment of a threatened category must be specified after the Category. Under the criteria A to C and D under Vulnerable, the first level of the hierarchy is indicated by the use of numbers (1–4) and if more than one is met, they are separated by means of the '+' symbol. The second level is indicated by the use of the lower-case alphabet characters (a–e). These are listed without any punctuation. A third level of the hierarchy under Criteria B and C involves the use of lower case roman numerals (i–v). These are placed in parentheses (with no space between the preceding alphabet character and start of the parenthesis) and separated by the use of commas if more than one is listed. Where more than one criterion is met, they should be separated by semicolons. The following are examples of such usage:

EX	CR A1cd	VU A2c+3c
EN B1ac(i,ii,iii)	EN A2c; D	VU D1+2
CR A2c+3c; B1ab(iii)	CR D	VU D2
EN B2ab(i,ii,iii)	VU C2a(ii)	
EN A1c; B1ab(iii); C2a(i)	EN B2b(iii)c(ii)	
EN B1ab(i,ii,v)c(iii,iv)+2b(i)c(ii,v)	VU B1ab(iii)+2ab(iii)	
EN A2abc+3bc+4abc; B1b(iii,iv,v)c(ii,iii,iv)+2b(iii,iv,v)c(ii,iii,iv)		

Annex 3: Documentation Requirements for Taxa Included on the IUCN Red List

The following is the **minimum** set of information, which should accompany every assessment submitted for incorporation into the *IUCN Red List of Threatened Species*™:

- Scientific name including authority details
- English common name/s and any other widely used common names (specify the language of each name supplied)
- Red List Category and Criteria
- Countries of occurrence (including country subdivisions for large nations, e.g. states within the USA, and overseas territories, e.g. islands far from the mainland country)
- For marine species, the Fisheries Areas in which they occur should be recorded (see http://www.iucn.org/themes/ssc/sis/faomap.htm for the Fisheries Areas as delimited by FAO, the Food and Agriculture Organization of the United Nations)
- For inland water species, the names of the river systems, lakes, etc. to which they are confined
- A map showing the geographic distribution (extent of occurrence)
- A rationale for the listing (including any numerical data, inferences or uncertainty that relate to the criteria and their thresholds)
- Current population trends (increasing, decreasing, stable or unknown)
- Habitat preferences (using a modified version of the Global Land Cover Characterization (GLCC) classification which is available electronically from http://www.iucn.org/themes/ssc/sis/authority.htm or on request from redlist@ssc-uk.org)
- Major threats (indicating past, current and future threats using a standard classification which is available from the SSC web site or e-mail address as shown above)
- Conservation measures, (indicating both current and proposed measures using a standard classification which is available from the SSC web site or e-mail address as shown above)
- Information on any changes in the Red List status of the taxon, and why the status has changed
- Data sources (cited in full; including unpublished sources and personal communications)
- Name/s and contact details of the assessor/s
- Before inclusion on the IUCN Red List, all assessments will be evaluated by

at least two members of a Red List Authority. The Red List Authority is appointed by the Chair of the IUCN Species Survival Commission and is usually a sub-group of a Specialist Group. The names of the evaluators will appear with each assessment.

In addition to the minimum documentation, the following information should also be supplied where appropriate:

- If a quantitative analysis is used for the assessment (i.e. Criterion E), the data, assumptions and structural equations (e.g., in the case of a Population Viability Analysis) should be included as part of the documentation.
- For Extinct or Extinct in the Wild taxa, extra documentation is required indicating the effective date of extinction, possible causes of the extinction and the details of surveys which have been conducted to search for the taxon.
- For taxa listed as Near Threatened, the rationale for listing should include a discussion of the criteria that are nearly met or the reasons for highlighting the taxon (e.g., they are dependent on ongoing conservation measures).
- For taxa listed as Data Deficient, the documentation should include what little information is available.

Assessments may be made using version 2.0 of the software package RAMAS® Red List (Akçakaya and Ferson 2001). This program assigns taxa to Red List Categories according to the rules of the IUCN Red List Criteria and has the advantage of being able to explicitly handle uncertainty in the data. The software captures most of the information required for the documentation above, but in some cases the information will be reported differently. The following points should be noted:

- If RAMAS® Red List is used to obtain a listing, this should be stated.
- Uncertain values should be entered into the program as a best estimate and a plausible range, or as an interval (see the RAMAS® Red List manual or help files for further details).
- The settings for attitude towards risk and uncertainty (i.e. dispute tolerance, risk tolerance and burden of proof) are all pre-set at a mid-point. If any of these settings are changed this should be documented and fully justified, especially if a less precautionary position is adopted.
- Depending on the uncertainties, the resulting classification can be a single category and/or a range of plausible categories. In such instances, the following approach should be adopted (the program will usually indicate this automatically in the Results window):
  - If the range of plausible categories extends across two or more of the threatened categories (e.g. Critically Endangered to Vulnerable) and no

preferred category is indicated, the precautionary approach is to take the highest category shown, i.e. CR in the above example. In such cases, the range of plausible categories should be documented under the rationale including a note that a precautionary approach was followed in order to distinguish it from the situation in the next point. The following notation has been suggested e.g. CR* (CR–VU).

  - If a range of plausible categories is given and a preferred category is indicated, the rationale should indicate the range of plausible categories met e.g. EN (CR–VU).

- The program specifies the criteria that contributed to the listing (see Status window). However, when data are uncertain, the listing criteria are approximate, and in some cases may not be determined at all. In such cases, the assessors should use the Text results to determine or verify the criteria and sub-criteria met. Listing criteria derived in this way must be clearly indicated in the rationale (refer to the RAMAS® Red List Help menu for further guidance on this issue).
- If the preferred category is indicated as Least Concern, but the plausible range extends into the threatened categories, a listing of 'Near Threatened' (NT) should be used. The criteria, which triggered the extension into the threatened range, should be recorded under the rationale.
- Any assessments made using this software must be submitted with the RAMAS® Red List input files (i.e. the *.RED files).

New global assessments or reassessments of taxa currently on the IUCN Red List, may be submitted to the IUCN/SSC Red List Programme Officer for incorporation (subject to peer review) in a future edition of the *IUCN Red List of Threatened Species*™. Submissions from within the SSC network should preferably be made using the Species Information Service (SIS) database. Other submissions may be submitted electronically; these should preferably be as files produced using RAMAS® Red List or any of the programs in Microsoft Office 97 (or earlier versions) e.g. Word, Excel or Access. Submissions should be sent to:
IUCN/SSC Red List Programme, IUCN/SSC UK Office, 219c Huntingdon Road, Cambridge, CB3 0DL, United Kingdom. Fax: +44 (0)1223-277845; Email: redlist@ssc-uk.org.

For further clarification or information about the IUCN Red List Criteria, documentation requirements (including the standards used) or submission of assessments, please contact the IUCN/SSC Red List Programme Officer at the address shown above.

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APPENDIX III

Threat Status for Mammals in Peninsular Malaysia

The information displayed below for each species below contains the following :

1) *family* – as used by G.B.Corbet and J.E.Hill, in *The Mammals of the Indomalayan Region – a systematic review* 1992.

2) *genus* – updated using published information from the above.

3) *species* – updated using published information from the above.

4) *common name* – based on the English common name as used by Lord Medway in *The Wild Mammals of Malaya* 1969 with additions from more recent publications.

5) *bahasa name* – as used by the Jabatan PERHILITAN

6) *code* - an internal tool for sorting database records; ignore.

7) *Regional distribution* - a map of the regional distribution compiled from Corbet & Hill, as well as the work of Boonsong Lekagul & Jeffery A. McNeely in *Mammals of Thailand* 1977; A.P.M. Van der Zoon in *Mammals of Indonesia* 1979. These maps are equivalent to the historical EOO for the species.

8) *distribution in Peninsular Malaysia* – the map of the *extent of occurrence* (EOO) and *area of occupation* (AOO) for each species. This has been built by normalizing the point locations of each field record by administrative districts and which is then used to identify the EOO – the current range, and then by identifying suitable habitat with the range, the AOO. For generalist species, the EOO is the same as the AOO *(see Tupia glis)*. For species with narrow habitat demands, the AOO is smaller than EOO, either because of natural ecological variability, or habitat change by human activities. For the species that are affected by ecological change, the AOO has been declining the extent of habitat clearance is shown at four intervals: the 'original extent' prior to 1970, 1970-1980, 1980-1990, and 1990-2000 *(see Balionycteris maculata)*.

9) *Review 2009 (area in ha.)* – gives the area of the EOO and AOO using the 2009 assessment model shown in 8). It should be noted that areas are given in hectares. IUCN quotes EOO and AOO areas as sq. km. To convert hectares to sq.km., divide by 100.

10) *EOO* – the total historical extent of occurrence or range, in hectares, based on the area of the districts in Peninsular Malaysia where the species has been recorded.

11) *AOO 80* –the extent of available habitat within the EOO that existed at the end of 1980. It is assumed that habitat quality is uniform and species density consistent over the whole habitat. Area in hectares.

12) *AOO 90* - the extent of available habitat within the EOO that existed at the end of 1990. It is assumed that habitat quality is uniform and species density consistent over the whole habitat. Area in hectares.

13) *AOO 00* - the extent of available habitat within the EOO that existed at the end of 2000. It is assumed that habitat quality is uniform and species density consistent over the whole habitat. Area in hectares.

14) *% decade change* – this gives the changes in the extent of available habitat as a percentage of the area at the start of the 10 year period from 1980 to 1990, and from 1990 to 2000. Using *Tupaia minor* as an example; at the end of 1990, the AOO was 224,280 ha. By 2000 the AOO had fallen to 168,005 ha. the change in percentage (AOO00-AOO90/AOO90*100=) -25.09%.

15) The assessment published by the IUCN for 2009.

16) *Output review 2007* – the output of the assessment by the Expert Group using IUCN Red list criteria by the *ad-hoc* group at Bkt. Lanchang in 2007.

17) *Output review 2010* – the output from this exercise using the AOO areas and % decade change in 11) to 14) above, and the review by the Expert Group at Paya Indah Wetlands in January 2010.

18) *criteria A* – red list criteria for change in population size.

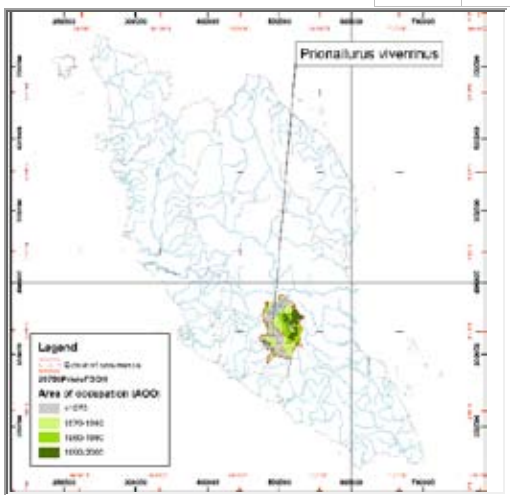
19) *criteria B* – red list criteria for change in the geographic range of the EOO or AOO of the species

20) *criteria C* – red list criteria for population size estimates and population trends

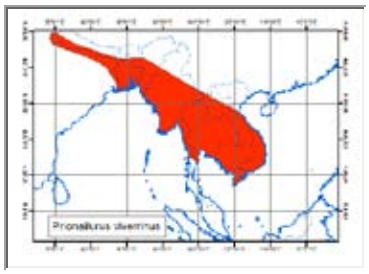
1) family:	2)genus	3)species:
Felidae	*Prionailurus*	*viverrinus*

4)common name	5)malay name:
Fishing cat	Kucing ikan

8)distribution in Peninsular Malaysia — 6)code: 20708 208 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	367,956	
11)AOO 80:	222,980	
12)AOO 90:	122,010	-45.28%
13)AOO 00:	64,261	-47.33%

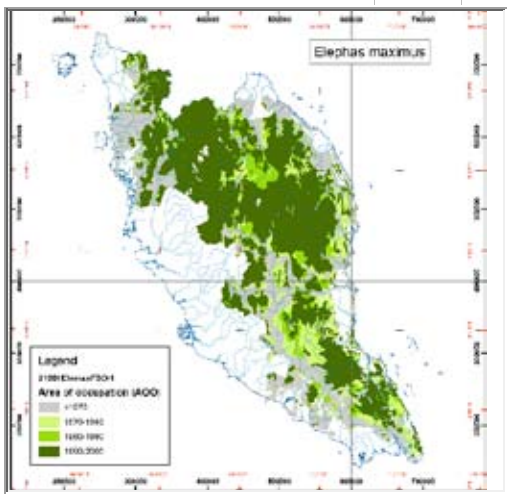
14)IUCN2009: EN A2cd+4cd

	15)Output review 2007:	16)Output review 2009:
17)criteria A:		VU A4c
18)criteria B		VU B2ab(ii,iii)
19)criteria C:		
20)criteria D	dd	

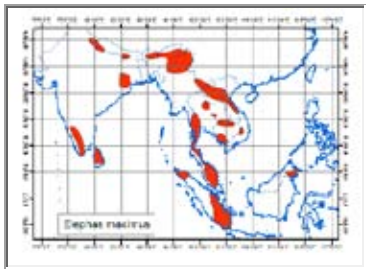
1) family:	2)genus	3)species:
Elephantidae	*Elephas*	*maximus*

4)common name	5)malay name:
Asian elephant	Gajah

8)distribution in Peninsular Malaysia — 6)code: 21001 209 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	9,610,714	
11)AOO 80:	6,568,122	
12)AOO 90:	5,488,637	-16.44%
13)AOO 00:	4,800,745	-12.53%

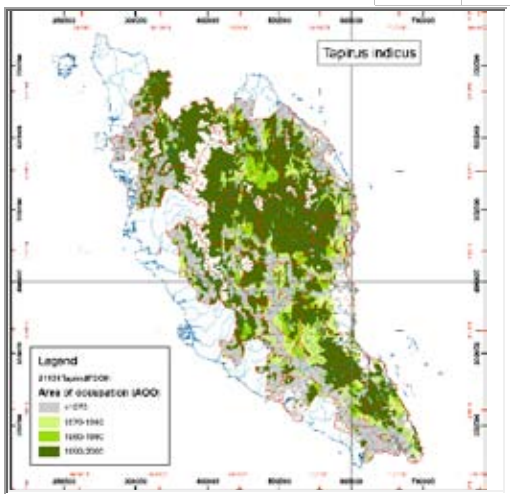
14)IUCN2009: EN A2c

	15)Output review 2007:	16)Output review 2009:
17)criteria A:		VU A4cd
18)criteria B		LC
19)criteria C:	En C2 a(ii)	
20)criteria D	n	

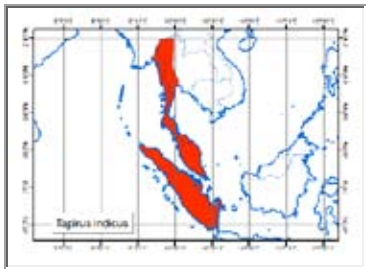
1) family:	2)genus	3)species:
Tapiridae	*Tapirus*	*indicus*

4)common name	5)malay name:
Malayan tapir	Badak cipan

8)distribution in Peninsular Malaysia — 6)code: 21101 210 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	10,189,952	
11)AOO 80:	6,375,614	
12)AOO 90:	5,230,739	-17.96%
13)AOO 00:	4,499,959	-13.97%

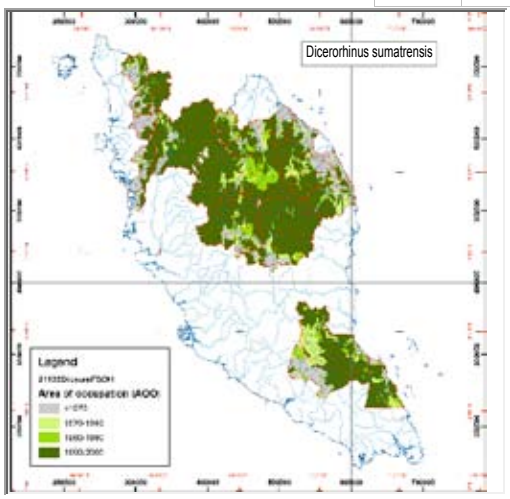
14)IUCN2009:

	15)Output review 2007:	16)Output review 2009:
17)criteria A:	EN A1	NT
18)criteria B	EN B2 ac(?)	LC
19)criteria C:		
20)criteria D	n	

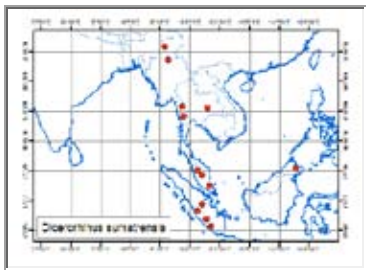
1) family:	2)genus	3)species:
Rhinocerotidae	*Dicerorhinus*	*sumatrensis*

4)common name	5)malay name:
Sumatran Rhinoceros	Badak kerbau

8)distribution in Peninsular Malaysia — 6)code: 21102 211 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	5,845,936	
11)AOO 80:	4,856,833	-11.76%
12)AOO 90:	4,285,890	-9.94%
13)AOO 00:	3,859,750	

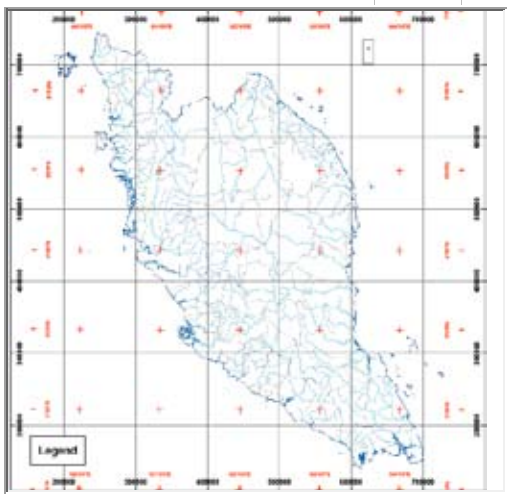
14)IUCN2009: A2abd; C1+2a(i

	15)Output review 2007:	16)Output review 2009:
17)criteria A:	CR A1bcd	
18)criteria B	dd	LC
19)criteria C:	CR C2 a(?)	CR C2a(i)
20)criteria D	dd	

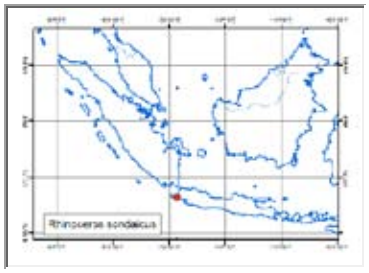
1) family:	2)genus	3)species:
Rhinocerotidae	*Rhinoceros*	*sondaicus*

4)common name	5)malay name:
Javan rhinoceros	Badak raya

8)distribution in Peninsular Malaysia — 6)code: 21102 212 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:		
11)AOO 80:		
12)AOO 90:		0.00%
13)AOO 00:		0.00%

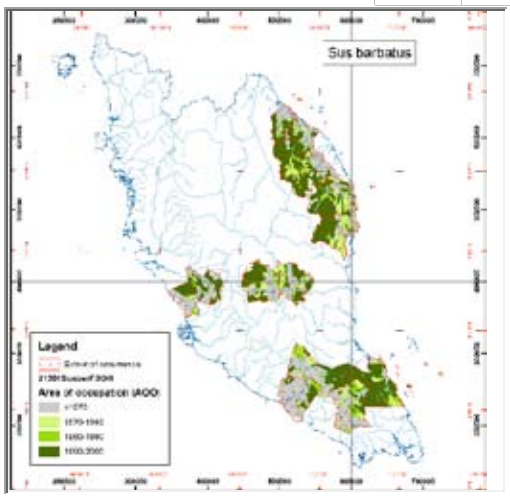
14)IUCN2009: CR C2a(i)

	15)Output review 2007:	16)Output review 2009:
17)criteria A:	EX	EX
18)criteria B	EX	EX
19)criteria C:	EX	EX
20)criteria D	EX	EX

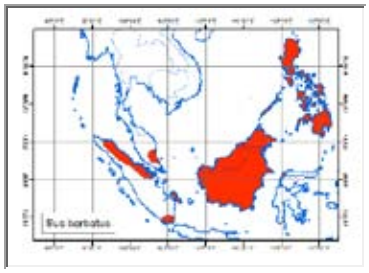
1) family:	2)genus	3)species:
Suidae	*Sus*	*barbatus*

4)common name	5)malay name:
Bearded pig	Babi bodoh

8)distribution in Peninsular Malaysia — 6)code: 21301 213 x



7)regional distribution:



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	3,013,855	
11)AOO 80:	1,911,513	-22.88%
12)AOO 90:	1,474,150	-13.04%
13)AOO 00:	1,281,883	

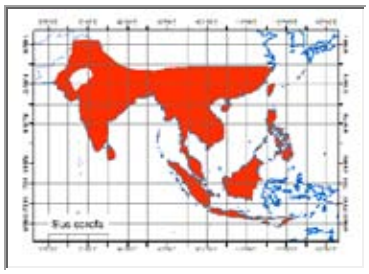
14)IUCN2009:

	15)Output review 2007:	16)Output review 2009:
17)criteria A:	VU A1cd	NT
18)criteria B	VU B2 ab(?)	LC
19)criteria C:		
20)criteria D	n	

1) family:	2)genus	3)species:	7)regional distribution:
Suidae	*Sus*	*scrofa*	

4)common name	5)malay name:
Common wild pig	Babi hutan

8)distribution in Peninsular Malaysia — 6)code: 21301 214 x



9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	12,200,225	
11)AOO 80:	12,200,225	0.00%
12)AOO 90:	12,200,225	0.00%
13)AOO 00:	12,200,225	0.00%

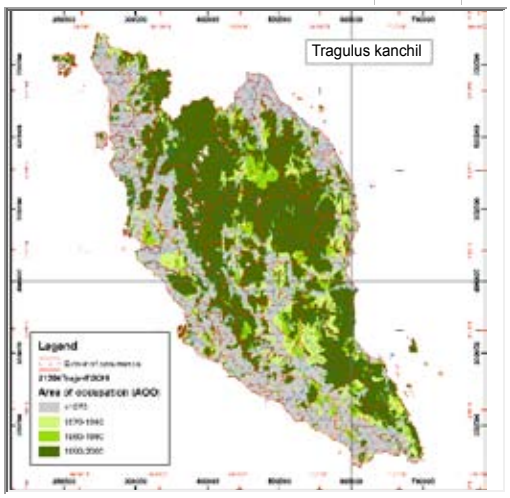
14)IUCN2009:

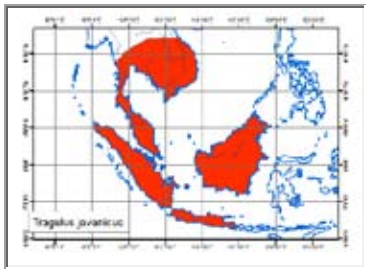
	15)Output review 2007:	16)Output review 2009:
17)criteria A:		
18)criteria B		LC
19)criteria C:		
20)criteria D	lc	

1) family:	2)genus	3)species:	7)regional distribution:
Tragulidae	*Tragulus*	*kanchil*	

4)common name	5)malay name:
Lesser mouse deer	Kancil

8)distribution in Peninsular Malaysia — 6)code: 21304 215 x





9)Review 2009 (area in ha.):

		14)% decade change
10)EOO:	13,211,673	
11)AOO 80:	8,714,428	-17.28%
12)AOO 90:	7,208,335	-13.70%
13)AOO 00:	6,220,697	

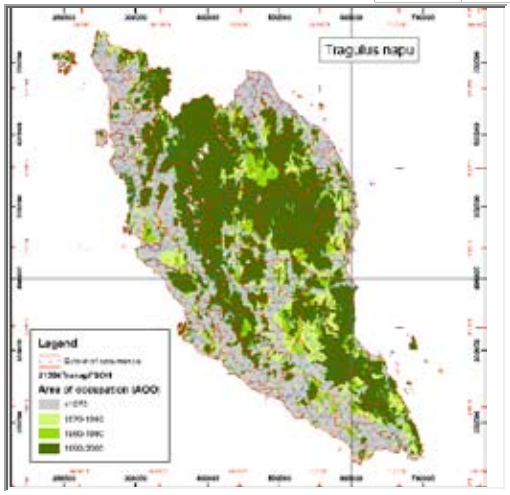
14)IUCN2009:

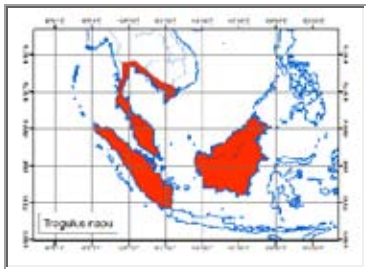
	15)Output review 2007:	16)Output review 2009:
17)criteria A:		
18)criteria B		LC
19)criteria C:		
20)criteria D	lc	

1) family:	2)genus	3)species:	7)regional distribution:
Tragulidae	*Tragulus*	*napu*	

4)common name	5)malay name:
Large mouse deer	Napuh

8)distribution in Peninsular Malaysia — 6)code: 21304 216 x





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18)criteria B		LC
19)criteria C:		
20)criteria D	lc	